RECLAMATION
Managing Water in the West

Coordinated Long-Term Operation of the Central Valley Project and State Water Project

Mid-Pacific Region
Bay-Delta Office

Final Environmental Impact Statement

U.S. Department of the Interior
Bureau of Reclamation

November 2015

Mission Statements

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to 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.

Executive Summary

ES.1 Introduction

This Environmental Impact Statement (EIS) for the Coordinated Long-Term Operation of the Central Valley Project (CVP) and State Water Project (SWP) has been prepared by the Department of the Interior, Bureau of Reclamation (Reclamation). Reclamation is the Federal lead agency for compliance with the National Environmental Policy Act (NEPA) and is completing the EIS as ordered by the United States District Court for the Eastern District of California (District Court). In 2008 and 2009, following litigation on previous Biological Opinion (BOs), Reclamation provisionally accepted and began implementing the BOs on continued long-term operation of the CVP, in coordination with the operation of the SWP issued by the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS), respectively, pursuant to the Federal Endangered Species Act of 1973 (ESA) as amended (United States Code [U.S.C.] 1531 et. seq.). In 2014, the Ninth Circuit upheld the District Court's ruling that Reclamation's provisional acceptance and implementation of the BOs required Reclamation to comply with NEPA. The District Court remanded Reclamation's decision back to the agency to comply with the court's ruling.

The EIS evaluates potential long-term direct, indirect, and cumulative impacts on the environment that could result from implementation of modifications to the continued long-term operation of the CVP and SWP.

ES.2 Background

ES.2.1 Central Valley Project

The first Federal action authorizing the CVP was by the Rivers and Harbors Act of August 30, 1935. The CVP was reauthorized for construction, operation, and maintenance by the Secretary of the Department of the Interior (Secretary), pursuant to the Reclamation Act of 1902, as amended and supplemented (the Federal Reclamation laws), and by the Rivers and Harbors Act of August 26, 1937. In 1992, the Central Valley Project Authorization Act of August 26, 1937 was amended by Section 3406(a) of the Central Valley Project Improvement Act (CVPIA), Public Law 102-575. (http://www.usbr.gov/history/cvpintro.html)

The CVP is composed of 20 reservoirs with a combined storage capacity of more than 11 million acre-feet, over 10 hydroelectric powerplants, and more than 500 miles of major canals and aqueducts. The major CVP facilities are located in the Sacramento-San Joaquin Rivers Delta Estuary (Delta) watershed including:

- **Major Reservoirs:** Trinity Lake (Trinity River), Whiskeytown Lake (Clear Creek); Shasta Lake (Sacramento River), Folsom Lake (American River), New Melones Reservoir (Stanislaus River), portions of the San Luis Reservoir complex (local drainages), and Millerton Lake (San Joaquin River).
- **Major Pumping Plants and Conveyance Facilities**: Red Bluff Pumping Plant (diverts water from Sacramento River into CVP Tehama-Colusa Canal), Folsom South Canal (diverts water from Folsom Lake to portions of Sacramento County), Contra Costa Canal Pumping Plant (diverts water from the Delta into CVP Contra Costa Canal), C.W. "Bill" Jones Pumping Plant (diverts water from the Delta into CVP Delta-Mendota Canal), Clear Creek Tunnel (conveys water from Trinity Lake to Whiskeytown Lake), Pacheco Tunnel and Conduit (conveys water from San Luis Reservoir to Santa Clara and San Benito counties), and Friant Kern and Madera canals (convey water from Millerton Lake to the eastern San Joaquin Valley).

These facilities are operated as an integrated project, although they are authorized and categorized in distinct units or divisions.

ES.2.2 State Water Project

The State Legislature appropriated funds to the California Department of Water Resources (DWR) to construct the SWP under the State Central Valley Project Act (Water Code section 11100 et seq.), Burns-Porter Act (California Water Resources Development Bond Act), State Contract Act (Public Contract Code section 10100 et seq.), Davis-Dolwig Act (Water Code sections 11900 - 11925), and other acts of the State Legislature.

Major SWP facilities include:

- **Reservoirs:** Lake Oroville and the Thermalito Complex (Feather River); Antelope Lake, Lake Davis, and Frenchman Lake (upper Feather River upstream of Lake Oroville); portions of the San Luis Reservoir complex (local drainages); reservoirs located downstream of San Luis Reservoir along the California Aqueduct and other SWP conveyance facilities (Quail Lake, Pyramid Lake, Castaic Lake, Silverwood Lake, Crafton Hills Reservoir, and Lake Perris).
- **Major Pumping Plants and Conveyance Facilities**: Barker Slough Pumping Plant (diverts water into SWP North Bay Aqueduct); Clifton Court Forebay and Harvey O. Banks Pumping Plant (diverts water from the Delta into SWP South Bay Aqueduct and the SWP California Aqueduct); California Aqueduct and associated pumping plants (convey water to the San Joaquin Valley, San Luis Obispo and Santa Barbara counties along the central coast, and southern California); Coastal Branch of the California Aqueduct (conveys

water to San Luis Obispo and Santa Barbara counties); and East Branch and West Branch (convey water to Southern California).

ES.2.3 Coordinated Operation of the CVP and SWP

The CVP and SWP are operated in a coordinated manner in accordance with Public Law 99-546 (October 27, 1986), directing the Secretary to execute the Coordinated Operation Agreement (COA). The CVP and SWP are also operated under State Water Resources Control Board (SWRCB) decisions and water right orders related to the CVP's and SWP's water right permits and licenses to appropriate water by diverting to storage, by directly diverting to use, or by re-diverting releases from storage later in the year or in subsequent years.

The CVP and SWP are permitted by SWRCB to store water, divert water and re-divert CVP and SWP water that has been stored in upstream reservoirs. The CVP and SWP have built water storage and water delivery facilities in the Central Valley to deliver water supplies to CVP and SWP contractors, including senior water users. The CVP's and SWP's water rights are conditioned by the SWRCB to protect the beneficial uses of water within the watersheds.

As conditions of the water right permits and licenses, SWRCB requires the CVP and SWP to meet specific water quality objectives within the Delta. Reclamation and DWR coordinate operation of the CVP and SWP, pursuant to the COA, to meet these and other operating requirements. The COA is an agreement between the Federal government and the State of California for the coordinated operation of the CVP and SWP.

Implementation of the COA has evolved continually since 1986 as CVP and SWP facilities, operational criteria, and physical and regulatory environment have changed. For example, adoption of the CVPIA in 1992 changed the purposes and operations of the CVP, and ESA responsibilities have affected operation of the CVP and SWP. DWR and Reclamation have operational arrangements to accommodate new facilities, water quality objectives, the CVPIA, other SWRCB criteria, and the ESA, but the COA has not been formally modified to address these newer operating conditions.

ES.2.4 Federal Endangered Species Consultation

The following species and their critical habitat listing rules were considered in recent ESA consultations with the USFWS and NMFS for the coordinated long-term operation of the CVP and SWP and in the analyses in this EIS.

- The Sacramento River winter-run Chinook Salmon (*Oncorhynchus tshawytscha*) evolutionarily significant unit (ESU) was originally listed as threatened in August 1989, under emergency provisions of the ESA, and formally listed as threatened in November 1990 (55 Federal Register (FR) 46515). They were re-classified as an endangered species on January 4, 1994 (59 FR 440).
- Central Valley spring-run Chinook Salmon (*O. tshawytscha*) ESU was listed as threatened on June 18, 2005 (70 FR 37160).

- The Central Valley Steelhead (*O. mykiss*) distinct population segment (DPS) was listed as threatened on January 5, 2006 (71 FR 834).
- Southern Oregon/Northern California Coast Coho Salmon (*O. kisutch*) ESU was listed as threatened on June 18, 2005 (70 FR 37160).
- Southern DPS of the North American Green Sturgeon (*Acipenser medirostris*) was listed as threatened on June 6, 2006 (71 FR 17757).
- The Southern Resident DPS of Killer Whales (*Orcinus orca*) was listed as endangered on November 18, 2005 (NMFS 2005).
- The Delta Smelt (*Hypomesus transpacificus*) was listed as threatened on March 5, 1993 (58 FR 12854). The species was recently proposed for re-listing as endangered under the ESA.

Fall and late-fall runs of Chinook Salmon are currently Federal Species of Concern, but have not been formally listed.

The Central California Coast Steelhead (*O. mykiss*) DPS was listed as threatened on January 5, 2006 (71 FR 834). The 2009 NMFS BO determined that the long-term operation of the CVP and SWP would not likely adversely affect Central California Coast Steelhead DPS and its critical habitat. Therefore, no further analysis of this DPS was performed and addressed in this EIS.

ES.2.4.1 Recent ESA Consultation Activities and Court Rulings

In August 2008, Reclamation submitted a biological assessment (BA) to the USFWS and NMFS to initiate formal consultation. BO's were issued by the USFWS (December 15, 2008) and NMFS (June 4, 2009) with separate Reasonable and Prudent Alternative (RPA) actions to allow CVP and SWP to continue operating without causing jeopardy to listed species or adverse modification to designated critical habitat. Reclamation provisionally accepted and began implementing the two BOs with the RPAs.

Several lawsuits were filed in the District Court challenging aspects of the 2008 USFWS BO and the 2009 NMFS BO and Reclamation's acceptance and implementation of the associated RPAs. Many of the lawsuits consolidated into two proceedings focused on each BO. The outcomes of the *Consolidated Delta Smelt Cases* and the *Consolidated Salmonid Cases* are summarized below.

- *Consolidated Delta Smelt Cases*
  - On November 16, 2009, the District Court ruled that Reclamation violated NEPA by failing to conduct a NEPA review of the potential impacts to the human environment before provisionally accepting and implementing the 2008 USFWS BO, including the RPA.
  - On December 14, 2010, the District Court found certain portions of the 2008 USFWS BO to be arbitrary and capricious in several respects, and remanded those portions of the BO to the USFWS without vacatur for further consideration. The District Court ordered Reclamation to review

  its decision to provisionally accept and implement the BO and RPA in accordance with NEPA.

  - The decision of the District Court related to the USFWS BO was appealed to the United States Court of Appeals for the Ninth Circuit (Appellate Court). On March 13, 2014, the Appellate Court reversed the District Court decision and upheld the BO. However, the Appellate Court affirmed the judgment of the District Court with respect to the NEPA claims.
  - The District Court amended the Judgement on September 30, 2014 consistent with the Appellate Court's decision. Petitions for Writ of Certiorari were submitted to the U.S. Supreme Court; however, the U.S. Supreme Court decided to not hear the cases.

- *Consolidated Salmonid Cases*
  - On March 5, 2010, the District Court ruled that Reclamation violated NEPA by failing to undertake a NEPA analysis of potential impacts to the human environment before provisionally accepting and implementing the 2009 NMFS BO and RPA.
  - On September 20, 2011, the District Court found the 2009 NMFS BO was arbitrary and capricious in several respects, and remanded the 2009 NMFS BO without vacatur for further consideration.
  - The decisions of the District Court related to the 2009 NMFS BO were appealed to the Appellate Court. On December 22, 2014, the Appellate Court reversed the District Court decision and upheld the BO.
  - The District Court issued the Final Order on May 5, 2015 consistent with the Appellate Court's Decision.

ES.3 Need to Prepare this Environmental Impact Statement

To comply with the District Court's 2010 orders regarding NEPA for the coordinated long-term operation of the CVP and SWP, Reclamation initiated preparation of this EIS in 2011. This EIS documents Reclamation's analysis of the effects of modifications to the coordinated long-term operation of the CVP and SWP that are likely to avoid jeopardy to listed species and destruction or adverse modification of designated critical habitat.

In accordance with the October 1, 2014, District Court's order in the *Consolidated Delta Smelt Cases*, the Final EIS and Record of Decision are to be completed on or before December 1, 2015. By order dated October 8, 2015, this date has been extended to January 12, 2016.

Many of the provisions of the RPAs, as set forth in the 2008 USFWS BO and the 2009 NMFS BO, require further study, monitoring, consultation, implementation of adaptive management programs, and subsequent environmental documentation for future facilities to be constructed or modified. Specific actions related to these provisions are not known at this time. Therefore, this EIS assumes the completion of future actions, including provisions of the RPAs, in a manner that would be consistent with ESA and does not address impacts during construction or start-up phases of these actions.

ES.4 Use of the Environmental Impact Statement

This EIS may be used by Reclamation or cooperating agencies that are participating in the preparation of this EIS to inform future decisions related to operation of the CVP and SWP, and implementation of the RPAs in the 2008 USFWS BO and 2009 NMFS BO.

ES.5 Purpose and Need

NEPA regulations require a statement regarding "the underlying purpose and need to which the agency is responding in proposing the alternatives, including the proposed action" (40 Code of Federal Regulations (CFR) 1502.13).

ES.5.1 Purpose of the Action

The purpose of the action considered in this EIS is to continue the operation of the CVP in coordination with operation of the SWP, for its authorized purposes, in a manner that:

- Is similar to historic operational parameters with certain modifications;
- Is consistent with Federal Reclamation law; other Federal laws and regulations; Federal permits and licenses; State of California water rights, permits, and licenses; and
- Enables Reclamation and DWR to satisfy their contractual obligations to the fullest extent possible.

ES.5.2 Need for the Action

Continued operation of the CVP is needed to provide river regulation, navigation; flood control; water supply for irrigation and domestic uses; fish and wildlife mitigation, protection, and restoration; fish and wildlife enhancement; and power generation. The CVP and the SWP facilities are also operated to provide recreation benefits and in accordance with the water rights and water quality requirements adopted by the SWRCB.

The USFWS and NMFS concluded in their 2008 and 2009 BOs, respectively, that the coordinated long-term operation of the CVP and SWP, as described in the 2008 Reclamation BA, jeopardized the continued existence of listed species and adversely modified critical habitat. To remedy this, the USFWS and NMFS provided RPAs in their respective BOs.

The Appellate Court confirmed the District Court ruling that Reclamation must conduct a NEPA review to determine whether the provisional acceptance and implementation of the RPA actions cause a significant effect to the human environment.

ES.6 Project Area

The project area boundaries are defined by the locations of most of the CVP facilities and their service areas; and all of the SWP facilities and the SWP service areas. The CVP facilities associated with Millerton Lake, including the Madera and Friant-Kern canals and their service areas, and the San Joaquin River Restoration Program are not part of the project area for this EIS because the operations of these facilities were not addressed in either the 2008 USFWS BO or 2009 NMFS BO.

ES.7 Study Period

The coordinated long-term operation of the CVP and SWP, as described in this EIS, would continue to at least 2030 before CVP and SWP operations would change. These changes could include projects considered as part of the cumulative effects analyses. Therefore, the EIS analyzes future conditions projected for the Year 2030. It is recognized that many changes between existing conditions and 2030 would occur without changes to CVP and SWP operations, including local land use decisions, implementation of new water management facilities, and climate change.

As the changing conditions described above and other future changes occur, changes in long-term operation of the CVP and SWP may be required. This may require the re-initiation of consultation on the 2008 USFWS BO and 2009 NMFS BO. Therefore, because the above-described changes in conditions are likely to occur by 2030 and because new BOs would be required, this EIS considers a study period that concludes in 2030.

ES.8 Proposed Action and Preferred Alternative

The Notice of Intent to prepare this EIS was published in March 2012 identified an “initial Proposed Action” that included the operational actions of the 2008 USFWS BO and 2009 NMFS BO, without structural changes included in the RPA actions that would require future studies and environmental documentation to define recommended actions, including fish passage around the CVP dams. The initial Proposed Action is included in this EIS as Alternative 2.

Based upon the analysis in this EIS of aquatic resources by 2030, climate change may result in substantially higher air temperatures than during recent conditions. Higher air temperatures would likely increase water temperatures in both the CVP reservoirs and in the rivers downstream of the CVP dams. Under these conditions, Reclamation may not be able to operate the reservoirs under the initial Proposed Action without fish passage in a manner that would meet water temperature objectives; and it may not be possible to avoid jeopardizing the continued existence of listed species and/or resulting in an adverse modification of critical habitat.

Based upon the results of the impact analyses presented in this EIS, the Preferred Alternative is the No Action Alternative. The No Action Alternative contains all of the RPA actions in the 2008 USFWS BO and 2009 NMFS BO, as amended, including the RPA actions to evaluate fish passage to upstream habitats that exhibit lower water temperatures. Further discussion of the selection of the Preferred Alternative will be included in the Record of Decision.

The Environmentally Preferred Alternative also will be identified and disclosed in the Record of Decision, as required by the Council of Environmental Quality regulations.

ES.9 Summary Description of Alternatives

Identification of the No Action Alternative and the range of alternatives for this EIS were developed to respond to the purpose and need for the action and to comments received during the scoping process and preparation of the EIS.

Twenty-three alternative concepts were identified during the scoping process and through meetings with stakeholders and agencies during preparation of this EIS. The alternative concepts were compared to screening criteria that were developed based on the purpose of the action. The alternative concepts were also reviewed to determine if they addressed substantial issues. Based upon the comparison of screening criteria to the alternative concepts, 17 of the 23 alternative concepts were identified to be included in one or more of the alternatives evaluated in this EIS. The alternative concepts were combined into five specific alternatives that were consistent with assumptions for the year 2030. Further development of the alternatives was informed by subsequent comments received during preparation of the EIS.

All of the alternatives, including the No Action Alternative, include the same assumptions related to (1) climate change and sea level rise in Year 2030, and (2) development throughout California in accordance with existing general plans, existing contracts, and implementation of reasonable and foreseeable water resources management projects.

ES.9.1 Inclusion of the Second Basis of Comparison

The No Action Alternative is defined as the projections of current conditions and trends into the future without implementation of the alternatives. These projected conditions are defined in Question 3 of the Council on Environmental Quality (CEQ) Forty Most Asked Questions as "'no change' from current management direction or level of management intensity." The No Action Alternative also can be defined as “no project” in cases where a new project is proposed for implementation. However, all of the alternatives evaluated in this EIS are to continue the coordinated long-term operation of the CVP and SWP. Therefore, the definition of the No Action Alternative used for this EIS is continuation of the current management direction and level of intensity.

For this EIS, the No Action Alternative is based upon the continued operation of the CVP and SWP in the same manner as was occurring at the time of the publication of the Notice of Intent in March 2012. Thus, the No Action Alternative consists of the coordinated long-term operation of the CVP and SWP, including full implementation of the RPAs in the 2008 USFWS BO and 2009 NMFS BO, because Reclamation provisionally accepted the BOs in 2008 and 2009, respectively, began implementing the RPAs, and continues to implement the RPAs to date. The No Action Alternative also includes changes not related to the long-term operation of the CVP and SWP or implementation of the RPAs in the 2008 USFWS BO and 2009 NMFS BO.

Numerous scoping comments requested that the No Action Alternative not include the RPAs in the 2008 USFWS BO and 2009 NMFS BO because, at that time, the District Court had remanded the BOs back to USFWS and NMFS. The comments indicated that the EIS should include a “basis of comparison” for the alternatives that was similar to conditions prior to implementation of the RPAs. Scoping comments also indicated that a ”No Action Alternative scenario” without implementation of the RPAs in the 2008 USFWS BO and 2009 NMFS BO could be used to analyze the effects of implementing the RPAs.

Determining an appropriate baseline without the 2008 USFWS BO and 2009 NMFS BO actions and yet continuing to meet all of Reclamation’s statutory and regulatory requirements is a difficult task. Simply analyzing a No Action Alternative that is similar to the project description described in either the 2004 Biological Assessment or 2008 Biological Assessment is insufficient, as each was found to jeopardize listed species, the 2004 Biological Assessment by the District Court in 2007, and the 2008 Biological Assessment by USFWS and NMFS. Either of these operations would be inconsistent with Reclamation’s existing policy and management direction.

Because the RPAs were provisionally accepted and the No Action Alternative represents a continuation of existing policy and management direction, the No Action Alternative includes the RPAs. However, in response to scoping comments and subsequent comments from stakeholders and interest groups, and to provide a basis for comparison of the effects of implementation of the RPAs (per the District Court’s mandate), this EIS includes a “Second Basis of Comparison” that represents a condition in 2030 without implementation of the 2008 USFWS BO and 2009 NMFS BO. All of the alternatives are compared to the No Action Alternative and to the Second Basis of Comparison to describe the effects that could occur in 2030 under both bases of comparison.

Several of the 2008 USFWS BO RPA and 2009 NMFS BO RPA actions had been initiated prior to issuance of the 2009 NMFS BO; those actions are included in the

Second Basis of Comparison. Reasonably foreseeable actions included in the No Action Alternative that are not related to the 2008 USFWS BO or 2009 NMFS BO are also included in the Second Basis of Comparison.

ES.9.2 No Action Alternative

The definition of the No Action Alternative is based upon the following assumptions.

- Continued long-term operation of the CVP and SWP in accordance with ongoing management policies, criteria, and regulations, including water right permits and licenses issued by the SWRCB; and operational requirements of the 2008 USFWS BO and the 2009 NMFS BO.
- Implementation of existing and future actions described in the 2008 USFWS BO and 2009 NMFS BO that would occur by 2030 without implementation of the BOs, including:
  - 2008 USFWS BO RPA Component 4, Habitat Restoration and 2009 NMFS BO RPA Action I.6.1, Restoration of Floodplain Habitat; and Action I.6.2, Near-Term Actions at Liberty Island/Lower Cache Slough and Lower Yolo Bypass; Action I.6.3, Lower Putah Creek Enhancements; Action I.6.4, Improvements to Lisbon Weir; and Action I.7, Reduce Migratory Delays and Loss of Salmon, Steelhead, and Sturgeon at Fremont Weir and Other Structures in the Yolo Bypass - Restoration of more than 10,000 acres of intertidal and associated subtidal wetlands in Suisun Marsh and Cache Slough; and at least 17,000 to 20,000 acres of seasonal floodplain restoration in Yolo Bypass.
  - 2009 NMFS BO RPA Action I.1.3, Clear Creek Spawning Gravel Augmentation - Gravel augmentation in Clear Creek in addition to several gravel augmentation programs in the Sacramento Valley watershed being implemented in accordance with CVPIA.
  - 2009 NMFS BO RPA Action I.1.4, Spring Creek Temperature Control Curtain Replacement - Replacement of the Spring Creek Temperature Control Curtain.
  - 2009 NMFS BO RPA Action I.2.6, Restore Battle Creek for Winter-Run, Spring-Run, and Central Valley Steelhead - Habitat restoration of Battle Creek.
  - 2009 NMFS BO RPA Action I.3.1, Operate Red Bluff Diversion Dam with Gates Out - Implementation of Red Bluff Pumping Plant.
  - 2009 NMFS BO RPA Action I.5, Funding for CVPIA Anadromous Fish Screen Program - Implementation of the CVPIA Anadromous Fish Screen Program.
  - 2009 NMFS BO RPA Action II.1, Lower American River Flow Management - Implementation of the American River Flow Management Standard.

- Implementation of existing and future actions not described in the 2009 NMFS BO that would occur by 2030 without implementation of any alternatives considered in this EIS, including:
  - Trinity River Restoration Program.
  - Clear Creek Mercury Abatement and Fisheries Restoration Project.
  - Iron Mountain Mine Superfund Site cleanup.
  - Mainstem Sacramento River and American River Gravel Augmentation Programs.
  - Nimbus Fish Hatchery Fish Passage Project.
  - Folsom Dam Water Control Manual Update.
  - FERC Relicensing for Middle Fork of the American River Project.
  - Lower Mokelumne River Spawning Habitat Improvement Project.
  - Dutch Slough Tidal Marsh Restoration.
  - Suisun Marsh Habitat Management, Preservation, and Restoration Plan Implementation.
  - Tidal Wetland Restoration in the Delta and Suisun Marsh.
  - San Joaquin River Restoration Program.
  - Stockton Deep Water Ship Channel Demonstration Dissolved Oxygen Project.
  - Grasslands Bypass Project.
  - Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS).
  - Municipal Water Supply Projects identified in Urban Water Management Plans that have undergone environmental review and are reasonably foreseeable.
  - Water Transfer Projects.

ES.9.3 Second Basis of Comparison

The definition of the Second Basis of Comparison is based upon the following assumptions.

- Continued long-term operation of the CVP and SWP in accordance with ongoing management policies, criteria, and regulations, including water right permits and licenses issued by the SWRCB without implementation of the 2008 USFWS BO and the 2009 NMFS BO.
- Implementation of existing and future actions that would occur by 2030 without implementation of the BOs, including actions that have already been constructed or have substantial progress:

- Restoration of more than 10,000 acres of intertidal and associated subtidal wetlands in Suisun Marsh and Cache Slough; and at least 17,000 to 20,000 acres of seasonal floodplain restoration in Yolo Bypass (as being implemented under a separate program adopted in 2014, Suisun Marsh Habitat Management, Preservation, and Restoration Plan, and referenced in 2008 USFWS BO RPA Component 4, Habitat Restoration; and as being developed under Yolo Bypass Salmonid Habitat Restoration and Fish Passage Implementation Plan and referenced in 2009 NMFS BO RPA Action I.6.1, Restoration of Floodplain Habitat; and Action I.6.2, Near-Term Actions at Liberty Island/Lower Cache Slough and Lower Yolo Bypass; Action I.6.3, Lower Putah Creek Enhancements; Action I.6.4, Improvements to Lisbon Weir; and Action I.7, Reduce Migratory Delays and Loss of Salmon, Steelhead, and Sturgeon at Fremont Weir and Other Structures in the Yolo Bypass).
- Gravel augmentation in the Sacramento Valley and Stanislaus River watershed (as being implemented under a separate program and including program under CVPIA and referenced in 2009 NMFS BO RPA Action I.1.3, Clear Creek Spawning Gravel Augmentation).
- Replacement of the Spring Creek Temperature Control Curtain (as was constructed and placed into operation in 2011 and referenced in 2009 NMFS BO RPA Action I.1.4, Spring Creek Temperature Control Curtain Replacement).
- Habitat restoration of Battle Creek (as being implemented under a separate program and referenced in 2009 NMFS BO RPA Action I.2.6, Restore Battle Creek for Winter-Run, Spring-Run, and Central Valley Steelhead).
- Implementation of Red Bluff Pumping Plant (as was constructed and placed into operation in 2012 and referenced in 2009 NMFS BO RPA Action I.3.1, Operate Red Bluff Diversion Dam with Gates Out).
- Implementation of the CVPIA Anadromous Fish Screen Program (as was initiated in the 1990s and referenced in 2009 NMFS BO RPA Action I.5, Funding for CVPIA Anadromous Fish Screen Program).
- Implementation of the American River Flow Management Standard (as was initiated in 2006 and referenced in 2009 NMFS BO RPA Action II.1, Lower American River Flow Management).
- Trinity River Restoration Program.
- Clear Creek Mercury Abatement and Fisheries Restoration Project.
- Iron Mountain Mine Superfund Site cleanup.
- Mainstem Sacramento River and American River Gravel Augmentation Programs.
- Nimbus Fish Hatchery Fish Passage Project.
- FERC Relicensing for Middle Fork of the American River Project.

  - Lower Mokelumne River Spawning Habitat Improvement Project.
  - Dutch Slough Tidal Marsh Restoration.
  - Tidal Wetland Restoration in the Delta and Suisun Marsh.
  - San Joaquin River Restoration Program.
  - Stockton Deep Water Ship Channel Demonstration Dissolved Oxygen Project.
  - Grasslands Bypass Project.
  - Municipal Water Supply Projects identified in Urban Water Management Plans that have undergone environmental review and are reasonably foreseeable.
  - Water Transfer Projects.

ES.9.4 Alternative 1

Alternative 1 was created because many comments requested an alternative that reflected conditions without implementation of the 2008 USFWS BO and the 2009 NMFS BO RPAs. Since the Second Basis of Comparison is not a true alternative, in accordance with NEPA guidelines, Reclamation could not select the Second Basis of Comparison as a preferred alternative. Therefore, Alternative 1 is identical to the Second Basis of Comparison.

ES.9.5 Alternative 2

Alternative 2 was first included in the Notice of Intent and identified as an initial proposed action that included the operational actions of the 2008 USFWS BO and 2009 NMFS BO. Alternative 2 does not include RPA actions that would require future studies and environmental documentation to define recommended actions (generally, structural actions). Therefore, Alternative 2 includes the assumptions in the No Action Alternative except:

- 2009 NMFS BO RPA Action I.2.5, Winter-Run Passage and Re-Introduction Program at Shasta Dam.
- 2009 NMFS BO RPA Action II.3, Structural Improvements for Temperature Management on the American River.
- 2009 NMFS BO RPA Action II.5, Fish Passage at Nimbus and Folsom Dams.
- 2009 NMFS BO RPA Action II.6, Implement Actions to Reduce Genetic Effects of Nimbus and Trinity River Fish Hatchery Operations.
- 2009 NMFS BO RPA Action III.2.1, Increase and Improve Quality of Spawning Habitat with Addition of Gravel.
- 2009 NMFS BO RPA Action III.2.2, Conduct Floodplain Restoration and Inundation Flows in Winter or Spring to Inundate Steelhead Juvenile Rearing Habitat on Stanislaus River.

- 2009 NMFS BO RPA Action III.2.3, Restore Freshwater Migratory Habitat for Juvenile Steelhead on Stanislaus River.
- 2009 NMFS BO RPA Action III.2.4, Fish Passage at New Melones, Tulloch, and Goodwin Dams.
- 2009 NMFS BO RPA Action IV.4, Tracy Fish Collection Facility Improvements to Reduce Pre-Screen Loss and Improve Screening Efficiency.
- 2009 NMFS BO RPA Action IV.4.2 Skinner Fish Collection Facility Improvements to Reduce Pre-Screen Loss and Improve Screening Efficiency.
- 2009 NMFS BO RPA Action IV.4.3 Tracy Fish Collection Facility and the Skinner Fish Collection Facility Actions to Improve Salvage Monitoring, Reporting and Release Survival Rates.
- 2009 NMFS BO RPA Action V Fish Passage.

ES.9.6 Alternative 3

Alternative 3 was developed based upon a scoping comment from the Coalition for a Sustainable Delta, including actions related to their "RPA Alternative 1," and a scoping comment received from Oakdale Irrigation District (OID) and South San Joaquin Irrigation District (SSJID). The definition of Alternative 3 is based upon the following assumptions.

- Continued long-term operation of the CVP and SWP in accordance with ongoing management policies, criteria, and regulations, including water right permits and licenses issued by the SWRCB; without the operational requirements of the 2008 USFWS BO and the 2009 NMFS BO RPAs.
- Implementation of the 2012 operations plan for New Melones Reservoir proposed by OID and SSJID.
- Additional demands for American River water supplies for up to 17,000 acre-feet/year under a Warren Act contract for El Dorado Irrigation District and 15,000 acre-feet/year under a water service contract for El Dorado County Water Agency.
- Implementation of actions described in the scoping comments letter from the Coalition for a Sustainable Delta related to their "RPA Alternative 1."
    - The Old and Middle River (OMR) flow criteria under Alternative 3 are based on concepts addressed in the 2008 USFWS BO and 2009 NMFS BO related to adaptive restrictions for temperature, turbidity, salinity, and presence of Delta Smelt.
    - Flood control operations for the New Melones Reservoir would be the same as under the No Action Alternative. However, New Melones Reservoir would be operated for different fishery flows, water quality flows, and San Joaquin River base flows and pulse flows at Vernalis.

  - Implement predator control programs for Black Bass, Striped Bass, and Pikeminnow to protect salmonids and Delta Smelt, including establishment of new catch limits.
  - Restore or create at least 10,000 acres of tidally influenced seasonal or perennial wetlands (these conditions are the same as under the No Action Alternative and Second Basis of Comparison).
  - Establish a trap and haul program for juvenile salmonids entering the Delta from the San Joaquin River upstream of the Head of Old River in March through June with a release site near Chipps Island.
  - Modify ocean harvest limits for consistency with Viable Salmonid Population Standards; including harvest management plan to show that abundance, productivity, and diversity (age-composition) are not appreciably reduced.
- Implementation of future actions that would occur by 2030 without implementation of any alternatives considered in this EIS, as described above for the Second Basis of Comparison.

ES.9.7 Alternative 4

Alternative 4 was developed based upon a scoping comment from the Coalition for a Sustainable Delta, including actions related to their “RPA Alternative 2.” The definition of Alternative 4 is based upon the following assumptions.

- Continued long-term operation of the CVP and SWP in accordance with ongoing management policies, criteria, and regulations, including water right permits and licenses issued by the SWRCB; without the operational requirements of the 2008 USFWS BO and the 2009 NMFS BO, as described under Second Basis of Comparison.
- Implementation of actions described in the scoping comments letter from the Coalition for a Sustainable Delta related to their “RPA Alternative 2.”
  - Limit floodplain development to protect salmonids and Delta Smelt by incorporating guidance into flood hazard mapping to comply with ESA; prioritizing consideration of ESA listed species and critical habitats in flood insurance studies; refine community rating system to provide credits for natural and beneficial functions; prohibit new development and substantial improvements to existing development within any designated floodway or within 170 feet of the ordinary high water line of any floodway.
  - Modify the requirements of the U.S. Army Corps of Engineers related to removal of vegetation on levees to allow for the planting of trees and shrubs along the levees; and installation of vegetation, woody material, and root re-enforcement material on the levees instead of riprap for erosion protection.

  - Implement predator control programs for Black Bass, Striped Bass, and Pikeminnow to protect salmonids and Delta Smelt, including establishment of new catch limits.
  - Restore or create at least 10,000 acres of tidally influenced seasonal or perennial wetlands (these conditions are the same as under the No Action Alternative and Second Basis of Comparison).
  - Establish a trap and haul program for juvenile salmonids entering the Delta from the San Joaquin River upstream of the Head of Old River in March through June with a release site near Chipps Island.
  - Modify ocean harvest limits to reduce by-catch of winter-run and spring-run Chinook Salmon to less than 10 percent of age-3 cohort in all years.
- Implementation of future actions that would occur by 2030 without implementation of any alternatives considered in this EIS, as described above for the Second Basis of Comparison.

ES.9.8 Alternative 5

Alternative 5 was developed considering comments from environmental interest groups during the scoping process. Alternative 5 is similar to the No Action Alternative with reduced potential for reverse flows in April and May and with associated increased Delta outflow; and use of the SWRCB D-1641 pulse flow at Vernalis. The definition of Alternative 5 is based upon the following assumptions.

- Continued long-term operation of the CVP and SWP in accordance with ongoing management policies, criteria, and regulations, including water right permits and licenses issued by the SWRCB; including the requirements of the 2008 USFWS BO and the 2009 NMFS BO.
- The OMR flow criteria similar to the RPA criteria in the 2008 USFWS BO and 2009 NMFS BO plus a requirement for positive OMR (no reverse flows) in April and May of all water year types.
- New Melones Reservoir operations are similar to assumptions under the No Action Alternative except additional requirements were added to meet the SWRCB D-1641 April and May pulse flows at Vernalis on the San Joaquin River.
- Additional demands for American River water supplies for up to 17,000 acre-feet/year under a Warren Act Contract for El Dorado Irrigation District and 15,000 acre-feet/year under a water service contract for El Dorado County Water Agency.
- Implementation of future actions that would occur by 2030 without implementation of any alternatives considered in this EIS, as described above for the No Action Alternative.

ES.10 Impact Analysis

An EIS must evaluate the effects of implementation of the alternatives on the environment; and identify any adverse environmental effects which cannot be avoided, the relationship between short-term uses of the human environment and long-term productivity; and any irreversible or irretrievable commitments of resources if the alternatives are implemented. The impact analyses section of each resource chapter (Chapters 5 through 21 of the EIS) address direct, indirect, and cumulative effects of the alternatives as compared to the No Action Alternative and the Second Basis of Comparison in the following manner:

- Alternatives 1 through 5 are compared to the No Action Alternative.
- Alternatives 1 through 5 and the No Action Alternative are compared to the Second Basis of Comparison.

Potential mitigation measures are presented to the extent possible for each resource to avoid, minimize, rectify, reduce, eliminate, or compensate for adverse environmental effects of Alternatives 1 through 5 as compared to the No Action Alternative. Mitigation measures were not included to address adverse impacts under the alternatives as compared to the Second Basis of Comparison because this analysis was included in this EIS for information purposes only.

Tables ES.1 and ES.2 present summaries of the environmental changes of Alternatives 1 through 5 as compared to the No Action Alternative and the Second Basis of Comparison, respectively. These tables are located at the end of this Executive Summary.

These tables summarize the results of both the quantitative and qualitative impact analyses. The tables include relative quantitative differences for adverse impacts to provide a basis for consideration of mitigation measures. Differences in the quantitative analyses of 5 percent or less are considered to be “similar” because the modeling analyses are based on CalSim II model output which operates with monthly time steps. Therefore, it was determined that changes in the model of 5 percent or less were related to the uncertainties in the model processing.

Changes in surface water conditions are provided as a basis for identifying the impacts as described in Aquatic, Terrestrial, and Recreation resources. Therefore, no mitigation measures are presented for Surface Water Resources.

ES.11 Public Involvement and Next Steps

Public involvement was initiated with the scoping process on March 28, 2012, with the publication of the Notice of Intent in the Federal Register (FR) and continued through June 28, 2012. Initially, the public scoping process was to be completed on May 29, 2012. During the public scoping process, other agencies and interested persons requested an extension of the public scoping period to allow additional opportunities to provide scoping comments. In response to these requests, Reclamation published a notice on May 25, 2012, extending the public scoping period through June 28, 2012. Reclamation held five scoping meetings which were attended by 256 individuals. Scoping comments were used in the development of a reasonable range of alternatives and identification of key issues.

Reclamation also posted on its website an initial range of alternatives discussed at a stakeholders meeting on October 19, 2012. Several project status meetings were held with cooperating agencies and other stakeholders during preparation of the Draft EIS. Comments received during these processes were used to refine the description of the alternatives.

The Draft EIS was issued for public review in July 2015. Reclamation posted notification of the availability of the Public Draft EIS and the location and timing of four public meetings on its website, in the Federal Register, and through press releases. Approximately 860 written and verbal comments were received on the Draft EIS. All of the comments received on the Draft EIS were considered in preparation of the Final EIS. Written responses to all substantive comments received are included in Appendices 1A through 1E of the Final EIS.

Reclamation will make the Final EIS available for 30 days before finalizing the Record of Decision (ROD). In the ROD, which is the final step in the NEPA process, Reclamation will document its decision on which actions, if any, to take to address the primary objectives. Reclamation will also identify the Environmentally Preferred Alternative, describe other risk reduction plans it considered, identify any mitigation plans, and describe factors and comments taken into consideration when making its decision.

1 **Table ES.1 Comparison of Alternatives 1 through 5 to the No Action Alternative**

	Alternative 1 Compared to the No Action Alternative	Alternative 2 Compared to the No Action Alternative	Alternative 3 Compared to the No Action Alternative	Alternative 4 Compared to the No Action Alternative	Alternative 5 Compared to the No Action Alternative
Surface Water					
Trinity Lake	Water surface elevations similar. Storage similar or increased.	No change.	Water surface elevations similar. Storage similar or increased.	Water surface elevations similar. Storage similar or increased.	Water surface elevations similar. Storage similar or increased.
Trinity River at Lewiston Dam	Flows similar or increased.	No change.	Flows similar or increased.	Flows similar or increased.	Water surface elevations similar. Storage similar.
Shasta Lake	Water surface elevations similar. Storage similar or increased.	No change.	Water surface elevations similar. Storage similar or increased.	Water surface elevations similar. Storage similar or increased.	Water surface elevations similar. Storage similar.
Sacramento River at Keswick Dam	Flows similar or increased except reduced in September and November (up to 44%).	No change.	Flows similar or increased except reduced in September and November (up to 42%).	Flows similar or increased except reduced in September and November (up to 44%).	Flows similar.
Sacramento River at Freeport	Flows similar or increased except reduced in September and November (up to 47%).	No change.	Flows similar or increased except reduced in September and November (up to 48%).	Flows similar or increased except reduced in September and November (up to 47%).	Flows similar.
Clear Creek near Igo	Flows same except reduced in May (41%).	No change.	Flows same except reduced in May (29%).	Flows same except reduced in May (41%).	No change.
Lake Oroville	Water surface elevations similar. Storage reduced except in June (up to 22%).	No change.	Water surface elevations similar. Storage similar or increased.	Water surface elevations similar. Storage reduced except in June (up to 22%).	Water surface elevations similar. Storage similar.

	Alternative 1 Compared to the No Action Alternative	Alternative 2 Compared to the No Action Alternative	Alternative 3 Compared to the No Action Alternative	Alternative 4 Compared to the No Action Alternative	Alternative 5 Compared to the No Action Alternative
Feather River downstream of Themalito Complex	Flows similar or increased except reduced in July-September and November-December (up to 65%).	No change.	Flows similar or increased except reduced in July-September and October-January (up to 70%).	Flows similar or increased except reduced in July-September and November-December (up to 65%).	Flows similar or increased except reduced in April-May (up to 27%).
Folsom Lake	Water surface elevations similar Storage similar or increased except reduced in June-August in above normal and below normal years (up to 15%).	No change.	Water surface elevations similar Storage similar or increased except reduced in July-August in above normal and August-September in below normal years (up to 10%).	Water surface elevations similar Storage similar or increased except in reduced June-August in above normal and below normal years (up to 15%).	Water surface elevations similar. Storage similar.
American River at Nimbus Dam	Flows similar or increased except reduced in September-November and June-July (up to 48%).	No change.	Flows similar or increased except reduced in August-November and June (up to 46%).	Flows similar or increased except reduced in September-November and June-July (up to 48%).	Flows similar or increased except reduced in September and April-May (up to 14%).
New Melones Reservoir	Water surface elevations similar Storage similar or increased.	No change.	Water surface elevations similar Storage similar or increased.	Water surface elevations similar Storage similar or increased.	Water surface elevations similar. Storage reduced in July-September in above normal years (up to 6%); and all months in below normal, dry, and critical dry years (up to 19 percent).
Stanislaus River at Goodwin Dam	Flows similar or increased except reduced in July-August, December, and March (up to 18%).	No change.	Flows similar or increased except reduced in October and February-July (up to 73%).	Flows similar or increased except reduced in July-August, December, and March (up to 18%).	Flows similar or increased except reduced in June-August (up to 18%).

	Alternative 1 Compared to the No Action Alternative	Alternative 2 Compared to the No Action Alternative	Alternative 3 Compared to the No Action Alternative	Alternative 4 Compared to the No Action Alternative	Alternative 5 Compared to the No Action Alternative
San Joaquin River at Vernalis	Flows similar or increased except reduced in October and April (up to 19%).	No change.	Flows similar or increased except reduced in October and May-June (up to 21%).	Flows similar or increased except reduced in October and April (up to 19%).	Flows similar or increased.
San Luis Reservoir	Water surface elevations similar Storage similar or increased.	No change.	Water surface elevations similar Storage similar or increased.	Water surface elevations similar Storage similar or increased.	Water surface elevations similar Storage similar or increased except in below normal years in June-July (up to 9%); in dry years in April-September (up to 17%); and in critical dry years in April-January (up to 18%).
Flows into Yolo Bypass	Flows similar or increased except in October in wet years (20%).	No change.	Flows similar or increased except in October in wet years (25%).	Flows similar or increased except in October in wet years (20%).	Flows similar.
Delta Outflow	Reduced flows in many months. Increased flows in some months, including in December, February-March, and June in wet years (up to 1,492 cfs); and similar or increased flows in June and September in dry years (up to 385 cfs).	No change.	Reduced flows in many months. Increased flows in some months, including in December-March, in wet years (up to 3.307cfs); and increased flows in January-February and June-July in dry years (up to 277 cfs).	Reduced flows in many months. Increased flows in some months, including in December, February-March, and June in wet years (up to 1,492 cfs); and similar or increased flows in June and September in dry years (up to 385 cfs).	Flows would be similar or increased.
Reverse Flows in Old and Middle Rivers	Increased negative flows except in July-September.	No change.	Increased negative flows except in July-September.	Increased negative flows except in July-September.	Increased positive flows except in July-August.

	Alternative 1 Compared to the No Action Alternative	Alternative 2 Compared to the No Action Alternative	Alternative 3 Compared to the No Action Alternative	Alternative 4 Compared to the No Action Alternative	Alternative 5 Compared to the No Action Alternative
Water Supplies					
Non-CVP and Non-SWP Deliveries	Deliveries similar. No mitigation needed.	No change. No mitigation needed.	Deliveries similar. No mitigation needed.	Deliveries similar. No mitigation needed.	Deliveries similar. No mitigation needed.
CVP Water Deliveries (including CVP agricultural and municipal and industrial water service contracts; Sacramento River Settlement Contracts, San Joaquin River Exchange Contracts, and Eastside Division Contracts)	Deliveries similar or increased. No mitigation needed.	No change. No mitigation needed.	Deliveries similar or increased. No mitigation needed.	Deliveries similar or increased. No mitigation needed.	Deliveries similar or increased in wet to dry years. Reduced deliveries in the Eastside Division Contractors in critical dry years (8%). Potential Mitigation measure: Reclamation would support water transfers from other basin water rights holders.
SWP Water Deliveries (In accordance with Table A contracts without Article 21 water)	Deliveries similar or increased. No mitigation needed.	No change. No mitigation needed.	Deliveries similar or increased. No mitigation needed.	Deliveries similar or increased. No mitigation needed.	Deliveries similar or increased. No mitigation needed.

	Alternative 1 Compared to the No Action Alternative	Alternative 2 Compared to the No Action Alternative	Alternative 3 Compared to the No Action Alternative	Alternative 4 Compared to the No Action Alternative	Alternative 5 Compared to the No Action Alternative
Surface Water Quality					
Salinity in Northern Delta (near Emmaton)	Salinity increased in fall and winter months (up to 377%). Reduced in June in wet to dry years (up to 30%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	No change. No mitigation needed.	Salinity increased in fall and winter months in wet and above normal years (up to 378%). Reduced in June of above normal years and September of below normal years (up to 8%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in the western Delta in fall and winter months (up to 377%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in January-February in all years (up to 8%). Reduced in April-June in critical dry years (up to 15%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.
Salinity in Western Delta (near Port Chicago)	Salinity increased in Oct-March in below normal, dry, and critical dry years, and September wet and above normal years (up to 96%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	No change. No mitigation needed.	Salinity increased in October-January, April-May, June, and September in wet and above normal years (up to 95%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in Oct-March in below normal, dry, and critical dry years, and September wet and above normal years (up to 96%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity similar in most months except reduced in April-May in dry and critical dry years (up to 8%). No mitigation needed.

	Alternative 1 Compared to the No Action Alternative	Alternative 2 Compared to the No Action Alternative	Alternative 3 Compared to the No Action Alternative	Alternative 4 Compared to the No Action Alternative	Alternative 5 Compared to the No Action Alternative
Salinity in Western Central Delta (near Antioch)	Salinity increased in fall and winter months (up to 265%). Reduced in June in wet to below normal years (up to 14%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	No change. No mitigation needed.	Salinity increased in fall and winter months (up to 262%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in fall and winter months (up to 265%). Reduced in June in wet to below normal years (up to 14%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in February in critical dry years (7%). Reduced in April-May in below normal to critical dry years, and in June in critical dry years (up to 20%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.
Salinity in Western Central Delta (near Contra Costa Water District Intakes)	Salinity increased in October-January and September in wet and above normal years (up to 65%). Reduced in March-June in wet to below normal years (up to 32%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	No change. No mitigation needed.	Salinity increased in October-December in all year types, and January in above normal to dry years, and in September in wet and above normal years (up to 76%). Reduced in April-June (up to 34%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in October-January and September in wet and above normal years (up to 65%). Reduced in March-June in wet to below normal years (up to 32%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in April-June in below normal to critical dry years (up to 40%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.

	Alternative 1 Compared to the No Action Alternative	Alternative 2 Compared to the No Action Alternative	Alternative 3 Compared to the No Action Alternative	Alternative 4 Compared to the No Action Alternative	Alternative 5 Compared to the No Action Alternative
Salinity in Southern Delta (near CVP and SWP intakes)	Salinity increased in fall and early winter months (up to 65%). Reduced in February-June (up to 22%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	No change. No mitigation needed.	Salinity increased in October-December (up to 29% at Jones Pumping Plant intake and up to 41% at Clifton Court intake). Reduced in June (up to 13% at Jones Pumping Plant intake and up to 19% at Clifton Court intake). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in fall and early winter months (up to 65%). Reduced in February-June (up to 22%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in June in dry and critical dry years (up to 12%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.
Mercury in Delta Fish	Mercury concentrations similar or reduced concentrations. No mitigation needed.	No change. No mitigation needed.	Mercury concentrations similar or reduced concentrations. No mitigation needed.	Mercury concentrations similar or reduced concentrations. No mitigation needed.	Mercury concentrations similar concentrations. No mitigation needed.
Selenium in Delta and Delta Fish	Selenium concentrations similar concentrations. No mitigation needed.	No change. No mitigation needed.	Selenium concentrations similar concentrations. No mitigation needed.	Selenium concentrations similar concentrations. No mitigation needed.	Selenium concentrations similar concentrations. No mitigation needed.
Groundwater Resources					
Trinity River Region	Similar groundwater conditions. No mitigation needed.	No change. No mitigation needed.	Similar groundwater conditions. No mitigation needed.	Similar groundwater conditions. No mitigation needed.	Similar groundwater conditions. No mitigation needed.

	Alternative 1 Compared to the No Action Alternative	Alternative 2 Compared to the No Action Alternative	Alternative 3 Compared to the No Action Alternative	Alternative 4 Compared to the No Action Alternative	Alternative 5 Compared to the No Action Alternative
Central Valley Region: Sacramento Valley	Similar groundwater conditions. No mitigation needed.	No change. No mitigation needed.	Similar groundwater conditions. No mitigation needed.	Similar groundwater conditions. No mitigation needed.	Similar groundwater conditions. No mitigation needed.
Central Valley Region: San Joaquin Valley	Reduced groundwater pumping (8%); and higher groundwater elevations (2-200 feet). Potentially improved groundwater quality. Reduced subsidence potential. No mitigation needed.	No change. No mitigation needed.	Reduced groundwater pumping (6%); and higher groundwater elevations (2-200 feet). Potentially improved groundwater quality. Reduced subsidence potential. No mitigation needed.	Reduced groundwater pumping (8%); and higher groundwater elevations (2-200 feet). Potentially improved groundwater quality. Reduced subsidence potential. No mitigation needed.	Similar groundwater pumping; and similar to higher groundwater elevations (2-25 feet). Similar groundwater quality. Similar subsidence potential. No mitigation needed.
San Francisco Bay Area, Central Coast, and Southern California Region	Potentially reduced groundwater pumping; and potentially higher groundwater elevations. Potentially improved groundwater quality. Less subsidence potential. No mitigation needed.	No change. No mitigation needed.	Potentially reduced groundwater pumping; and potentially higher groundwater elevations. Potentially improved groundwater quality. Less subsidence potential. No mitigation needed.	Potentially reduced groundwater pumping; and potentially higher groundwater elevations. Potentially improved groundwater quality. Less subsidence potential. No mitigation needed.	Similar groundwater pumping; and groundwater elevations. Potentially similar groundwater quality. Similar subsidence potential. No mitigation needed.
CVP and SWP Energy Resources					
Energy Generated and Used by CVP and SWP Water Users	Similar CVP net generation. Decreased SWP net generation over the long-term (41%). Potentially reduced energy use by CVP and SWP water users. No mitigation needed.	No change. No mitigation needed.	Similar CVP net generation. Decreased SWP net generation over the long-term (27%). Potentially reduced energy use by CVP and SWP water users. No mitigation needed.	Similar CVP net generation. Decreased SWP net generation over the long-term (41%). Potentially reduced energy use by CVP and SWP water users. No mitigation needed.	Similar CVP and SWP net generation. Similar reduced energy use. No mitigation needed.

	Alternative 1 Compared to the No Action Alternative	**Alternative 2 Compared to the No Action Alternative**	**Alternative 3 Compared to the No Action Alternative**	**Alternative 4 Compared to the No Action Alternative**	**Alternative 5 Compared to the No Action Alternative**
Aquatic Resources					
Trinity River: Coho Salmon	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Trinity River: Spring-run Chinook Salmon	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Trinity River: Fall-run Chinook Salmon	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Trinity River: Steelhead	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Trinity River: Green Sturgeon	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Trinity Lake and Lewiston Reservoir: Reservoir Fish	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Trinity River: Pacific Lamprey	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Trinity River: Eulachon	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.

	Alternative 1 Compared to the No Action Alternative	Alternative 2 Compared to the No Action Alternative	Alternative 3 Compared to the No Action Alternative	Alternative 4 Compared to the No Action Alternative	Alternative 5 Compared to the No Action Alternative
Sacramento River System: Winter-run Chinook Salmon	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Potential mitigation measure: Implement fish passage around dams.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030; reduced pulse flows along lower Clear Creek; and lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants. Potential mitigation measure: Implement fish passage around dams to reduce temperature impacts. No mitigation measures have been identified for remaining impacts.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Improved conditions due to predator controls. Potential mitigation measure: Implement fish passage around dams.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Improved conditions due to predator controls. Potential mitigation measure: Implement fish passage around dams.	Similar conditions. No mitigation needed.

	Alternative 1 Compared to the No Action Alternative	**Alternative 2 Compared to the No Action Alternative**	**Alternative 3 Compared to the No Action Alternative**	**Alternative 4 Compared to the No Action Alternative**	**Alternative 5 Compared to the No Action Alternative**
Sacramento River System: Spring-run Chinook Salmon	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Potential mitigation measure: Implement fish passage around dams.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030; reduced pulse flows along lower Clear Creek; and lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants. Potential mitigation measure: Implement fish passage around dams to reduce temperature impacts. No mitigation measures have been identified for remaining impacts.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Improved conditions due to predator controls. Potential mitigation measure: Implement fish passage around dams.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Improved conditions due to predator controls. Potential mitigation measure: Implement fish passage around dams.	Similar conditions. No mitigation needed.
Sacramento River System: Fall-run Chinook Salmon	Similar conditions. No mitigation needed.	Reduced habitat conditions due to reduced pulse flows along lower Clear Creek; and lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants. No mitigation measures have been identified for remaining impacts.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.

	Alternative 1 Compared to the No Action Alternative	**Alternative 2 Compared to the No Action Alternative**	**Alternative 3 Compared to the No Action Alternative**	**Alternative 4 Compared to the No Action Alternative**	**Alternative 5 Compared to the No Action Alternative**
Sacramento River System: Late Fall-run Chinook Salmon	Similar conditions. No mitigation needed.	Reduced habitat conditions due to lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants. Potential mitigation measure: Implement fish passage around dams to reduce temperature impacts. No mitigation measures have been identified for remaining impacts.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Sacramento River System: Steelhead	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Potential mitigation measure: Implement fish passage around dams.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Potential mitigation measure: Implement fish passage around dams.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Potential mitigation measure: Implement fish passage around dams.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Potential mitigation measure: Implement fish passage around dams.	Similar conditions. No mitigation needed.
Sacramento River System: Green Sturgeon and White Sturgeon	Likely to result in improved conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Likely to result in improved conditions. No mitigation needed.	Likely to result in improved conditions. No mitigation needed.	Similar conditions. No mitigation needed.

	Alternative 1 Compared to the No Action Alternative	**Alternative 2 Compared to the No Action Alternative**	**Alternative 3 Compared to the No Action Alternative**	**Alternative 4 Compared to the No Action Alternative**	**Alternative 5 Compared to the No Action Alternative**
Delta: Delta Smelt	Reduced habitat conditions due to increased potential for entrainment during larval and juvenile stages, and increased salinity in the fall in the western Delta. No mitigation measures have been identified at this time.	Similar conditions. No mitigation needed.	Reduced habitat conditions due to increased potential for entrainment during larval and juvenile stages, and increased salinity in the fall in the western Delta. No mitigation measures have been identified at this time.	Reduced habitat conditions due to increased potential for entrainment during larval and juvenile stages, and increased salinity in the fall in the western Delta. No mitigation measures have been identified at this time.	Similar conditions. No mitigation needed.
Delta: Longfin Smelt	Reduced habitat conditions due to more negative Old and Middle River flows and other factors (as indicated by lower Longfin Smelt abundance indices). No mitigation measures have been identified at this time.	Similar conditions. No mitigation needed.	Reduced habitat conditions due to more negative Old and Middle River flows and other factors (as indicated by lower Longfin Smelt abundance indices). No mitigation measures have been identified at this time.	Reduced habitat conditions due to more negative Old and Middle River flows and other factors (as indicated by lower Longfin Smelt abundance indices). No mitigation measures have been identified at this time.	Similar conditions. No mitigation needed.
Delta: Sacramento Splittail	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Sacramento River System: Reservoir Fish	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Sacramento River System: Pacific Lamprey	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.

	Alternative 1 Compared to the No Action Alternative	**Alternative 2 Compared to the No Action Alternative**	**Alternative 3 Compared to the No Action Alternative**	**Alternative 4 Compared to the No Action Alternative**	**Alternative 5 Compared to the No Action Alternative**
Sacramento River System: Striped Bass, American Shad, and Hardhead	Similar conditions for Hardhead. Reduced habitat conditions for Striped Bass and American Shad due to reduced survival in larval and juvenile stages and increased salinity in the spring in the western Delta. No mitigation measures have been identified at this time.	Similar conditions. No mitigation needed.	Similar conditions for Hardhead. Reduced habitat conditions for Striped Bass and American Shad due to reduced survival in larval and juvenile stages and increased salinity in the spring in the western Delta. Adverse conditions for Striped Bass due to changes in harvest limitations. No mitigation measures have been identified at this time.	Similar conditions for Hardhead. Reduced habitat conditions for Striped Bass and American Shad due to reduced survival in larval and juvenile stages and increased salinity in the spring in the western Delta. Adverse conditions for Striped Bass due to changes in harvest limitations. No mitigation measures have been identified at this time.	Similar conditions. No mitigation needed.

	Alternative 1 Compared to the No Action Alternative	**Alternative 2 Compared to the No Action Alternative**	**Alternative 3 Compared to the No Action Alternative**	**Alternative 4 Compared to the No Action Alternative**	**Alternative 5 Compared to the No Action Alternative**
Stanislaus River: Fall-run Chinook Salmon	Similar conditions. No mitigation needed.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030; and lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants. Potential mitigation measure: Implement fish passage around dams to reduce temperature impacts. No mitigation measures have been identified for remaining impacts.	Potential improved habitat conditions due to predator controls, trap and haul operations, and harvest restrictions; however, the effectiveness of these measures is uncertain. No mitigation needed.	Potential improved habitat conditions due to predator controls, trap and haul operations, and harvest restrictions; however, the effectiveness of these measures is uncertain. No mitigation needed.	Similar conditions. No mitigation needed.

	Alternative 1 Compared to the No Action Alternative	Alternative 2 Compared to the No Action Alternative	Alternative 3 Compared to the No Action Alternative	Alternative 4 Compared to the No Action Alternative	Alternative 5 Compared to the No Action Alternative
Stanislaus River: Steelhead	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030; and lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants. Potential mitigation measure: Implement fish passage around dams to reduce temperature impacts. No mitigation measures have been identified for remaining impacts.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030; and lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants. Potential mitigation measure: Implement fish passage around dams to reduce temperature impacts. No mitigation measures have been identified for remaining impacts.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030; and lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants. Potential improved habitat conditions due to predator controls and trap and haul operations; however, the effectiveness of these measures is uncertain. Potential mitigation measure: Implement fish passage around dams to reduce temperature impacts. No mitigation measures have been identified for remaining impacts.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030; and lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants. Potential improved habitat conditions due to predator controls and trap and haul operations; however, the effectiveness of these measures is uncertain. Potential mitigation measure: Implement fish passage around dams to reduce temperature impacts. No mitigation measures have been identified for remaining impacts.	Similar conditions. No mitigation needed.
Stanislaus River: White Sturgeon	Conditions may be similar; however, adverse impacts could occur due to higher water temperatures. No mitigation measures have been identified at this time.	Similar conditions. No mitigation needed.	Conditions may be similar; however, adverse impacts could occur due to higher water temperatures. No mitigation measures have been identified at this time.	Conditions may be similar; however, adverse impacts could occur due to higher water temperatures. No mitigation measures have been identified at this time.	Similar conditions. No mitigation needed.

	Alternative 1 Compared to the No Action Alternative	Alternative 2 Compared to the No Action Alternative	Alternative 3 Compared to the No Action Alternative	Alternative 4 Compared to the No Action Alternative	Alternative 5 Compared to the No Action Alternative
New Melones Reservoir; Reservoir Fish	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Stanislaus River: Other Fish	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions for lampreys and Hardheads. Adverse conditions for Striped Bass due to changes in harvest limitations. No mitigation needed for lamprey and Hardhead. No mitigation measures have been identified at this time for Striped Bass.	Similar conditions for lampreys and Hardheads. Adverse conditions for Striped Bass due to changes in harvest limitations. No mitigation needed for lamprey and Hardhead. No mitigation measures have been identified at this time for Striped Bass.	Similar conditions. No mitigation needed.
Pacific Ocean: Killer Whale	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Terrestrial Resources					
Terrestrial Resources along Shoreline of CVP and SWP Reservoirs	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Terrestrial Resources along Rivers Downstream of CVP and SWP Reservoirs	Similar or improved conditions along Trinity, Sacramento, American, and Feather rivers. Reduced conditions along Stanislaus River. No mitigation measures identified at this time for changes along the Stanislaus River.	No change. No mitigation needed.	Similar or improved conditions along Trinity, Sacramento, American, and Feather rivers. Reduced conditions along Stanislaus River. No mitigation measures identified at this time for changes along the Stanislaus River.	Similar or improved conditions along Trinity, Sacramento, American, and Feather rivers. Reduced conditions along Stanislaus River. No mitigation measures identified at this time for changes along the Stanislaus River.	Similar or improved conditions along Trinity, Sacramento, American, and Feather rivers. Improved conditions along Stanislaus River. No mitigation needed.

	Alternative 1 Compared to the No Action Alternative	Alternative 2 Compared to the No Action Alternative	Alternative 3 Compared to the No Action Alternative	Alternative 4 Compared to the No Action Alternative	Alternative 5 Compared to the No Action Alternative
Terrestrial Resources in Yolo Bypass	Similar conditions in Yolo Bypass. No mitigation needed.	No change. No mitigation needed.	Similar or improved conditions in Yolo Bypass. No mitigation needed.	Similar conditions in Yolo Bypass. No mitigation needed.	Similar conditions in Yolo Bypass. No mitigation needed.
Terrestrial Resources in Western Delta	Increased extent of salt water in the fall months of wet and above normal years in western Delta which could adversely affect terrestrial resources that use freshwater habitat. No mitigation measures identified at this time.	No change. No mitigation needed.	Increased extent of salt water in the fall months of wet and above normal years in western Delta which could adversely affect terrestrial resources that use freshwater habitat. No mitigation measures identified at this time.	Increased extent of salt water in the fall months of wet and above normal years in western Delta which could adversely affect terrestrial resources that use freshwater habitat. No mitigation measures identified at this time.	Similar habitat in western Delta. No mitigation needed.
Geology and Soils Resources					
Geology and Soils Resources	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Agricultural Resources					
Agricultural Production and Employment	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Land Use					
Municipal and Industrial Land Use	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Visual Resources					
Visual Resources of Land Irrigated with CVP and SWP Water	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Visual Resources at Reservoirs that Store CVP and SWP Water	Similar or improved conditions. No mitigation needed.	No change. No mitigation needed.	Similar or improved conditions. No mitigation needed.	Similar or improved conditions. No mitigation needed.	Similar conditions. No mitigation needed.

	Alternative 1 Compared to the No Action Alternative	Alternative 2 Compared to the No Action Alternative	Alternative 3 Compared to the No Action Alternative	Alternative 4 Compared to the No Action Alternative	Alternative 5 Compared to the No Action Alternative
Recreation Resources					
Recreation Resources at Reservoirs that Store CVP and SWP Water	Similar or improved conditions. No mitigation needed.	No change. No mitigation needed.	Similar or improved conditions. No mitigation needed.	Similar or improved conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Recreation Resources in Rivers downstream of CVP and SWP Reservoirs	Similar or improved conditions. No mitigation needed.	No change. No mitigation needed.	Similar or improved conditions. Reduced opportunities for Striped Bass and sport ocean salmon fishing. No mitigation measures identified at this time.	Similar or improved conditions. Reduced opportunities for Striped Bass and sport ocean salmon fishing. No mitigation measures identified at this time.	Similar conditions. No mitigation needed.
Air Quality and Greenhouse Gas Emissions					
Emissions of Criteria Air Pollutants and Precursors and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants from Diesel Engines at Groundwater Wells	Similar air quality conditions in the Trinity River Region and Sacramento Valley. Improved air quality conditions in the San Joaquin Valley and the San Francisco Bay Area, Central Coast, and Southern California regions. No mitigation needed.	No change. No mitigation needed.	Similar air quality conditions in the Trinity River Region and Sacramento Valley. Reduced air quality conditions in the San Joaquin Valley and the San Francisco Bay Area, Central Coast, and Southern California regions. No mitigation needed.	Similar air quality conditions in the Trinity River Region and Sacramento Valley. Improved air quality conditions in the San Joaquin Valley and the San Francisco Bay Area, Central Coast, and Southern California regions. No mitigation needed.	Similar air quality conditions in the Trinity River Region and Sacramento Valley. Similar air quality conditions in the San Joaquin Valley and the San Francisco Bay Area, Central Coast, and Southern California regions. No mitigation needed.

	Alternative 1 Compared to the No Action Alternative	Alternative 2 Compared to the No Action Alternative	Alternative 3 Compared to the No Action Alternative	Alternative 4 Compared to the No Action Alternative	Alternative 5 Compared to the No Action Alternative
Increased Greenhouse Gas Emissions (GHG) due to Changes in Energy Resources Related to CVP and SWP Water Use	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could increase in the San Francisco Bay Area, Central Coast, and Southern California regions.	No change.	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could increase in the San Francisco Bay Area, Central Coast, and Southern California regions.	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could increase in the San Francisco Bay Area, Central Coast, and Southern California regions.	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could increase in the San Francisco Bay Area, Central Coast, and Southern California regions.
Cultural Resources					
Potential for Disturbance of Cultural Resources	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Public Health					
Water Supply Availability for Wildland Firefighting	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Potential Exposure to Mercury in Fish in Delta	Similar or reduced concentrations. No mitigation needed.	No change. No mitigation needed.	Similar or reduced concentrations. No mitigation needed.	Similar or reduced concentrations. No mitigation needed.	Similar concentrations. No mitigation needed.
Socioeconomics					
Agricultural and Municipal and Industrial Employment	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Municipal and Industrial Water Supply Operating Expenses	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Recreational Economics CVP and SWP Reservoirs	Similar or improved conditions. No mitigation needed.	No change. No mitigation needed.	Similar or improved conditions. No mitigation needed.	Similar or improved conditions. No mitigation needed.	Similar or improved conditions. No mitigation needed.

	Alternative 1 Compared to the No Action Alternative	**Alternative 2 Compared to the No Action Alternative**	**Alternative 3 Compared to the No Action Alternative**	**Alternative 4 Compared to the No Action Alternative**	**Alternative 5 Compared to the No Action Alternative**
Recreational Economics Related to Striped Bass Fishing in Delta	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Reduced recreational opportunities and associated economics. No mitigation identified at this time.	Reduced recreational opportunities and associated economics. No mitigation identified at this time.	Similar conditions. No mitigation needed.
Commercial and Sport Ocean Salmon Fishing	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Reduced commercial and sport ocean salmon fishing and associated economics. No mitigation identified at this time.	Reduced commercial and sport ocean salmon fishing and associated economics. No mitigation identified at this time.	Similar conditions. No mitigation needed.
Indian Trust Assets					
Potential for Disturbance of Indian Trust Assets	No change. No mitigation needed.	No change. No mitigation needed.	No change. No mitigation needed.	No change. No mitigation needed.	No change. No mitigation needed.
Environmental Justice					
Emissions of Criteria Air Pollutants and Precursors and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants from Diesel Engines at Groundwater Wells	Improved air quality conditions. No mitigation needed.	No change. No mitigation needed.	Reduced air quality conditions. No mitigation needed.	Improved air quality conditions. No mitigation needed.	Similar air quality conditions. No mitigation needed.
Potential Exposure to Mercury in Fish in Delta	Similar or reduced concentrations. No mitigation needed.	No change. No mitigation needed.	Similar or reduced concentrations. No mitigation needed.	Similar or reduced concentrations. No mitigation needed.	Similar concentrations. No mitigation needed.

1 **Table ES.2 Comparison of Alternatives 1 through 5 and the No Action Alternative to the Second Basis of Comparison**

	No Action Alternative Compared to Second Basis of Comparison	**Alternative 1 Compared to the Second Basis of Comparison**	**Alternative 2 Compared to the Second Basis of Comparison**	**Alternative 3 Compared to the Second Basis of Comparison**	**Alternative 4 Compared to the Second Basis of Comparison**	**Alternative 5 Compared to the Second Basis of Comparison**
Surface Water Conditions						
Trinity Lake	Water surface elevations similar Storage would be similar in most months, except reduced in November-December in above normal years (up to 6%) and all months in critical dry years (up to 10%).	No change.	Water surface elevations similar Storage would be similar in most months, except reduced in November-December in above normal years (up to 6%) and all months in critical dry years (up to 10%).	Water surface elevations similar Storage similar or increased.	No change.	Water surface elevations similar Storage would be similar in most months, except reduced in all months in critical dry years (up to 10%).
Trinity River at Lewiston Dam	Flows similar or increased except reduced in December-February in wet to below normal years (up to 30%).	No change.	Flows similar or increased except reduced in December-February in wet to below normal years (up to 30%).	Flows similar or increased.	No change.	Flows similar or increased except reduced in December-February in wet to below normal years (up to 21%).
Shasta Lake	Water surface elevations similar Storage reduced in September-February in wet to dry years (up to 11%) and in all months in critical dry years (up to 14%).	No change.	Water surface elevations similar Storage reduced in September-February in wet to dry years (up to 11%) and in all months in critical dry years (up to 14%).	Water surface elevations similar Storage similar or increased.	No change.	Water surface elevations similar Storage reduced in September-February in most months of wet to dry years (up to 10%), and in all months in critical dry years (up to 17%).

	No Action Alternative Compared to Second Basis of Comparison	**Alternative 1 Compared to the Second Basis of Comparison**	**Alternative 2 Compared to the Second Basis of Comparison**	**Alternative 3 Compared to the Second Basis of Comparison**	**Alternative 4 Compared to the Second Basis of Comparison**	**Alternative 5 Compared to the Second Basis of Comparison**
Sacramento River at Keswick Dam	Flows reduced (up to 21%) except September and November.	No change.	Flows reduced (up to 21%) except September and November.	Flows similar or increased except reduced in August in below normal years (up to 6%).	No change.	Flows reduced (up to 16%) except September and November.
Sacramento River at Freeport	Flows similar or increased except reduced in May and June (up to 27%).	No change.	Flows similar or increased except reduced in May and June (up to 27%).	Flows similar or increased except reduced in June in below normal years (up to 13%).	No change.	Flows similar or increased except reduced in May and June (up to 28%).
Clear Creek near Igo	Flows similar or increased.	No change.	Flows similar or increased.	No change.	No change.	Flows similar or increased.
Lake Oroville	Water surface elevations similar. Similar in most months May-July in wet to dry years and in all months in critical dry years. Reduced in many months from September-February in all year types (up to 18%).	No change.	Water surface elevations similar. Similar in most months May-July in wet to dry years and in all months in critical dry years. Reduced in many months from September-February in all year types (up to 18%).	Water surface elevations similar Storage similar.	No change.	Water surface elevations similar. Similar in most months May-July in wet to dry years and in all months in critical dry years. Reduced in many months from September-February in all year types (up to 18%).
Feather River downstream of Thermalito Complex	Flows similar or increased except reduced in August-June (up to 52%).	No change.	Flows similar or increased except reduced in August-June (up to 52%).	Flows similar or increased except reduced in August-June (up to 28%).	No change.	Flows similar or increased except reduced in August-June (up to 58%).

	No Action Alternative Compared to Second Basis of Comparison	Alternative 1 Compared to the Second Basis of Comparison	Alternative 2 Compared to the Second Basis of Comparison	Alternative 3 Compared to the Second Basis of Comparison	Alternative 4 Compared to the Second Basis of Comparison	Alternative 5 Compared to the Second Basis of Comparison
Folsom Lake	Water surface elevations similar Storage similar in many months except reduced flows in September-January (up to 12%) in wet to below normal years and July-September in critical dry years (up to 11%).	No change.	Water surface elevations similar Storage similar in many months except reduced flows in September-January (up to 12%) in wet to below normal years and July-September in critical dry years (up to 11%).	Water surface elevations similar Storage similar.	No change.	Water surface elevations similar Storage similar in many months except reduced flows in August-January (up to 13%) in wet to below normal years and July in critical dry years (8%).
American River at Nimbus Dam	Flows similar or increased except reduced in June-August, December, February, and April (up to 25%).	No change.	Flows similar or increased except reduced in June-August, December, February, and April (up to 25%).	Flows similar or increased except reduced flows in June-August and April (up to 17%).	No change.	Flows similar or increased except reduced in December-February, April, June, and August (up to 25%).
New Melones Reservoir	Water surface elevations similar Storage similar in wet, below normal, and dry years, and in most months in above normal and critical dry years. Storage reduced in October in above normal water years (6%) and in October-January and April-June in critical dry years (up to 7%).	No change.	Water surface elevations similar Storage similar in wet, below normal, and dry years, and in most months in above normal and critical dry years. Storage reduced in October in above normal water years (6%) and in October-January and April-June in critical dry years (up to 7%).	Water surface elevations similar Storage similar or increased.	No change.	Water surface elevations similar Storage reduced in all months in all water year types (up to 23%).

	No Action Alternative Compared to Second Basis of Comparison	Alternative 1 Compared to the Second Basis of Comparison	Alternative 2 Compared to the Second Basis of Comparison	Alternative 3 Compared to the Second Basis of Comparison	Alternative 4 Compared to the Second Basis of Comparison	Alternative 5 Compared to the Second Basis of Comparison
Stanislaus River at Goodwin Dam	Flows similar or increased except reduced in November-March and May-June (up to 25%).	No change.	Flows similar or increased except reduced in November-March and May-June (up to 25%).	Flows reduced in all months (up to 79%) except April and August.	No change.	Flows reduced in all months (up to 25%) except October, April, and May.
San Joaquin River at Vernalis	Flows similar or increased except reduced in November and May-June (up to 9%).	No change.	Flows similar or increased except reduced in November and May-June (up to 9%).	Flows similar or increased except reduced in May-June (up to 27%).	No change.	Flows similar or increased except reduced in November and June (up to 10%).

	No Action Alternative Compared to Second Basis of Comparison	Alternative 1 Compared to the Second Basis of Comparison	Alternative 2 Compared to the Second Basis of Comparison	Alternative 3 Compared to the Second Basis of Comparison	Alternative 4 Compared to the Second Basis of Comparison	Alternative 5 Compared to the Second Basis of Comparison
San Luis Reservoir	Water surface elevations reduced in all months in wet to below normal water years and in February-September in dry and critical dry years (up to 16%). Storage reduced in October-June in most water years (up to 71%).	No change.	Water surface elevations reduced in all months in wet to below normal water years and in February-September in dry and critical dry years (up to 16%). Storage reduced in October-June in most water years (up to 71%).	Water surface elevations similar except reduced in January-February in above normal years (up to 6%) and February-August in critical dry years (up to 7%). Storage similar or increased in some months except in December-February and June in wet years (up to 16%), October-July in above normal and below normal years (up to 40%), January-September in dry years (up to 19%), and October-August in critical dry years (up to 29%).	No change.	Water surface elevations reduced in all months in all year types (up to 70%). Storage would be reduced in October-August in wet to below normal years (up to 17%), in January-September in dry years (up to 14%), and in all months in critical dry years (up to 14%).

	No Action Alternative Compared to Second Basis of Comparison	**Alternative 1 Compared to the Second Basis of Comparison**	**Alternative 2 Compared to the Second Basis of Comparison**	**Alternative 3 Compared to the Second Basis of Comparison**	**Alternative 4 Compared to the Second Basis of Comparison**	**Alternative 5 Compared to the Second Basis of Comparison**
Flows into Yolo Bypass	Flows similar or increased except reduced in November-December in wet years (up to 15%), January-March in above normal years (14%), December-March in below normal years (up to 25%), and December in dry years (6%).	No change.	Flows similar or increased except reduced in November-December in wet years (up to 15%), January-March in above normal years (14%), December-March in below normal years (up to 25%), and December in dry years (6%).	Flows similar except reduced in October of wet years (6%).	No change.	Flows similar or increased except reduced in November-January in wet years (up to 15%), January-March in above normal years (15%), December-March in below normal years (up to 24%), and December in dry years (7%).
Delta Outflow	Flows similar or increased in many months. Reduced flows in some months, including in December, February-March, and June in wet years (up to 1,590 cfs).	No change.	Flows similar or increased in many months. Reduced flows in some months, including in December, February-March, and June in wet years (up to 1,590 cfs).	Flows would increase in many months. Reduced flows in some months, including October and March-June in wet years (up to 1,127 cfs), and October and May-June in dry years (up to 373 cfs).	No change.	Flows similar or increased in many months. Reduced flows in some months, including in December, February-March, and June in wet years (up to 1,713 cfs), and June in dry years (526 cfs).
Reverse Flows in Old and Middle Rivers	Increased positive flows except in June-August in most years and March in wet years.	No change.	Increased positive flows except in June-August in most years and March in wet years.	Increased negative flows in June-August in most years and March in wet years.	No change.	Increased negative flows in July-August in most years and March and June in wet years.

	No Action Alternative Compared to Second Basis of Comparison	Alternative 1 Compared to the Second Basis of Comparison	Alternative 2 Compared to the Second Basis of Comparison	Alternative 3 Compared to the Second Basis of Comparison	Alternative 4 Compared to the Second Basis of Comparison	Alternative 5 Compared to the Second Basis of Comparison
Water Supplies						
Non-CVP and Non-SWP Deliveries	Deliveries similar.	Deliveries similar.	Deliveries similar.	Deliveries similar.	Deliveries similar.	Deliveries similar.
North of Delta CVP Water Deliveries: Agricultural Water Contractors	Deliveries reduced up to 16% over the long-term to 34% in critical dry years.	No change.	Deliveries reduced up to 16% over the long-term to 34% in critical dry years.	Deliveries similar over the long-term. Reduced up to 9% in dry years to 11% in critical dry years.	No change.	Deliveries reduced up to 16% over the long-term to 31% in critical dry years.
North of Delta CVP Water Deliveries: Municipal and Industrial Water Contractors	Deliveries similar.	No change.	Deliveries similar.	Deliveries similar.	No change.	Deliveries similar.
South of Delta CVP Water Deliveries: Agricultural Water Contractors	Deliveries reduced up to 23% over the long-term to 33% in critical dry years.	No change.	Deliveries reduced up to 23% over the long-term to 33% in critical dry years.	Deliveries similar over the long-term. Reduced up to 8% in dry years to 14% in critical dry years.	No change.	Deliveries reduced up to 24% over the long-term to 33% in critical dry years.
South of Delta CVP Water Deliveries: Municipal and Industrial Water Contractors	Deliveries reduced up to 10% over the long-term to 5% in critical dry years.	No change.	Deliveries reduced up to 10% over the long-term to 5% in critical dry years.	Deliveries similar.	No change.	Deliveries reduced up to 10% over the long-term to 8% in critical dry years.
CVP Water Deliveries: Eastside Division Contractors	Deliveries reduced up to 19% in critical dry years.	No change.	Deliveries reduced up to 19% in critical dry years.	Deliveries similar.	No change.	Deliveries reduced up to 19% in critical dry years.
North of Delta: SWP Water Deliveries under Table A without Article 21 water	Deliveries reduced up to 13% over the long-term to 20% in critical dry years.	No change.	Deliveries reduced up to 13% over the long-term to 20% in critical dry years.	Deliveries similar over the long-term and in dry years. Reduced by 10% in critical dry years.	No change.	Deliveries reduced up to 19% over the long-term to 21% in critical dry years.

	No Action Alternative Compared to Second Basis of Comparison	Alternative 1 Compared to the Second Basis of Comparison	Alternative 2 Compared to the Second Basis of Comparison	Alternative 3 Compared to the Second Basis of Comparison	Alternative 4 Compared to the Second Basis of Comparison	Alternative 5 Compared to the Second Basis of Comparison
North of Delta: SWP Water Deliveries under Table A without Article 21 water	Deliveries reduced up to 18% over the long-term to 22% in critical dry years.	No change.	Deliveries reduced up to 18% over the long-term to 22% in critical dry years.	Deliveries similar over the long-term and in dry years. Reduced by 11% in critical dry years.	No change.	Deliveries reduced up to 19% over the long-term to 23% in critical dry years.
Surface Water Quality						
Salinity in Northern Delta (near Emmaton)	Salinity increased in June in wet to dry years (up to 21%). Reduced in fall and winter months in wet and above normal years (up to 79%).	No change.	Salinity increased in June in wet to dry years (up to 21%). Reduced in fall and winter months in wet and above normal years (up to 79%).	Salinity increased in June in wet to dry years (up to 35%). Reduced in fall and winter months in wet and above normal years (up to 24%).	No change.	Salinity increased in June in wet to dry years (up to 21%). Reduced in fall and winter months in wet and above normal years (up to 79%).
Salinity in Western Delta (near Port Chicago)	Salinity reduced in September-May (up to 49%).	No change.	Salinity reduced in September-May (up to 49%).	Salinity increased in June in wet to below normal years (up to 9%). Reduced in January-March (up to 25%).	No change.	Salinity reduced in September-May (up to 49%).
Salinity in Western Central Delta (near Antioch)	Salinity increased in June in wet to below normal years (up to 16%). Reduced in fall and winter months (up to 73%).	No change.	Salinity increased in June in wet to below normal years (up to 16%). Reduced in fall and winter months (up to 73%).	Salinity increased in May in wet years and June in wet to dry years (up to 20%). Reduced in January-April (up to 40%).	No change.	Salinity increased in June in wet to below normal years (up to 14%). Reduced in fall and winter months (up to 73%).

	No Action Alternative Compared to Second Basis of Comparison	Alternative 1 Compared to the Second Basis of Comparison	Alternative 2 Compared to the Second Basis of Comparison	Alternative 3 Compared to the Second Basis of Comparison	Alternative 4 Compared to the Second Basis of Comparison	Alternative 5 Compared to the Second Basis of Comparison
Salinity in Western Central Delta (near Contra Costa Water District Intakes)	Salinity increased in March-June (up to 47%). Reduced in October-January and September (up to 42%).	No change.	Salinity increased in March-June (up to 47%). Reduced in October-January and September (up to 42%).	Salinity increased in March-April in dry and critical dry years (up to 16%). Reduced in December-February in dry and critical dry years (up to 23%).	No change.	Salinity increased in March-June (up to 63%). Reduced in October-January and September (up to 41%).
Salinity in Southern Delta (near CVP and SWP intakes)	Salinity increased in February-June (up to 23%). Reduced in October-January (up to 28%).	No change.	Salinity increased in February-June (up to 23%). Reduced in October-January (up to 28%).	Salinity increased in February-May in dry and critical dry years (up to 23%).	No change.	Salinity increased in February-June (up to 26%). Reduced in October-January (up to 28%).
Mercury in Delta Fish	Mercury concentrations increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).	No change.	Mercury concentrations increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).	Similar conditions.	No change.	Mercury concentrations increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).
Selenium in Delta and Delta Fish	Selenium concentrations similar concentrations.	No change.	Selenium concentrations similar concentrations.	Selenium concentrations similar concentrations.	No change.	Selenium concentrations similar concentrations.
Groundwater Resources						
Trinity River Region	Similar groundwater conditions.	No change.	Similar groundwater conditions.	Similar groundwater conditions.	No change.	Similar groundwater conditions.
Central Valley Region: Sacramento Valley	Similar groundwater conditions.	No change.	Similar groundwater conditions.	Similar groundwater conditions.	No change.	Similar groundwater conditions.

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Central Valley Region: San Joaquin Valley	Increased groundwater pumping (8%); and lower groundwater elevations (2-200 feet). Potentially reduced groundwater quality. Increased subsidence potential.	No change.	Increased groundwater pumping (8%); and lower groundwater elevations (2-200 feet). Potentially reduced groundwater quality. Increased subsidence potential.	Similar groundwater pumping; and similar to lower groundwater elevations (2-25 feet). Similar groundwater quality. Similar subsidence potential.	No change.	Increased groundwater pumping (8%); and lower groundwater elevations (2-200 feet). Potentially reduced groundwater quality. Increased subsidence potential.
San Francisco Bay Area, Central Coast, and Southern California Region	Potentially increased groundwater pumping; and potentially lower groundwater elevations. Potentially reduced groundwater quality. Increased subsidence potential.	No change.	Potentially increased groundwater pumping; and potentially lower groundwater elevations. Potentially reduced groundwater quality. Increased subsidence potential.	Potentially increased groundwater pumping; and potentially lower groundwater elevations. Potentially reduced groundwater quality. Increased subsidence potential.	No change.	Potentially increased groundwater pumping; and potentially lower groundwater elevations. Potentially reduced groundwater quality. Increased subsidence potential.
CVP and SWP Energy Resources						
Energy Generated and Used by CVP and SWP Water Users	Similar CVP net generation. Increased net generation over the long-term (29%). Potentially increased energy use by CVP and SWP water users.	No change.	Similar CVP net generation. Increased net generation over the long-term (29%). Potentially increased energy use by CVP and SWP water users.	Similar CVP net generation. Increased net generation over the long-term (10%). Potentially increased energy use by CVP and SWP water users.	No change.	Similar CVP net generation. Increased net generation over the long-term (30%). Potentially increased energy use by CVP and SWP water users.

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Aquatic Resources						
Trinity River: Coho Salmon	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Trinity River: Spring-run Chinook Salmon	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Trinity River: Fall-run Chinook Salmon	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Trinity River: Steelhead	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Trinity River: Green Sturgeon	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Trinity Lake and Lewiston Reservoir: Reservoir Fish	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Trinity River: Pacific Lamprey	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Trinity River: Eulachon	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Sacramento River System: Winter-run Chinook Salmon	Improved habitat conditions due to fish passage at dams and other actions to address high water temperatures caused by climate change by 2030.	No change.	Similar conditions.	Improved habitat conditions due to improved escapement potential and predator controls.	Similar conditions.	Improved habitat conditions due to fish passage at dams and other actions to address high water temperatures caused by climate change by 2030.

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Sacramento River System: Spring-run Chinook Salmon	Improved habitat conditions due to fish passage at dams and other actions to address high water temperatures caused by climate change by 2030.	No change.	Similar conditions.	Improved habitat conditions due to harvest limitations and predator controls.	Similar conditions.	Improved habitat conditions due to fish passage at dams and other actions to address high water temperatures caused by climate change by 2030.
Sacramento River System: Fall-run Chinook Salmon	Similar conditions.	No change.	Similar conditions.	Similar conditions.	Similar conditions.	Similar conditions.
Sacramento River System: Late Fall-run Chinook Salmon	Improved habitat conditions due to measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants.	No change.	Similar conditions.	Similar conditions.	Similar conditions.	Improved habitat conditions due to measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants.

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Sacramento River System: Steelhead	Improved habitat conditions due to fish passage programs to address high water temperatures caused by climate change by 2030; and measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants.	No change.	Similar conditions.	Similar conditions.	Similar conditions.	Improved habitat conditions due to fish passage programs to address high water temperatures caused by climate change by 2030; and measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants.
Sacramento River System: Green Sturgeon and White Sturgeon	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030 that are not improved by other actions.	No change.	Similar conditions.	Improved habitat conditions due to lower water temperatures.	No change.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030 that are not improved by other actions.
Delta: Delta Smelt	Improved habitat conditions due to reduced potential for entrainment during larval and juvenile stages, and reduced salinity in the fall in the western Delta.	No change.	Similar conditions.	Similar conditions.	No change.	Improved habitat conditions due to reduced potential for entrainment during larval and juvenile stages, and reduced salinity in the fall in the western Delta.

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Delta: Longfin Smelt	Improved habitat conditions due to more positive Old and Middle River flows and other factors (as indicated by higher Longfin Smelt abundance indices).	No change.	Similar conditions.	Similar conditions.	No change.	Improved habitat conditions due to more positive Old and Middle River flows and other factors (as indicated by higher Longfin Smelt abundance indices).
Delta: Sacramento Splittail	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Sacramento River System: Reservoir Fish	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Sacramento River System: Pacific Lamprey	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Sacramento River System: Striped Bass, American Shad, and Hardhead	Similar conditions for Hardhead. Improved habitat conditions for Striped Bass and American Shad due to improved survival in larval and juvenile stages and reduced salinity in the spring in the western Delta.	No change.	Similar conditions.	Similar habitat conditions for Hardhead, Striped Bass, and American Shad. Adverse conditions for Striped Bass due to changes in harvest limitations.	No change in habitat conditions for Hardhead, Striped Bass, and American Shad. Adverse conditions for Striped Bass due to changes in harvest limitations.	Similar conditions for Hardhead. Improved habitat conditions for Striped Bass and American Shad due to improved survival in larval and juvenile stages and reduced salinity in the spring in the western Delta.

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Stanislaus River: Fall-run Chinook Salmon	Similar or improved conditions.	No change.	Similar conditions.	Potential improved habitat conditions due to predator controls, trap and haul operations, and harvest restrictions; however, the effectiveness of these measures is uncertain.	Potential improved habitat conditions due to predator controls, trap and haul operations, and harvest restrictions; however, the effectiveness of these measures is uncertain.	Similar or improved conditions.
Stanislaus River: Steelhead	Improved habitat conditions due to measures to address high water temperatures caused by climate change by 2030; and measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants.	No change.	Similar conditions.	Potential improved habitat conditions due to predator controls and trap and haul operations; however, the effectiveness of these measures is uncertain.	Potential improved habitat conditions due to predator controls and trap and haul operations; however, the effectiveness of these measures is uncertain.	Improved habitat conditions due to measures to address high water temperatures caused by climate change by 2030; and measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants.
Stanislaus River: White Sturgeon	Conditions may be similar; however, improved conditions could occur due to lower water temperatures.	No change.	Similar conditions.	Similar conditions.	No change.	Conditions may be similar; however, improved conditions could occur due to lower water temperatures.
New Melones Reservoir; Reservoir Fish	Similar conditions.	No change.	Similar conditions.	Improved conditions for black bass nest survival.	No change.	Similar conditions.

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Stanislaus River: Other Fish	Similar conditions.	No change.	Similar conditions.	Similar conditions for lamprey and Hardhead. Adverse conditions for Striped Bass due to changes in harvest limitations.	Similar conditions for lamprey and Hardhead. Adverse conditions for Striped Bass due to changes in harvest limitations.	Similar conditions.
Pacific Ocean: Killer Whale	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Terrestrial Resources						
Terrestrial Resources along Shoreline of CVP and SWP Reservoirs	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Terrestrial Resources along Rivers Downstream of CVP and SWP Reservoirs	Similar or improved conditions along Trinity, Sacramento, American, and Stanislaus rivers. Reduced conditions along Feather River. No mitigation measures identified at this time for changes along Feather River.	No change.	Similar or improved conditions along Trinity, Sacramento, American, and Stanislaus rivers. Reduced conditions along Feather River. No mitigation measures identified at this time for changes along Feather River.	Similar or improved conditions along Trinity, Sacramento, Feather, and American rivers. Reduced conditions along Stanislaus River. No mitigation measures identified at this time for changes along Stanislaus River.	No change.	Similar or improved conditions along Trinity, American, and Stanislaus rivers. Reduced conditions along Feather and Sacramento rivers. No mitigation measures identified at this time for changes along Feather and Sacramento rivers.
Terrestrial Resources in Yolo Bypass	Similar conditions in Yolo Bypass.	No change.	Similar conditions in Yolo Bypass.	Similar conditions in Yolo Bypass.	No change.	Similar or reduced conditions in Yolo Bypass.

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Terrestrial Resources in Western Delta	Increased extent of freshwater habitat in western Delta.	No change.	Increased extent of freshwater habitat in western Delta.	Similar conditions.	No change.	Increased extent of freshwater habitat in western Delta.
Geology and Soils Resources						
Geology and Soils Resources	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Agricultural Resources						
Agricultural Production and Employment	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Land Use						
Municipal and Industrial Land Use	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Visual Resources						
Visual Resources of Land Irrigated with CVP and SWP Water	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.

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Visual Resources at Reservoirs that Store CVP and SWP Water	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, and New Melones Reservoir. Similar conditions at San Luis Reservoir in above normal to dry years. Reduced conditions at San Luis Reservoir in wet and critical dry years (up to 6%). Potentially reduced conditions in the San Francisco Bay Area, Central Coast, and Southern California regions (up to 18%).	No change.	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, and New Melones Reservoir. Similar conditions at San Luis Reservoir in above normal to dry years. Reduced conditions at San Luis Reservoir in wet and critical dry years (up to 6%). Potentially reduced conditions in the San Francisco Bay Area, Central Coast, and Southern California regions (up to 18%).	Similar conditions.	No change.	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, and New Melones Reservoir. Similar conditions at San Luis Reservoir in above normal to dry years. Reduced conditions at San Luis Reservoir in wet and critical dry years (up to 9%). Potentially reduced conditions in the San Francisco Bay Area, Central Coast, and Southern California regions (up to 18%).

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Recreation Resources						
Recreation Resources at Reservoirs that Store CVP and SWP Water	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, and New Melones Reservoir. Similar conditions at San Luis Reservoir in above normal to dry years. Reduced conditions at San Luis Reservoir in wet and critical dry years (up to 6%). Potentially reduced conditions in the San Francisco Bay Area, Central Coast, and Southern California regions (up to 18%).	No change.	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, and New Melones Reservoir. Similar conditions at San Luis Reservoir in above normal to dry years. Reduced conditions at San Luis Reservoir in wet and critical dry years (up to 6%). Potentially reduced conditions in the San Francisco Bay Area, Central Coast, and Southern California regions (up to 18%).	Similar conditions.	No change.	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, and New Melones Reservoir. Similar conditions at San Luis Reservoir in above normal to dry years. Reduced conditions at San Luis Reservoir in wet and critical dry years (up to 9%). Potentially reduced conditions in the San Francisco Bay Area, Central Coast, and Southern California regions (up to 18%).

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Recreation Resources in Rivers downstream of CVP and SWP Reservoirs	Similar or improved conditions; except reduced conditions in June and August along the Feather and American rivers, and in May along the Feather River and Sacramento River near Freeport.	No change.	Similar or improved conditions; except reduced conditions in June and August along the Feather and American rivers, and in May along the Feather River and Sacramento River near Freeport.	Similar or improved conditions along rivers. Reduced opportunities for Striped Bass and sport ocean salmon fishing.	No change along rivers. Reduced opportunities for Striped Bass and sport ocean salmon fishing.	Similar or improved conditions; except reduced conditions in May and June and August along the Sacramento and Feather rivers, in August along the American River; and in June-August along Stanislaus River.
Air Quality and Greenhouse Gas Emissions						
Emissions of Criteria Air Pollutants and Precursors and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants from Diesel Engines at Groundwater Wells	Similar air quality conditions in the Trinity River Region and Sacramento Valley. Potential increase in emissions (up to 18%) in the San Joaquin Valley and the San Francisco Bay Area, Central Coast, and Southern California regions.	No change.	Similar air quality conditions in the Trinity River Region and Sacramento Valley. Potential increase in emissions (up to 18%) in the San Joaquin Valley and the San Francisco Bay Area, Central Coast, and Southern California regions.	Similar conditions.	No change.	Similar air quality conditions in the Trinity River Region and Sacramento Valley. Potential increase in emissions (up to 18%) in the San Joaquin Valley and the San Francisco Bay Area, Central Coast, and Southern California regions.

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Increased Greenhouse Gas Emissions due to Changes in Energy Resources Related to CVP and SWP Water Use	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could be reduced in the San Francisco Bay Area, Central Coast, and Southern California regions.	No change.	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could be reduced in the San Francisco Bay Area, Central Coast, and Southern California regions.	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could be reduced in the San Francisco Bay Area, Central Coast, and Southern California regions.	No change.	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could be reduced in the San Francisco Bay Area, Central Coast, and Southern California regions.
Cultural Resources						
Potential for Disturbance of Cultural Resources	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Public Health						
Water Supply Availability for Wildland Firefighting	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir. Reduced potential at San Luis Reservoir (6%).	No change.	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir. Reduced potential at San Luis Reservoir (6%).	Similar conditions.	No change.	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir. Reduced potential at San Luis Reservoir (9%).
Potential Exposure to Mercury in Fish in Delta	Increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).	No change.	Increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).	Similar conditions.	No change.	Increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).

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Socioeconomics						
Agricultural and Municipal and Industrial Employment	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Municipal and Industrial Water Supply Operating Expenses	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Recreational Economics CVP and SWP Reservoirs	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir. Reduced potential at San Luis Reservoir and reservoirs that store CVP and SWP water in San Francisco Bay Area, Central Coast, and Southern California regions.	No change.	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir. Reduced potential at San Luis Reservoir and reservoirs that store CVP and SWP water in San Francisco Bay Area, Central Coast, and Southern California regions.	Similar conditions.	No change.	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir. Reduced potential at San Luis Reservoir and reservoirs that store CVP and SWP water in San Francisco Bay Area, Central Coast, and Southern California regions.
Recreational Economics Related to Striped Bass Fishing in Delta	Similar conditions.	No change.	Similar conditions.	Reduced recreational opportunities and associated economics.	Reduced recreational opportunities and associated economics.	Similar conditions.
Commercial and Sport Ocean Salmon Fishing	Similar conditions.	No change.	Similar conditions.	Reduced commercial and sport ocean salmon fishing and associated economics.	Reduced commercial and sport ocean salmon fishing and associated economics.	Similar conditions.

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Indian Trust Assets						
Potential for Disturbance of Indian Trust Assets	No change.	No change.	No change.	No change.	No change.	No change.
Environmental Justice						
Emissions of Criteria Air Pollutants and Precursors and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants from Diesel Engines at Groundwater Wells	Potential increase in emissions (up to 18%).	No change.	Potential increase in emissions (up to 18%).	Similar conditions.	No change.	Potential increase in emissions (up to 18%).
Potential Exposure to Mercury in Fish in Delta	Increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).	No change.	Increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).	Similar conditions.	No change.	Increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).

Contents

Appendixes

Tables

Figures

Abbreviations and Acronyms

µg/g	Micrograms per gram
µg/L	Micrograms/liter
µg/m^3	Micrograms per cubic meter
µmhos/cm	Micromhos per centimeter
µS/cm	MicroSiemens per centimeter
AB	Assembly Bill
ACID	Anderson-Cottonwood Irrigation District
ACS	American Community Survey
AF	Acre-foot/Acre-feet
AFRP	Anadromous Fish Restoration Program
AFSP	Anadromous Fish Screen Program
AIP	Alternative Intake Project
ANN	Artificial Neural Network
AQMP	Air Quality Management Plan
ARB	California Air Resources Board
ARG	American River Group
AVEK	Antelope Valley-East Kern Water Agency
(b)(2)IT	B2 Interagency Team
BA	Biological Assessment
BARDP	Bay Area Regional Desalination Project
BCAA	bromochloroacetic acid
BCC	Birds of Conservation Concern
BCDC	San Francisco Bay Conservation and Development Commission
BCSD	Bias-correction and Spatial Disaggregation
BDCP	Bay Delta Conservation Plan
BIA	Bureau of Indian Affairs
BKD	Bacterial Kidney Disease
BLM	Bureau of Land Management
BO	Biological Opinion
BP	Before Present
BRT	Biological Review Team
BSPP	Barker Slough Pumping Plant
BVWD	Bella Vista Water District

°C	Centigrade degrees
CA	California Aqueduct
CAA	Clean Air Act
CAAQS	California Ambient Air Quality Standard
CAL FIRE	California Department of Forestry and Fire Prevention
CASGEM	California Statewide Groundwater Elevation Monitoring Program
CalEPA	California Environmental Protection Agency
CAISO	California Independent System Operator Corporation
CALFED	CALFED Bay-Delta Program
CAL FIRE	California Department of Forestry and Fire Prevention
CAT	California Climate Action Team
CBMWD	Central Basin Municipal Water District
CCAA	California Clean Air Act
CCC	Criteria Continuous Concentration
CCF	Clifton Court Forebay
CCSD	Cambria Community Services District
CCTT	Clear Creek Technical Team
CCWD	Contra Costa Water District
CDFW	California Department of Fish and Wildlife (previously known as Department of Fish and Game)
CDP	Census Designated Place
CDPH	California Department of Public Health
CDWA	Central Delta Water Agency
CEC	California Energy Commission
CEQ	Council on Environmental Quality
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFR	Code of Federal Regulations
cfs	Cubic feet per second
CGS	California Geological Survey
CH_4	Methane
CHRIS	California Historical Resources Information System
cm	centimeter
CMARP	Comprehensive Monitoring, Assessment and Research Program
CMC	Criteria Maximum Concentration
CMIP3	Coupled Model Intercomparison Project Phase 3

CNAGPRA	California Native American Grave Protection and Repatriation Act
CNAHC	California Native American Heritage Commission
CNDDB	California Natural Diversity Database
CNPS	California Native Plant Society
CPUC	California Public utilities Commission
CO	Carbon monoxide
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
COA	Coordinated Operation Agreement
COC	Constituents of Concern
CRD	Contract Rate of Delivery
CRHR	California Register of Historical Resources
CRPR	California Rare Plant Rank
CSD	Community Service District
CSJWCD	Central San Joaquin Water Conservation District
CTR	California Toxics Rule
CVHM	Central Valley Hydrologic Model
CVOO	Central Valley Operations Office
CVP	Central Valley Project
CVPA	Central Valley Project Act
CVPIA	Central Valley Project Improvement Act
CVPM	Central Valley Production Model
CVRWQCB	Central Valley Regional Water Quality Control Board
CV-Salts	Central Valley Salinity Alternatives for Long-term Sustainability
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
D-893	State Water Resources Control Board Decision 893
D-1422	State Water Resources Control Board Decision 1422
D-1485	State Water Resources Control Board Decision 1485
D-1616	State Water Resources Control Board Decision 1616
D-1629	State Water Resources Control Board Decision 1629
D-1641	State Water Resources Control Board Decision 1641
DAT	Data Assessment Team
DBCP	Dibromochloropropane
DBP	Disinfection byproducts
DBW	Department of Boating and Waterways

DCC	Delta Cross Channel
DCCA	Dichloroacetic Acid
DCID	Deer Creek Irrigation District
DCT	Delta Condition Team
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
Delta	Sacramento-San Joaquin Rivers Delta Estuary
Delta Reform Act	Sacramento-San Joaquin Delta Reform Act of 2009
DFA	California Department of Food and Agriculture
DICU	Delta Island Consumptive Use
District Court	U.S. District Court for the Eastern District of California
DMC	Delta-Mendota Canal
DMC/CA Intertie	Delta-Mendota Canal and California Aqueduct Intertie
DO	Dissolved Oxygen
DOC	Dissolved organic carbon
DOI	Department of the Interior
DOM	Dissolved Organic Matter
DOSS	Delta Operations Salmonid and Sturgeon
DPC	Delta Protection Commission
DPM	Delta Passage Model
DPS	Distinct Population Segment
DSRAM	Delta Smelt Risk Assessment Matrix
dw	dry weight
DWR	California Department of Water Resources
EDWPA	El Dorado Water and Power Authority
EBMUD	East Bay Municipal Utility District
EC	Electrical Conductivity
ECe	Electrical Conductivity of a Saturated Soil Index
ECw	Electrical Conductivity
EFH	Essential Fish Habitat
E:I	Export to Inflow Ratio
EID	El Dorado Irrigation District
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EJ	Environmental Justice
EO	Executive Order
EOM	end-of-month

EOS	End-of-September
EQ	exceedance quotient
ERP	Ecosystem Restoration Program
ESA	Endangered Species Act
ESU	Evolutionary Significant Unit
ET	evapotranspiration
ETM	Estuarine Turbidity Maximum
EWA	Environmental Water Account
EWP	Environmental Water Program
°F	Fahrenheit degrees
FCAA	Federal Clean Air Act
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FID	Fresno Irrigation District
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FMMP	Farmland Mapping and Monitoring Program
FMP	Farm Process
FMS	Flow Management Standard
FMWT	Fall Midwater Trawl Survey
FP	Fully-Protected Species
FPPA	Farmland Protection Policy Act
FR	Federal Register
FRFH	Feather River Fish Hatchery
FRPA	Fish Restoration Program Agreement
FRPP	Farm and Ranch Land Protection Program
FRWP	Freeport Regional Water Project
ft	Foot/Feet
ft/s	Feet per second
FTE	full-time equivalent
GAMA	Groundwater Ambient Monitoring and Assessment
GBP	Grasslands Bypass Project
GCID	Glenn-Colusa Irrigation District
GCM	global climate model
GDP	gross domestic product
GHG	Greenhouse Gas
GIS	geographic information system
gpm	Gallons per minute

GORT	Gate Operations Review Team
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
GWh	Gigawatt-hour
GWMP	Groundwater Management Plans
GWP	Global Warming Potential
HAP	Hazardous Air Pollutants
HC	Hydrocarbons
HCP	Habitat Conservation Plan
HFC	hydrofluorocarbons
HFC	High Flow Channel
HGMP	Hatchery Genetic Management Plan
HOR	Head of Old River
HORB	Head of Old River Barrier
I/E or I:E	Inflow to Export Ratio (San Joaquin River)
I-O	Input-Output Model
ID	Irrigation District
IEP	Interagency Ecological Program
IEUA	Inland Empire Utilities Agency
IFIM	Instream Flow Incremental Methodology
IHN	Infectious Hematopoietic Necrosis
ILRP	Irrigated Lands Regulatory Program
in	Inch/Inches
IPCC	Intergovernmental Panel on Climate Change
IPO	Interim Plan of Operation
IRWMP	Integrated Regional Water Management Plan
ISRMA	Interlakes Special Recreation Management Area
ITA	Indian Trust Assets
JCSD	Jurupa Community Services District
JPOD	Joint Point of Diversion
Km	Kilometers
KRCD	Kings River Conservation District
LACSD	Los Angeles County Sanitation District
lbs	Pounds
LFC	Low Flow Channel
LIM	Land Inventory and Monitoring System

LYRA	Lower Yuba River Accord

m	meter
m/day	meters per day
M&I	Municipal and Industrial
m/s	meter per second
MACT	Maximum Achievable Control Technology
MAF	Million acre-feet or Million acre-foot
MBTA	Migratory Bird Treaty Act
MCAA	Monochloroacetic Acid
MCL	Maximum Contaminant Level
MERP	Mercury Exposure Reduction Program
Metropolitan	Metropolitan Water District of Southern California
mg/L	Milligrams per liter
mgd	Million gallons per day
MIDS	Morrow Island Distribution System
MLD	Most Likely Descendent
mm	Millimeter
mmhos/cm	millimhos per centimeter
MMPA	Marine Mammal Protection Act
MOA	Memorandum of Agreement
MORE	Mokelumne River Water & Power Authority
MOU	Memorandum of Understanding
MRR	minimum release requirements
msl	Mean Sea Level
mS/cm	MilliSiemens per Centimeter
MVCD	Mosquito and Vector Control Districts
MW	Megawatt
MWDOC	Metropolitan Water District of Orange County
MWDSC	Metropolitan Water District of Southern California
MWh	Megawatt-hours

N	Nitrogen
N_2O	Nitrous oxide
NAA	No Action Alternative
NAAQS	National Ambient Air Quality Standard
NAGPRA	Native American Graves Protection and Repatriation Act
NAHC	Native American Heritage Commission
NAICS	North American Industry Classification

NASS	National Agricultural Statistics Service
NAWMP	North American Waterfowl Management Plan
NBA	North Bay Aqueduct
NCPA	Northern California Power Agency
NCCP	Natural Community Conservation Plan
NDMA	N-nitrosodimethylamine
NDWA	North Delta Water Agency
NESHAP	National Emission Standards for Hazardous Air Pollutants
NEPA	National Environmental Policy Act
ng/L	nanograms per liter
NHPA	National Historic Preservation Act
NHTSA	National Highway and Traffic Safety Administration
NMFS	National Marine Fisheries Service
NMFS BO	National Marine Fisheries Service 2009 Biological Opinion
NO_2	nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NO_x	Nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NPPA	Native Plant Protection Act
NPS	National Park Service
NRA	National Recreation Area
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NRWQC	National Recommended Water Quality Criteria
NSJCGBA	Northeastern San Joaquin County Groundwater Banking Authority
NSPS	New Source Performance Standards
NSR	New Source Review
NTR	National Toxics Rule
NTU	Nephelometric Turbidity Unit
NWR	National Wildlife Refuge
O_3	Ozone
OBB	Orange Blossom Bridge
OBTCC	Oak Bottom Temperature Control Curtain
OCAP	Operations Criteria and Plan
OEHHA	California Office of Environmental Health Hazard Assessment

OFF	Operations and Fishery Forum
OID	Oakdale Irrigation District
OMR	Old and Middle Rivers
OMWD	Olivenhain Municipal Water District
OWA	Oroville Wildlife Area
P	Phosphorous
PAH	Polycyclic Aromatic Hydrocarbons
Pb	Lead
PBDE	Polybrominated Diphenyl Ethers
PBO	Programmatic Biological Opinion
PCB	Polychlorinated Biphenyls
PCE	Perchloroethylene
PCE	Primary Constituent Element
PCWA	Placer County Water Agency
PDA	Public-Domain Allotments
PEIS	Programmatic Environmental Impact Statement
PFC	perfluorocarbons
PFMC	Pacific Fishery Management Council
PG&E	Pacific Gas & Electric Company
PHG	Public Health Goal
PM	Particulate matter
PM_{10}	Particulate matter less than 10 microns in aerodynamic diameter
$PM_{2.5}$	Particulate matter less than 2.5 microns in aerodynamic diameter
POD	Pelagic Organism Decline
Porter-Cologne Act	Porter Cologne Water Quality Control Act
ppb	Parts per billion (by volume)
ppm	Parts per million (by volume)
PRC	California Public Records Code
Projects	Central Valley Project and State Water Project
PSD	Federal Prevention of Significant Deterioration
psu	Practical Salinity Unit
PTE	Potential To Emit
PWD	Palmdale Water District
RBDD	Red Bluff Diversion Dam
RBPP	Red Bluff Pumping Plant
RCWD	Rancho California Water District

Reclamation	Department of the Interior, Bureau of Reclamation
RHNA	Regional Housing Needs Assessment
RM	River Mile
RMP	Resource Management Plan
ROD	Record of Decision
ROG	Reactive Organic Gas
RPA	Reasonable and Prudent Alternative
RPS	California Renewable Portfolio Standard
RRDS	Roaring River Distribution System
RWQCB	Regional Water Quality Control Board
SA	Settlement Agreement
SAFCA	Sacramento Area Flood Control Agency
SB	Senate Bill
SBA	South Bay Aqueduct
SBC	Second Basis of Comparison
SBCWD	San Benito County Water District
SCDD	Spring Creek Debris Dam
SCE	Southern California Edison
SCI	Sacramento Catch Index
SCVWD	Santa Clara Valley Water District
SDWA	Safe Drinking Water Act
Secretary	Secretary of the Department of the Interior
SED	Substitute Environmental Document
SEWD	Stockton East Water District
SF6	sulfur hexafluoride
SGA	Sacramento Groundwater Authority
SGMA	California Sustainable Groundwater Management Act
Shasta-Trinity LRMP	Shasta-Trinity National Forest Land and Resource Management Plan
SHPO	State Historic Preservation Officer
SIP	State Implementation Plan
SJRRRP	San Joaquin River Restoration Program
SJRTC	San Joaquin River Technical Committee
SJVAPCD	San Joaquin Valley Air Pollution Control District
SLC	State Lands Commission
SLE	St. Louis Encephalitis Virus
SMP	Suisun Marsh Habitat Management, Preservation, and Restoration Plan

SMPA	Suisun Marsh Preservation Agreement
SMSCG	Suisun Marsh Salinity Control Gate
SMUD	Sacramento Municipal Utilities District
SNMP	Salt and Nitrate Management Plan
SO_2	Sulfur Dioxide
SOx	sulfur oxides
SOG	Stanislaus Operations Group (also known as the Stanislaus Operations Team [SOT])
SONCC	Southern Oregon/Northern California Coast
SRA	State Recreation Area
SRCA	Sacramento River Conservation Area
SRCD	Suisun Resource Conservation District
SRES	Special Report on Emissions Scenarios
SRTTG	Sacramento River Temperature Task Group
SRWA	Sacramento River Wildlife Area
SSC	Species of Special Concern
SSJID	South San Joaquin Irrigation District
SSWD	South Sutter Water District
SWAP	Statewide Agricultural Production Model
SWAMP	State Water Resources Control Board Surface Water Ambient Monitoring Program
SWG	Smelt Working Group
SWP	State Water Project
SWPOCO	State Water Project Operations Control Office
SWRCB	State Water Resources Control Board
TAC	Toxic Air Contaminant
TAF	Thousands of acre-feet
TBP	Temporary Barrier Project
TCAA	Trichloroacetic Acid
TCD	Temperature Control Device
TCDD	Tetrachlorodibenzodioxin
TCE	Trichloroethylene
TDS	Total Dissolved Solids
TFCF	Tracy Fish Collection Facility
TMDL	Total Maximum Daily Load
TOC	Total Organic Carbon
tpy	Tons per year
TRRP	Trinity River Restoration Program

TSS	Total Suspended Sediment
UCD	University of California, Davis
UCCE	University of California Cooperative Extension
USACE	U.S. Army Corps of Engineers
USC	United States Code
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USFWS BO	U.S. Fish and Wildlife Service 2008 Biological Opinion
USGS	U.S. Geological Survey
USGVMWD	Upper San Gabriel Valley Municipal Water District
UWMP	Urban Water Management Plan
VAMP	Vernalis Adaptive Management Program
VIC	Variable Infiltration Capacity
VOC	Volatile organic compound
VVWRA	Victor Valley Wastewater Reclamation Authority
WBMWD	Western Basin Municipal Water District
WBS	water balance subregion
WDCWA	Woodland-Davis Clean Water Agency
WEE	Western Equine Encephalitis
Western	Western Area Power Administration
WMA	Wildlife Management Area
WMD	Western Municipal Water District
WNV	West Nile Virus
WOMT	Water Operations Management Team
WQCP	Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary
WR	Water Rights
WRESL	water resources simulation language
WRO	Water Rights Order
WSD	Water Storage District
WSRCD	Western Shasta Resource Conservation District
WUA	Weighted Useable Area
ww	wet weight
WY	Water Year

YCWA	Yuba County Water Agency
YOY	Young-of-the-Year
Yuba Accord	Lower Yuba River Accord

Chapter 1

Introduction

1.1 Introduction

This Environmental Impact Statement (EIS) on the Coordinated Long-Term Operation of the Central Valley Project (CVP) and State Water Project (SWP) has been prepared by the U.S. Department of the Interior, Bureau of Reclamation (Reclamation). Reclamation is the Federal lead agency for compliance with the National Environmental Policy Act (NEPA) as ordered by the United States District Court for the Eastern District of California (District Court). In 2008 and 2009, following litigation on previous Biological Opinion (BOs), Reclamation provisionally accepted and began implementing the BOs on continued long-term operation of the CVP, in coordination with the operation of the SWP issued by the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS), respectively, pursuant to the Federal Endangered Species Act of 1973 (ESA) as amended (United States Code [U.S.C.] 1531 et. seq.). In 2014, the Ninth Circuit upheld the District Court’s ruling that Reclamation’s provisional acceptance and implementation of the BOs required Reclamation to comply with NEPA. The District Court remanded Reclamation’s decision back to the agency to comply with the court’s ruling.

This EIS evaluates potential long-term direct, indirect, and cumulative impacts on the environment that could result from implementation of modifications to the continued long-term operation of the CVP and SWP. This EIS does not evaluate impacts related to implementing project-specific actions, such as impacts during construction and startup periods for actions that are not fully defined at this time and that may be implemented by Reclamation or other agencies as part of the long-term operation of the CVP and SWP.

1.2 Background

This chapter presents an overview of the CVP and SWP, the coordinated operation of the CVP and SWP, and endangered species consultations related to the long-term operation of the CVP and SWP. The long-term operation of the CVP and SWP is described in more detail in Chapter 3, Description of Alternatives; Chapter 5, Surface Water Resources and Water Supplies; and Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations.

1.2.1 Overview of the Central Valley Project

California initiated a comprehensive water plan for the state more than 100 years ago to provide water conservation, flood control, water storage, and water distribution. In 1933, the state legislature, governor, and the electorate approved construction of the CVP. Because of difficulty in marketing bonds to finance construction, the project could not be constructed by the state, and the Federal government was requested to construct the CVP.

The first Federal authorization of the CVP was by the Rivers and Harbors Act of August 30, 1935. The CVP was reauthorized for construction, operation, and maintenance by the Secretary of the Department of the Interior (Secretary), pursuant to the Reclamation Act of 1902, as amended and supplemented by the Rivers and Harbors Act of August 26, 1937. The 1937 act also provided that the dams and reservoirs of the CVP "… be used, first, for river regulation, improvement of navigation, and flood control; second, for irrigation and domestic uses; and, third, for power."

In 1992, the Central Valley Project Authorization Act of August 26, 1937, was amended by Section 3406(a) of the Central Valley Project Improvement Act (CVPIA), Public Law 102-575. The CVPIA modified the 1937 act and specified that the dams and reservoirs of the CVP be used "first, for river regulation, improvement of navigation, and flood control; second for irrigation and domestic uses and fish and wildlife mitigation, protection and restoration purposes; and third for power and fish and wildlife enhancement."

The CVP is composed of more than 18 reservoirs with a combined storage capacity of more than 11 million acre-feet, more than 10 hydroelectric power plants, and more than 500 miles of major canals and aqueducts (Figure 1.1 at the end of this chapter). The major CVP reservoirs are in the Sacramento-San Joaquin Rivers Delta Estuary (Delta) watershed, including Shasta Lake on the Sacramento River, Folsom Lake on the American River, New Melones Reservoir on the Stanislaus River, and Millerton Lake on the San Joaquin River. The CVP also diverts water from Trinity Lake (on the Trinity River) to the Sacramento River system. CVP pumping plants and canals include the Red Bluff Pumping Plant, which diverts water from the Sacramento River into the CVP Tehama-Colusa Canal; Folsom South Canal, which conveys water from Folsom Lake to southeastern Sacramento County; Contra Costa Canal Pumping Plant, which diverts water from Rock Slough in the Delta into the CVP Contra Costa Canal; and Jones Pumping Plant, which diverts water from the south Delta into the CVP Delta-Mendota Canal (DMC).

These facilities are generally operated as an integrated project, although they are authorized and categorized in more distinct units or divisions. However, not all facilities are operated to meet each of the above-identified project purposes. For example, flood control is not an authorized purpose of the CVP Trinity River Division.

The facilities, operational criteria and constraints, and authorizations of the CVP are described in Chapter 5, Surface Water Resources and Water Supplies.

1.2.2 Overview of the State Water Project

After World War II, California's population almost doubled, and more water was needed. In addition, devastating floods occurred in northern and central

California in the 1950s. To provide more reliable water supplies and reduce the flood risk in the Sacramento Valley, the state legislature appropriated funds to the California Department of Water Resources (DWR) to construct the SWP under the State Central Valley Project Act (Water Code Section 11100 et seq.), Burns-Porter Act (California Water Resources Development Bond Act), State Contract Act (Public Contract Code Section 10100 et seq.), Davis-Dolwig Act (Water Code Sections 11900 through 11925), and other acts of the state legislature. The plans for the SWP included a reservoir on the Feather River near Oroville (Lake Oroville), a Delta cross channel, an electric power transmission system, an aqueduct to convey water from the Delta to Solano and Napa counties (North Bay Aqueduct), an aqueduct to convey water from the Delta to the San Francisco Bay Area (South Bay Aqueduct and a reservoir in Alameda County), an aqueduct (California Aqueduct) with the San Luis Dam to convey water from the Delta to the San Joaquin Valley and southern California, and several reservoirs in southern California.

DWR is required to plan for recreational and fish and wildlife uses of water in connection with the SWP and other state-constructed water projects (Water Code Sections 233, 345, 346, 12582). The Davis-Dolwig Act (Water Code Sections 11900 through 11925) established the policy that preservation of fish and wildlife is part of state costs to be paid by SWP water supply contractors, and recreation and enhancement of fish and wildlife are to be provided by appropriations from the General Fund.

1.2.3 Coordinated Operation of the CVP and SWP

The CVP and SWP are operated in a coordinated manner in accordance with Public Law 99-546 (October 27, 1986), directing the Secretary to execute the Coordinated Operation Agreement (COA). The CVP and SWP are also operated under State Water Resources Control Board (SWRCB) decisions and water right orders related to the CVP's and SWP's water right permits and licenses to appropriate water by diverting to storage, by directly diverting to use, or by re-diverting releases from storage later in the year or in subsequent years.

The CVP and SWP are permitted by SWRCB to store water, divert water and re-divert CVP and SWP water that has been stored in upstream reservoirs. The CVP and SWP have built water storage and water delivery facilities in the Central Valley to deliver water supplies to CVP and SWP contractors, including senior water users. The CVP's and SWP's water rights are conditioned by the SWRCB to protect the beneficial uses of water within the watersheds.

As conditions of the water right permits and licenses, SWRCB requires the CVP and SWP to meet specific water quality objectives within the Delta. Reclamation and DWR coordinate operation of the CVP and SWP, pursuant to the COA, to meet these and other operating requirements. The COA is an agreement between the Federal government and the State of California for the coordinated operation of the CVP and SWP. The agreement suspended a 1960 agreement and superseded annual coordination agreements that had been implemented following construction of the SWP.

The COA established the operating framework for the CVP and SWP based upon conditions in the 1980s, by setting forth: (1) definitions of the CVP and SWP facilities and their water supplies, (2) procedures for coordination of operations, (3) formulas for sharing joint responsibilities for meeting Delta standards and ensuring no injury to other legal uses of water, (4) criteria for sharing unstored flow in the Delta, (5) a framework for exchange of water and services between the SWP and CVP, and (6) provisions for periodic reviews. Coordinated operation by agreed-on criteria can increase the efficiency of both the CVP and the SWP.

Implementation of the COA has evolved continually since 1986 as CVP and SWP facilities, operational criteria, and physical and regulatory environment have changed. For example, adoption of the CVPIA in 1992 changed purposes and operations of the CVP, and ESA responsibilities have affected operation of the CVP and SWP. Since 1986, facilities operations have been modified in response to statutory and regulatory requirements that were not part of the original COA assumptions or requirements. In addition, water quality objectives have been revised by the SWRCB since 1986 in the 1995 and 2006 Water Quality Control Plans and implemented through SWRCB Decision 1641. DWR and Reclamation have operational arrangements to accommodate new facilities, water quality objectives, the CVPIA, other SWRCB criteria, and the ESA, but the COA has not been formally modified to address these newer operating conditions.

1.2.4 Federal Endangered Species Consultation

In addition to the conditions and limitations imposed by the SWRCB on the water rights permits and licenses for the CVP and SWP, Federal agencies have an obligation pursuant to Section (7a)(2) of the ESA to determine that any discretionary action authorized, funded, or carried out by the agency is not likely to jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of their critical habitat [16 U.S.C. 1536 (a)(2)]. A discretionary agency action jeopardizes the continued existence of a listed species if the action is reasonably expected to directly or indirectly appreciably reduce the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of the listed species (50 Code of Federal Regulations [CFR] 402.02).

In carrying out its obligations, Reclamation must consult with the appropriate regulatory agency or agencies (e.g., USFWS and NMFS) when an action may affect listed species. After the formal consultation process, those agencies render written statements (Biological Opinions or BOs) setting forth their opinion as to effects of the agency action on listed species and its designated critical habitat. If these agencies conclude that the action will jeopardize the continued existence of a listed species or result in the destruction or adverse modification of their designated critical habitat, they must suggest a Reasonable and Prudent Alternative (or RPA) to the agency action if one exists. As defined in the ESA, RPAs “refer to alternative actions identified during formal consultation that can be implemented in a manner consistent with the intended purpose of the action, that can be implemented consistent with the scope of the Federal agency’s legal authority and jurisdiction, that is economically and technologically feasible, and that the Director believes would avoid the likelihood of jeopardizing the continued existence of listed species or resulting in the destruction or adverse modification of critical habitat" (40 CFR 402.02).

If the SWP seeks to avail itself of the incidental take exemption provided by the BOs, the coordinated long-term operation of the SWP would be subject to the BOs, including any reasonable and prudent measures, terms and conditions, or RPAs required by the BOs.

1.2.4.1 Threatened and Endangered Species Considered in ESA Consultation for Coordinated Long-Term Operation of the CVP and SWP

The following species, and their associated ESA and critical habitat listing rules, were considered in recent ESA consultations with USFWS and NMFS for the coordinated long-term operation of the CVP and SWP analysis in this document:

- Sacramento River winter-run Chinook Salmon (*Oncorhynchus tshawytscha*) Evolutionarily Significant Unit (ESU) was originally listed as threatened in August 1989, under emergency provisions of the ESA, and formally listed as threatened in November 1990 (55 FR 46515). They were re-classified as an endangered species on January 4, 1994 (59 FR 440).
- Central Valley spring-run Chinook Salmon (*O. tshawytscha*) ESU was listed as threatened on June 18, 2005 (70 FR 37160).
- Central Valley Steelhead (*O. mykiss*) Distinct Population Segment (DPS) was listed as threatened on January 5, 2006 (71 FR 834).
- Southern Oregon/Northern California Coast Coho Salmon (*O. kisutch*) ESU was reaffirmed as threatened on June 18, 2005 (70 FR 37160).
- Southern DPS of the North American Green Sturgeon (*Acipenser medirostris*) was listed as threatened on June 6, 2006 (71 FR 17757).
- Southern Resident DPS of Killer Whales (*Orcinus orca*) was listed as endangered on November 18, 2005 (70 FR 69903-69912).
- Delta Smelt (*Hypomesus transpacificus*) was listed as threatened on March 5, 1993 (58 FR 12854). The species was recently proposed for re-listing as endangered under the ESA.

Fall and late-fall runs of Chinook Salmon are currently Federal Species of Concern, but have not been formally listed.

Central California Coast Steelhead (*O. mykiss*) DPS was listed as threatened on January 5, 2006 (71 FR 834). The 2009 NMFS BO determined that the long-term operation of the CVP and SWP would not likely adversely affect Central California Coast Steelhead DPS and its critical habitat. Therefore, no further analysis of this DPS was performed for this EIS.

1.2.4.2 Recent ESA Consultation Activities and Court Rulings

Reclamation submitted a biological assessment to USFWS and NMFS for consultation on the long-term operation of the CVP and SWP in June 2004. Because SWP operations are coordinated with CVP operations, SWP operations are included in Reclamation's action. NMFS has responsibility for anadromous fish and marine mammals, and USFWS has jurisdiction over all other ESA listed species.

In July 2004, USFWS issued its BO "Formal and Early Section 7 Endangered Species Consultation on the Coordinated Operations of the Central Valley Project and State Water Project and the Operations Criteria and Plan to Address Potential Critical Habitat Issues." In February 2005, USFWS issued the "Re-Initiation 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."

On October 22, 2004, NMFS issued its "Biological Opinion and Conference Opinion on the Long-Term Operations of the Central Valley Project and State Water Project."

On April 26, 2006, Reclamation requested that the NMFS consultation be re-initiated based on the new listing of the Southern DPS of the North American Green Sturgeon. On May 19, 2006, Reclamation requested that the USFWS consultation be re-initiated because of the potential for the re-initiation of the NMFS consultation to affect the Delta Smelt and because of recently compiled data related to the pelagic organism decline.

Following the issuance of the 2004 and 2005 BOs, litigation was filed against the Department of the Interior and the Department of Commerce challenging the validity of these BOs. Following a finding that the CVP/SWP operation analyzed in the 2005 BO jeopardized the continued existence of Delta Smelt, on December 14, 2007, the District Court issued an Interim Remedial Order in *Natural Resources Defense Council, et al. v. Kempthorne*, 1:05-cv-1207 OWW GSA (E.D. Cal. 2007), to provide additional protection for Delta Smelt pending completion of a new USFWS BO for the continued long-term operation of the CVP and SWP. The Interim Remedial Order remained in effect until USFWS issued a new BO for the continued long-term operation of the CVP and SWP on December 15, 2008.

On April 16, 2008, the District Court issued a Memorandum Decision and Order on the Cross-Motions for Summary Judgment filed in *Pacific Coast Federation of Fishermen's Associations, et al. v. Gutierrez*, 1:06-cv-245-OWW-GSA (E.D. Cal. 2008). The District Court found that the BO issued by NMFS in 2004 was invalid. An evidentiary hearing followed, resulting in a Remedies Ruling on July 18, 2008. The ruling concluded that the District Court needed further evidence to consider the Plaintiffs' proposed restrictions on the long-term coordinated CVP and SWP operation.

In August 2008, Reclamation submitted a biological assessment to USFWS and NMFS for consultation.

On December 15, 2008, USFWS issued a BO analyzing the effects of the coordinated long-term operation of the CVP and SWP on Delta Smelt and its designated critical habitat. The 2008 USFWS BO concluded that ‘‘the coordinated operation of the CVP and SWP, as proposed, [was] likely to jeopardize the continued existence of the Delta Smelt’’ and ‘‘adversely modify Delta Smelt critical habitat.’’ The BO included an RPA for long-term operation of the CVP and SWP designed to allow the projects to continue operating without causing jeopardy to Delta Smelt or adverse modification of designated critical habitat.

On December 15, 2008, Reclamation provisionally accepted and began implementing the USFWS RPA.

On June 4, 2009, NMFS issued a BO analyzing the effects of the coordinated long-term operation of the CVP and SWP on listed salmonids, Green Sturgeon, and southern resident Killer Whale and their designated critical habitats. The NMFS BO concluded that the long-term operation of the CVP and SWP, as proposed, was likely to jeopardize the continued existence of Sacramento River winter-run Chinook Salmon, Central Valley spring-run Chinook Salmon, Central Valley Steelhead, Southern DPS of North American Green Sturgeon, and Southern Resident Killer Whales. Further, the BO concluded that the proposed action would destroy or adversely modify critical habitat for Sacramento River winter-run Chinook Salmon, Central Valley spring-run Chinook Salmon, Central Valley Steelhead, and Southern DPS of North American Green Sturgeon.

The 2009 NMFS BO included an RPA designed to allow the CVP and SWP to continue operating without causing jeopardy to the analyzed species or adverse modification of their designated critical habitat. On June 4, 2009, Reclamation provisionally accepted and began implementing the NMFS RPA.

Several lawsuits were filed in the District Court challenging aspects of the 2008 USFWS BO and the 2009 NMFS BO and Reclamation’s acceptance and implementation of the associated RPAs. Many of the lawsuits were consolidated into two proceedings focused on each BO. The outcomes of the *Consolidated Delta Smelt Cases* and the *Consolidated Salmonid Cases* are summarized below.

- *Consolidated Delta Smelt Cases*
    - On November 16, 2009, the District Court ruled that Reclamation violated NEPA by failing to conduct a NEPA review of the potential impacts on the human environment before provisionally accepting and implementing the 2008 USFWS BO, including the RPA.
    - On December 14, 2010, the District Court found certain portions of the 2008 USFWS BO to be arbitrary and capricious in several respects and remanded those portions of the BO to USFWS without vacatur for further consideration. The District Court ordered Reclamation to review its decision to provisionally accept and implement the BO and RPA in accordance with NEPA.

  - The decision of the District Court related to the USFWS BO was appealed to the United States Court of Appeals for the Ninth Circuit (Appellate Court). On March 13, 2014, the Appellate Court reversed the District Court and upheld the BO. However, the Appellate Court affirmed the judgment of the District Court with respect to the NEPA claims.
  - The District Court amended the Judgement on September 30, 2014 consistent with the Appellate Court's decision. Petitions for Writ of Certiorari were submitted to the U.S. Supreme Court; however, the U.S. Supreme Court decided to not hear the cases.
- *Consolidated Salmonid Cases*
  - On March 5, 2010, the District Court ruled that Reclamation violated NEPA by failing to undertake a NEPA analysis of potential impacts on the human environment before provisionally accepting and implementing the 2009 NMFS BO and RPA.
  - On September 20, 2011, the District Court found the NMFS BO was arbitrary and capricious in several respects and remanded the 2009 NMFS BO to NMFS without vacatur for further consideration.
  - The decisions of the District Court related to the 2009 NMFS BO were appealed to the Appellate Court. On December 22, 2014, the Appellate Court reversed the District Court and upheld the BO.
  - The District Court issued the Final Order on May 5, 2015 consistent with the Appellate Court's Decision.

1.3 Need to Prepare this Environmental Impact Statement

Compliance with NEPA is a Federal responsibility and involves the participation of Federal, state, tribal, and local agencies, as well as concerned and affected members of the public in the planning process. NEPA requires that Federal agencies analyze and disclose the potential environmental impacts and possible mitigation for Federal actions and a reasonable range of alternatives to the proposed action. NEPA is required when a discretionary Federal action is proposed. The regulations [40 CFR 1508.18(a)] define a Federal action as including new and continuing activities, actions partly or entirely financed by Federal agencies (where some control and responsibility over the action remain with the Federal agency [43 CFR 46.100]), actions conducted by Federal agencies, actions approved by Federal agencies, new or revised agency rules or regulations, and proposals for legislation.

Section 102 of NEPA (42 U.S.C. 4332) indicates that a detailed analysis, such as an EIS, should be completed with proposals for Federal actions that substantially affect the quality of the human environment, including the natural and physical environment and the relationship of people with that environment (40 CFR 1508.14).

To comply with the District Court's 2010 orders regarding NEPA, Reclamation initiated preparation of this EIS in 2011. This EIS documents Reclamation's analysis of the effects of modifications to the coordinated long-term operation of the CVP and SWP that are likely to avoid jeopardy to listed species and destruction or adverse modification of designated critical habitat.

In accordance with the District Court's order in the *Consolidated Delta Smelt Cases*, the Final EIS and Record of Decision are to be completed on or before December 1, 2015. By order dated October 8, 2015, this date has been extended to January 12, 2016.

As described in Chapter 3, Description of Alternatives, many of the provisions of the RPAs, as set forth in the 2008 USFWS BO and the 2009 NMFS BO, require further study, monitoring, further consultation, implementation of adaptive management programs, and subsequent environmental documentation for future facilities to be constructed or modified. Specific actions related to these provisions are not known at this time. Therefore, this EIS assumes the completion of future actions, including provisions of the RPAs, in a manner that would be consistent with the ESA and does not address impacts during construction and startup phases of these actions.

1.4 Use of the Environmental Impact Statement

This EIS may be used by Reclamation or cooperating agencies that are participating in the preparation of this EIS to inform future decisions related to the ESA consultation and implementation of the RPAs in the 2008 USFWS BO and 2009 NMFS BO. A cooperating agency is defined as any Federal agency, except the NEPA lead agency, that has jurisdiction by law or has special expertise with respect to any environmental issue that should be addressed in the EIS (40 CFR 1501.6). A cooperating agency also can include a governmental entity (state, tribal, or local) that has jurisdiction by law or special expertise with respect to any environmental impact associated with the action being considered. The cooperating agencies for this EIS are listed in Section 1.6.

1.5 Proposed Action and Preferred Alternative

The Notice of Intent identified an "initial Proposed Action" that included the operational actions of the 2008 USFWS BO and 2009 NMFS BO, without structural changes included in the RPA actions that would require future studies and environmental documentation to define recommended actions, including fish passage around the CVP dams. The initial Proposed Action is included in this EIS as Alternative 2.

Based upon the analysis of aquatic resources (see Chapter 9, Fish and Aquatic Resources), by 2030, climate change may result in substantially higher air temperatures than during recent conditions. Higher air temperatures would likely increase water temperatures in both the CVP reservoirs and in the rivers downstream of the CVP dams. Under these conditions, Reclamation may not be able to operate the reservoirs under the initial Proposed Action without fish passage in a manner that would meet water temperature objectives; and it may not be possible to avoid jeopardizing the continued existence of listed species and/or resulting in an adverse modification of critical habitat.

Based upon the results of the impact analyses presented in Chapters 5 through 21 of this EIS, the Preferred Alternative is the No Action Alternative. The No Action Alternative contains all of the RPA actions in the 2008 USFWS BO and 2009 NMFS BO, as amended, including the RPA actions to evaluate fish passage to upstream habitats that exhibit lower water temperatures. Further discussion of the selection of the Preferred Alternative will be included in the Record of Decision.

The Environmentally Preferred Alternative also will be identified and disclosed in the Record of Decision, as required by the Council of Environmental Quality regulations.

1.6 Project Area

The project area boundaries are defined by the locations of most of the CVP facilities and their service areas and all of the SWP facilities and the SWP service areas, as shown on Figure 1.1. The CVP facilities associated with Millerton Lake, including the Madera and Friant-Kern canals and their service areas, and the San Joaquin River Restoration Program are not part of the project area for this EIS because the operations of these facilities were not addressed in the 2008 USFWS BO and 2009 NMFS BO.

1.6.1 CVP Facilities

The CVP facilities evaluated in this EIS include reservoirs on the Trinity, Sacramento, American, and Stanislaus rivers; Mendota Pool on the San Joaquin River; rivers, streams, canals, and aqueducts used to convey CVP water; and the CVP service area that relies upon water from the following reservoirs (as described in Chapter 5, Surface Water Resources and Water Supplies, and Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations).

- A portion of the water from Trinity River is stored and re-regulated in Trinity Lake, Lewiston Lake, and Whiskeytown Reservoir and diverted through tunnels and power plants into the Sacramento River. Water is also stored and re-regulated in Shasta Lake and Folsom Lake. Water from these reservoirs and other reservoirs owned or operated by the CVP flows into the Sacramento River. The Red Bluff Pumping Plant on the Sacramento River lifts water into the Tehama Colusa Canal for delivery to CVP contractors. Water also is delivered from the Sacramento River, American River, and the Folsom South Canal to CVP contractors, water rights holders, and settlement contractors.

- The Sacramento River conveys water to the Delta for delivery through the Contra Costa Canal and Jones Pumping Plant. The Contra Costa Canal originates at Rock Slough near Oakley and extends to the Martinez Reservoir. Water from the Contra Costa Canal is delivered to the Contra Costa Water District. The Jones Pumping Plant at the southern end of the Delta lifts the water into the DMC. This canal delivers water to CVP contractors, who divert water directly from the DMC, and to San Joaquin River exchange contractors, who divert directly from the San Joaquin River and the Mendota Pool. CVP water is also conveyed to the San Luis Reservoir for deliveries to CVP contractors through the San Luis Canal. Water from the San Luis Reservoir is also conveyed through the Pacheco Tunnel to CVP contractors in Santa Clara and San Benito counties.
- The CVP provides water stored in New Melones Reservoir for water rights holders in the Stanislaus River watershed and CVP contractors in the northern San Joaquin Valley and to meet existing water right permit conditions to support fish and wildlife and water quality beneficial uses.

The project area includes portions of the watersheds upstream of the CVP reservoirs that support anadromous fish species, as addressed in the NMFS BO, and the service areas of CVP water users in the Trinity River Region, Sacramento and San Joaquin valleys in the Central Valley Region, and the San Francisco-Bay Area Region.

1.6.2 SWP Facilities

The SWP facilities evaluated in this EIS include Lake Oroville on the Feather River; rivers, streams, canals, and aqueducts used to convey SWP water; and the SWP service area that relies upon water from these reservoirs including:

- SWP water is stored and re-regulated in Lake Oroville and released into the Feather River, which flows into the Sacramento River. Water also is delivered from the Feather River to SWP contractors, water rights holders, and settlement contractors.
- SWP water flows in the Sacramento River to the Delta and is exported from the Delta at the Banks Pumping Plant. The Banks Pumping Plant pumps the water into the California Aqueduct, which delivers water to the SWP contractors and conveys water to the San Luis Reservoir for continued delivery in the California Aqueduct to the San Joaquin Valley, Central Coast Region, and southern California.
- The SWP provides water from the Delta to Solano and Napa counties through the North Bay Aqueduct and to Alameda and Santa Clara counties through the South Bay Aqueduct (including Lake Del Valle).

- The SWP provides water from the Delta to the Central Coast Region through the Coastal Branch Aqueduct.
- The SWP provides water from the Delta to southern California through the California Aqueduct (including Quail, Pyramid, Castaic, Silverwood, and Perris lakes).
- The SWP delivers water to the Cross-Valley Canal, when the systems have capacity, for CVP contractors.

The project area includes the service areas in the Sacramento and San Joaquin valleys in the Central Valley Region as well as the San Francisco-Bay Area, Central Coast, and Southern California regions.

1.7 Study Period

The coordinated long-term operation of the CVP and SWP, as described in this EIS, is assumed to continue to at least 2030 before CVP and SWP operations would change. These changes could include projects considered as part of the cumulative effects analyses, as described in Chapter 3, Description of Alternatives. Therefore, this EIS analyzes future conditions projected for 2030. It is recognized that many changes between existing conditions and 2030 conditions would occur without changes to CVP and SWP operations, including:

- Land use changes will occur in the Delta watershed as growth occurs as projected in local agency general plans. Much of this growth is expected in the service areas of water users with water rights that may be senior to the CVP and SWP or within the Sacramento Valley, and municipal and industrial CVP contractors will increase water demands for population growth as described in the general plans. These actions could reduce the available water supplies for use by the CVP and SWP. This EIS assumes that this growth will occur by 2030. Therefore, the effects of land use changes by 2030 will be similar in the comparison of all alternatives.
- Climate change could change CVP and SWP water supplies if the amount of snow decreases and the amount of rain either decreases or occurs within a shorter period and limits the amount of water captured in reservoirs. Sea-level rise would increase salinity in the western, central, and southern Delta, which could limit the time when CVP and SWP divert water. These actions could reduce the available water supplies for use by the CVP and SWP. Federal and state agencies have completed numerous studies that project future climate change and sea-level rise scenarios. The specific characteristics of climate change and sea-level rise are not defined at this time because this EIS includes only qualitative analyses. All of the alternatives, including the No Action Alternative, evaluated in this EIS include the same assumptions for climate change and sea-level rise. Therefore, the effects of climate change and sea-level rise will be similar in the comparison of all alternatives.

- Numerous studies are being prepared by Federal, state, and local agencies to evaluate implementation of storage projects in the Delta watershed, Delta conveyance, Delta ecosystem restoration, Delta water quality improvement through construction of treatment facilities for discharges into the Delta, and changes to the SWRCB Water Quality Control Plan. As described in Chapter 3, Description of Alternatives, most of those studies have not been completed. However, many of the facilities recommended by those studies are expected to be constructed and operational by 2030. Therefore, the effects of implementation of those facilities will be similar in the comparison of all alternatives.

As the changing conditions described above and other future changes occur, changes in long-term operation of the CVP and SWP may be required. This may require the re-initiation of consultation on the 2008 USFWS BO and 2009 NMFS BO. Therefore, because the above-described changes in conditions are likely to occur by 2030 and because new BOs would be required, this EIS considers a study period that concludes in 2030.

1.8 Participants in Preparation of the EIS

For this EIS, Reclamation is the Federal lead agency. The Federal cooperating agencies include USFWS, NMFS, U.S. Environmental Protection Agency, U.S. Army Corps of Engineers, and Bureau of Indian Affairs.

Reclamation also provided non-federal agencies with the opportunity to participate in the NEPA process if they qualified under NEPA (as described above) as a cooperating agency. In August 2012, Reclamation invited 747 non-federal entities to be cooperating agencies for this EIS, including:

- DWR
- SWRCB
- California Department of Fish and Wildlife
- Agencies that have contracts with the CVP or SWP for water delivery, water service repayment, exchange or settlement, or use of CVP or SWP facilities for conveyance
- State and Federal Contractors Water Agency
- Cities and counties within the CVP and SWP service areas
- Federally recognized tribes within the CVP and SWP service areas or areas affected by long-term operation of the CVP and SWP

Non-federal entities that meet the specified criteria for cooperating agencies are required to enter into a Memorandum of Understanding (MOU) [43 CFR 46.225(d)] with Reclamation. The MOU provides a framework for cooperating agencies to agree to their respective roles, responsibilities, and limitations, including, as appropriate, target schedules.

Reclamation has signed cooperating agency MOUs with the following entities:

- Anderson-Cottonwood Irrigation District
- California Department of Water Resources
- California Valley Miwok Tribe
- City of Hesperia
- Contra Costa Water District
- East Bay Municipal Utility District
- Friant Water Authority
- Glenn-Colusa Irrigation District
- Metropolitan Water District of Southern California
- Oakdale Irrigation District
- Reclamation District 108
- San Diego County Water Authority
- San Juan Water District
- San Luis & Delta-Mendota Water Authority
- Santa Clara Valley Water District
- Tehama Colusa Canal Authority
- Stockton East Water District
- Sutter Mutual Water District
- Zone 7 Water Agency

Reclamation also received a request from an interested party to include the Federal Emergency Management Agency (FEMA) as a cooperating agency. However, Reclamation concluded that FEMA does not meet the requirements for being a cooperative agency in accordance with Section 1501.6 of NEPA for a “Federal agency which has special expertise related to environmental issues, which should be addressed in the statement” and beyond that which could not be addressed by other cooperating Federal agencies.

1.8.1 Stakeholder and Public Involvement during Preparation of the EIS

The scoping process was initiated on March 28, 2012, with the publication of the Notice of Intent in the Federal Register (FR) and continued through June 28, 2012. Initially, the public scoping process was to be completed on May 29, 2012. During the public scoping process, other agencies and interested persons requested an extension of the public scoping process to allow additional opportunities to provide scoping comments. In response to these requests, Reclamation published a notice on May 25, 2012, extending the public scoping period through June 28, 2012.

Scoping meetings were held to inform the public and interested stakeholders about the project and to solicit comments and input on the EIS. The scoping meetings were held in the following locations and resulted in the following level of public participation:

- Madera on April 25, 2012 (6 participants)

- Diamond Bar on April 26, 2012 (3 participants)
- Sacramento on May 2, 2012 (15 participants)
- Marysville on May 3, 2012 (2 participants)
- Los Banos on May 22, 2012 (230 participants)

Reclamation posted the scoping notices in the FR, on its website, and in newspapers that served areas where the scoping meetings were held. Reclamation also published press releases to news organizations and others that have requested notifications for all press releases.

Scoping comments were used in the development of a reasonable range of alternatives and identification of key issues that would require analysis in the Environmental Consequences sections of this EIS, as described in Chapter 3, Description of Alternatives, and Chapter 23, Consultation, Coordination, and Cooperation.

Reclamation also posted on its website an initial range of alternatives discussed at a stakeholders meeting on October 19, 2012. As described in Chapter 3, Description of Alternatives, comments received during that process were used to refine the description of the alternatives.

Project status meetings were held with cooperating agencies and other stakeholders during preparation of the Draft EIS, including meetings in Sacramento on January 16, May 29, and November 5, 2014; and February 20 and June 24, 2015.

1.8.2 Stakeholder and Public Involvement during Preparation of the Final EIS

The Draft EIS was published for public review in July 2015. The distribution list for the Public Draft EIS is included in Chapter 24. Reclamation posted notification of the availability of the Public Draft EIS and the location and timing of public hearing(s) on its website, in the FR, and through press releases.

Four public meetings were held during the public review period for the Draft EIS in the following locations, with the following level of participation:

- Sacramento on September 9, 2015 (9 participants)
- Red Bluff on September 10, 2015 (9 participants)
- Los Banos on Tuesday, September 15, 2015 (9 participants)
- Irvine on September 17, 2015 (2 participants)

Approximately 860 written and verbal comments were received on the Draft EIS. All of the comments received on the Draft EIS were considered in preparation of the Final EIS. Written responses to all substantive comments received are included in Appendices 1A through 1E of the Final EIS.

1.9 Related Projects and Activities

Because the EIS study area is large, many activities and studies that are currently ongoing or planned for the near future could be affected by the findings of the EIS or are related actions of long-term operation of the CVP and SWP. Preliminary information from these studies and projects has been used to describe the No Action Alternative or to assess cumulative impacts of implementing alternatives evaluated in this EIS. Some of these projects are adjacent to, but not specifically part of the Study Area (e.g., San Joaquin River Restoration Program). However, these projects have been included in the cumulative effects analysis because of indirect effects on the Study Area. The following studies and projects are summarized in Chapter 3, Description of Alternatives, as either part of the No Action Alternative or the cumulative effects analyses:

- Trinity River Restoration Program
- Continued Implementation of the Central Valley Project Improvement Act Provisions
- Clear Creek Mercury Abatement and Fisheries Restoration Project
- Iron Mountain Mine Superfund Site
- Mainstem Sacramento River, American River, and Stanislaus River Gravel Augmentation Program
- Nimbus Fish Hatchery Fish Passage Project
- Folsom Dam Water Control Manual Update
- FERC Relicensing for Middle Fork of the American River Project
- Lower Mokelumne River Spawning Habitat Improvement Project
- Dutch Slough Tidal Marsh Restoration
- Suisun Marsh Habitat Management, Preservation, and Restoration Plan Implementation
- Tidal Wetland Restoration in the Delta and Suisun Marsh
- San Joaquin River Restoration Program
- Stockton Deep Water Ship Channel Dissolved Oxygen Project
- Grassland Bypass Project
- Central Valley Salinity Alternatives for Long-term Sustainability (CV-Salts)
- Long-term Water Transfers
- Municipal Water Supply Projects that are being implemented (including City of Stockton Delta Water Supply Project, Woodland-Davis Water Supply Project, water recycling programs, San Diego County Water Authority

Carlsbad Seawater Desalination Facility, groundwater bank and wellfield expansions)

- Yolo Bypass Salmonid Habitat Restoration and Fish Passage Implementation Plan
- Bay-Delta Water Quality Control Plan Update
- California WaterFix (Bay Delta Conservation Plan)
- California EcoRestore
- Shasta Lake Water Resources Investigation
- North of Delta Offstream Storage Investigation
- Federal Energy Regulatory Commission (FERC) License Renewal Projects (including SWP Oroville Project, Yuba-Bear and Drum Spaulding Projects, Turlock Irrigation District and Modesto Irrigation District Don Pedro Project, and Merced Irrigation District Merced River Hydroelectric Project)
- El Dorado Water and Power Authority Supplemental Water Rights Project
- Northeastern San Joaquin County Groundwater Banking Authority
- Semitropic Water Storage District Delta Wetlands
- North Bay Aqueduct Alternative Intake
- Los Vaqueros Reservoir Expansion Phase 2
- Upper San Joaquin River Basin Storage Investigation
- Central Valley Regional Water Quality Control Board Irrigated Lands Regulatory Program
- San Luis Reservoir Low Point Improvement Project
- Future Water Supply Projects (including groundwater storage and recovery projects; major conveyance projects, including Sacramento River Water Reliability Project, water recycling, and desalination projects)
- Contra Loma Reservoir and Recreation Resource Management Plan
- San Luis Reservoir State Recreation Area Resource Management Plan/General Plan
- *Westlands Water District v. United States Settlement*
- Mill Creek Riparian Assessment
- Yolo County Habitat/Natural Community Conservation Plan
- North Delta Flood Control and Ecosystem Restoration Project
- Franks Tract Project
- Future Water Supply Projects (including groundwater storage and recovery, conveyance, water recycling, desalination, and water transfers).

1.10 Organization of the Environmental Impact Statement

The Final EIS was prepared by incorporating changes identified during the public review of the Draft EIS. Chapters 1 through 25 and the Executive Summary have been revised and included in the Final EIS in response to comments received on the Draft EIS. Changes to the Appendices 3A through 19B have been included in the Final EIS as Errata sheets placed in front of each appendix. Appendices 1A through 1E include the comments on the Draft EIS and their corresponding responses. Three additional appendices have been added to the Final EIS to provide more detailed information requested by several commenters (Appendices 5E, 9O, and 9P).

This EIS is organized as follows:

- The **Executive Summary** presents the purpose and intended uses of this EIS and summarizes the project background, need to prepare this EIS, project area and study period, an overview of the alternatives, and major conclusions of the environmental analysis. A table summarizing the environmental consequences, mitigation measures, and significant impacts for the alternatives is included.
- **Chapter 1, Introduction,** summarizes the project background, need to prepare this EIS, use of this EIS, project area and study period, stakeholder and public involvement in the preparation of the EIS, and related projects and activities.
- **Chapter 2, Purpose and Need for the Action,** summarizes the underlying purpose and need to which Reclamation is responding in proposing the alternatives for the action.
- **Chapter 3, Description of Alternatives,** summarizes the methods used for developing the alternatives considered in the EIS, describes the alternatives, and discusses the alternatives considered but eliminated from detailed analysis.
- **Chapter 4, Approach to Environmental Analyses,** describes the approach and terms used in the description of the regulatory setting, affected environment, environmental consequences, cumulative effects, and mitigation measures, if appropriate, for the resource topics identified in Chapters 5 through 21.
- **Chapters 5 through 21** include the regulatory setting, affected environment, and environmental consequences for 17 resource topics and discuss methods of analysis, environmental impacts, and mitigation measures for potential direct and indirect impacts. References for each resource are included within each of these chapters, as follows:
  - Chapter 5 – Surface Water Resources and Water Supplies
  - Chapter 6 – Surface Water Quality

  - Chapter 7 – Groundwater Resources and Groundwater Quality
  - Chapter 8 – Energy
  - Chapter 9 – Fisheries and Aquatic Resources
  - Chapter 10 – Terrestrial Biological Resources
  - Chapter 11 – Geology and Soils
  - Chapter 12 – Agricultural Resources
  - Chapter 13 – Land Use
  - Chapter 14 – Visual Resources
  - Chapter 15 – Recreation Resources
  - Chapter 16 – Air Quality and Greenhouse Gas Emissions
  - Chapter 17 – Cultural Resources
  - Chapter 18 – Public Health
  - Chapter 19 – Socioeconomics
  - Chapter 20 – Indian Trust Assets
  - Chapter 21 – Environmental Justice

- **Chapter 22, Other NEPA Considerations,** summarizes the environmental effects of implementation of the alternatives related to growth-inducing indirect impacts, the relationship between short-term and long-term productivity, irreversible and irretrievable commitments of resources, and impacts on other Federal and non-federal projects and plans.

- **Chapter 23, Consultation, Coordination, and Cooperation,** summarizes public and stakeholder involvement activities under NEPA; Native American consultation; consultation with other Federal, state, regional, and local agencies; consultation with other entities and organizations; and unresolved issues.

- **Chapter 24, Distribution List for Draft EIS and Final EIS,** provides locations where the Draft EIS was available for review and provides an overview of governmental entities, organizations, and interested parties that received a copy of the Draft EIS. The Final EIS was distributed to the same distribution list.

- **Chapter 25, List of Preparers,** provides a list of individuals who participated in the preparation of the EIS.

- **Chapter 26, Index,** provides an index of key topics in Chapters 1 through 23.

- **Appendices** contain background information including modeling methodologies, assumptions, and results; and lists and statuses of species federally listed as threatened and endangered evaluated in this EIS.

Figure 1.1 Study Area

Chapter 2

Purpose and Need for the Action

2.1 Introduction

National Environmental Policy Act (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" (40 Code of Federal Regulations 1502.13).

2.2 Purpose of the Action

The purpose of the action considered in this Environmental Impact Statement (EIS) is to continue the operation of the Central Valley Project (CVP), in coordination with operation of the State Water Project (SWP), for the authorized purposes, in a manner that:

- Is similar to historical operational parameters with certain modifications
- Is consistent with Federal Reclamation law; other Federal laws and regulations; Federal permits and licenses; and State of California water rights, permits, and licenses
- Enables the Bureau of Reclamation (Reclamation) and the California Department of Water Resources (DWR) to satisfy their contractual obligations to the fullest extent possible

2.3 Need for the Action

Continued operation of the CVP is needed to provide river regulation; improvement of navigation; flood control; water supply for irrigation and domestic uses; fish and wildlife mitigation, protection, and restoration; fish and wildlife enhancement; and power generation. The CVP and the SWP facilities also are operated to provide recreation benefits and in accordance with the water rights and water quality requirements adopted by the State Water Resources Control Board.

As described in Chapter 1, Introduction, the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) concluded in their 2008 and 2009 Biological Opinions (BOs), respectively, that coordinated long-term operation of the CVP and SWP, as described in the 2008 Reclamation Biological Assessment, jeopardizes the continued existences of listed species and adversely modifies critical habitat. To remedy this, USFWS and NMFS provided Reasonable and Prudent Alternatives (RPAs) in their BOs.

The U.S. Court of Appeals for the Ninth Circuit confirmed the U.S. District Court for the Eastern District of California ruling that Reclamation must conduct a NEPA review to determine whether the RPA actions cause a significant impact on the human environment. Potential modifications to the coordinated operation of the CVP and SWP analyzed in the EIS process should be consistent with the intended purpose of the action, be within the scope of Reclamation's legal authority and jurisdiction, be economically and technologically feasible, and avoid the likelihood of jeopardizing listed species or resulting in the destruction or adverse modification of critical habitat in compliance with the requirements of Section 7(a)(2) of the Endangered Species Act.

Chapter 3

Description of Alternatives

3.1 Introduction

This chapter describes the methodology used for development of all potential alternatives and the basis for selecting the reasonable range of alternatives which are evaluated in detail in this Environmental Impact Statement (EIS).

3.2 Approach to Identify Potential Alternatives

This EIS evaluates a range of alternatives to the No Action Alternative for the coordinated long-term operation of the Central Valley Project (CVP) and the State Water Project (SWP) in the Year 2030. The No-Action Alternative includes full implementation of the 2008 USFWS Biological Opinion (2008 USFWS BO) and the 2009 National Marine Fisheries Service (NMFS) Biological Opinion (2009 NMFS BO) Reasonable and Prudent Alternatives (RPAs), in addition to other ongoing and future programs that are reasonably foreseeable to occur by 2030.

Identification of the No Action Alternative and the range of action alternatives for this EIS were developed in response to the purpose and need for the action as well as comments received during the scoping process and during preparation of the Draft EIS, as summarized below.

3.2.1 Scoping Process

The scoping process was initiated on March 28, 2012, with the publication of the Notice of Intent in the Federal Register (FR) and continued through June 28, 2012. Five scoping meetings were held to inform the public and interested stakeholders about the project, and to solicit comments and input on the EIS. The scoping meetings were held in Madera, Diamond Bar, Sacramento, Marysville, and Los Banos, California, in April and May 2012. Many scoping comments addressed the definition and range of alternatives, as summarized below and in the Scoping Report (included as Appendix 23A of this EIS).

- Alternative South Delta operation criteria, including:
    - Changes to Old and Middle River (OMR) flow criteria from what was described in the 2008 USFWS BO and 2009 NMFS BO
    - Changes to operational criteria of CVP and SWP south Delta intakes relative to the ratio of San Joaquin River inflows to south Delta exports;
    - Changes to measurement methods for OMR flow criteria related to locations of measurements and inclusion of Contra Costa Water District intakes within the calculations of OMR flows.

- Measures to benefit the survival and recovery of listed aquatic species that do not involve modifications of long-term operation of the CVP and SWP, such as improved water quality, reduction of populations of predators of listed aquatic species in the Delta, regulation of small unscreened water diversions, restoration of floodplain habitat, and provisions for levee vegetation approaches.
- Measures to improve primary productivity and food supply for salmonids and smelts Smelt (both Delta Smelt and Longfin Smelt), including through increased spring outflow, reduced Delta diversions, and changes in Delta flow patterns resulting from channel modifications or changes in Delta exports that change Delta residence times for aquatic species.
- Measures to support federal and state fish population doubling mandates and goals.
- Measures to increase opportunities for transfer of water through the Delta.
- Measures to increase water supply availability from the CVP and SWP south Delta intakes.
- Measures to reduce reliance on Delta water supplies by reducing water supply availability from the CVP and SWP south Delta intakes.
- Complete cessation of long-term operation of the CVP and SWP, including benefits related to the operation of the CVP and SWP reservoirs, such as flood management and recreational benefits.
- Measures to prioritize CVP operations of the Trinity, Sacramento, American, and Stanislaus rivers to meet in-watershed water demands, not only in accordance with existing water rights and agreements, but also for CVP water contractors specifically located within the American and Stanislaus river watersheds.
- Measures to prioritize use of Central Valley Project Improvement Act (CVPIA) restoration funds within geographic locations collected from CVP water users in those locations.

3.2.2 Concepts Identified during Preparation of the Draft EIS

As described in Chapter 23, Consultation and Coordination, status meetings were held throughout preparation of the Draft EIS with stakeholders and interested parties between 2012 and 2015. Following the scoping process, the discussions were initially focused on identification of the No Action Alternative, other bases of comparisons, and alternative concepts to the RPAs. Based upon these discussions, the development of alternatives process initially focused on identification of the No Action Alternative, and subsequently, upon development of the range of alternatives to the No Action Alternative.

3.3 Identification of the Bases of Comparison

Council on Environmental Quality (CEQ) regulations require an EIS to include evaluation of a No Action Alternative (40 CFR 1502.14). The No Action Alternative is defined as the projections of current conditions and trends into the future without implementation of alternatives. These projected conditions are defined by CEQ as "'no change' from current management direction or level of management intensity." The No Action Alternative also can be defined as "no project" in cases where a new project is proposed for implementation. However, all of the alternatives evaluated in this EIS are to continue the coordinated long-term operation of the CVP and SWP. Therefore, the definition of the No Action Alternative used for this EIS is continuation of the current management direction and level of intensity.

For this EIS, the No Action Alternative is based upon the continued operation of the CVP and SWP in the same manner as was occurring at the time of the publication of the Notice of Intent in March 2012. Thus, the No Action Alternative consists of the coordinated long-term operation of the CVP and SWP, including full implementation of the RPAs in the 2008 USFWS BO and 2009 NMFS BO, because Reclamation provisionally accepted the BOs in 2008 and 2009, respectively, began implementing the RPAs, and continues to implement the RPAs to date. The No Action Alternative also includes changes not related to the long-term operation of the CVP and SWP or implementation of the RPAs in the 2008 USFWS BO and 2009 NMFS BO, as described in subsequent sections of this chapter.

Numerous scoping comments requested that the No Action Alternative not include the RPAs in the 2008 USFWS BO and 2009 NMFS BO because, at that time, the District Court had remanded the biological opinions (BOs) back to USFWS and NMFS. The comments indicated that the EIS should include a "basis of comparison" for the alternatives that was similar to conditions prior to implementation of the RPAs. Scoping comments also indicated that a "No Action Alternative scenario" without implementation of the RPAs in the 2008 USFWS BO and 2009 NMFS BO could be used to analyze the effects of implementing the RPAs.

Determining an appropriate baseline without the 2008 USFWS BO and 2009 NMFS BO actions and yet continuing to meet all of Reclamation's statutory and regulatory requirements is a difficult task. Simply analyzing a No Action Alternative that is similar to the project description described in either the 2004 Biological Assessment or 2008 Biological Assessment is insufficient, as each was found to jeopardize listed species, the 2004 Biological Assessment by the District Court in 2007, and the 2008 Biological Assessment by USFWS and NMFS. Either of these operations would be inconsistent with Reclamation's existing policy and management direction.

Because the RPAs were provisionally accepted and the No Action Alternative, represents a continuation of existing policy and management direction, the No Action Alternative includes the RPAs. However, in response to scoping comments and subsequent comments from stakeholders and interest groups; and to provide a basis for comparison of the effects of implementation of the RPAs (per the District Court's mandate), this EIS includes a "Second Basis of Comparison" that represents a condition in 2030 without implementation of the 2008 USFWS BO and 2009 NMFS BO. All of the alternatives are compared to the No Action Alternative and to the Second Basis of Comparison to describe the effects that could occur by 2030 under both bases of comparison.

Several of the 2009 NMFS BO RPA actions had been initiated prior to issuance of the 2009 NMFS BO; and therefore, those actions are included in the Second Basis of Comparison, as described below. Reasonably foreseeable actions included in the No Action Alternative that are not related to the 2008 USFWS BO or 2009 NMFS BO are also included in the Second Basis of Comparison.

3.3.1 Conditions in Year 2030 without Implementation of Alternatives 1 through 5

Changes that would occur over the next 15 years without implementation of the alternatives are not analyzed in this EIS. However, the changes to environmental justice factors that are assumed to occur by 2030 under the No Action Alternative and the Second Basis of Comparison are summarized in this section, including:

- Continued long-term operation of the CVP and SWP in accordance with ongoing management policies, criteria, and regulations, including water right permits and licenses issued by the State Water Resources Control Board (SWRCB); and operational requirements of the 2008 USFWS BO and the 2009 NMFS BO.
- Implementation of existing and future actions described in the 2008 USFWS BO and 2009 NMFS BO that would occur by 2030 without implementation of the BOs.
- Implementation of existing and future actions not described in the 2009 NMFS BO that would occur by 2030 without implementation of any alternatives considered in this EIS.

3.3.1.1 Continued Long-Term Operation of the CVP and SWP Facilities

The CVP and SWP are operated in a coordinated manner in accordance with Public Law 99-546 (October 27, 1986), directing the Secretary to execute the Coordinated Operation Agreement (COA). The CVP and SWP are also operated under State Water Resources Control Board (SWRCB) decisions and water right orders related to the CVP's and SWP's water right permits and licenses to appropriate water by diverting to storage, by directly diverting to use, or by re-diverting releases from storage later in the year or in subsequent years.

The CVP and SWP are permitted by SWRCB to store water, divert water and re-divert CVP and SWP water that has been stored in upstream reservoirs. The CVP and SWP have built water storage and water delivery facilities in the Central Valley to deliver water supplies to CVP and SWP contractors, including senior water users. The CVP's and SWP's water rights are conditioned by the SWRCB to protect the beneficial uses of water within the watersheds.

As conditions of the water right permits and licenses, SWRCB requires the CVP and SWP to meet specific water quality objectives within the Delta. Reclamation and DWR coordinate operation of the CVP and SWP, pursuant to the COA, to meet these and other operating requirements. The COA is an agreement between the Federal government and the State of California for the coordinated operation of the CVP and SWP. The agreement suspended a 1960 agreement and superseded annual coordination agreements that had been implemented following construction of the SWP.

The COA established the operating framework for the CVP and SWP based upon conditions in the 1980s, by setting forth: (1) definitions of the CVP and SWP facilities and their water supplies, (2) procedures for coordination of operations, (3) formulas for sharing joint responsibilities for meeting Delta standards and ensuring no injury to other legal uses of water, (4) criteria for sharing unstored flow in the Delta, (5) a framework for exchange of water and services between the SWP and CVP, and (6) provisions for periodic reviews. Coordinated operation by agreed-on criteria can increase the efficiency of both the CVP and the SWP.

Implementation of the COA has evolved continually since 1986 as CVP and SWP facilities, operational criteria, and physical and regulatory environment have changed. For example, adoption of the CVPIA in 1992 changed purposes and operations of the CVP, and ESA responsibilities have affected operation of the CVP and SWP. Since 1986, facilities operations have been modified in response to statutory and regulatory requirements that were not part of the original COA assumptions or requirements. In addition, water quality objectives have been revised by the SWRCB since 1986 in the 1995 and 2006 Water Quality Control Plans and implemented through SWRCB Decision 1641. DWR and Reclamation have operational arrangements to accommodate new facilities, water quality objectives, the CVPIA, other SWRCB criteria, and the ESA, but the COA has not been formally modified to address these newer operating conditions.

The ongoing operational management policies of the CVP and SWP are anticipated to continue under the No Action Alternative and Second Basis of Comparison. These operational assumptions are described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations, and summarized in Chapter 5, Surface Water Resources and Water Supplies.

3.3.1.2 Actions included in the 2008 USFWS BO and 2009 NMFS BO that Would Have Occurred without Implementation of the Biological Opinions

Several actions included in the 2008 USFWS BO RPA and 2009 NMFS BO RPA are ongoing and others have been completed, including the following actions.

- 2008 USFWS BO RPA Component 4, Habitat Restoration. In 2014, Reclamation, California Department of Fish and Wildlife (CDFW), and USFWS adopted and initiated implementation of the Suisun Marsh Habitat Management, Preservation, and Restoration Plan (Suisun Marsh Management

Plan). The No Action Alternative assumes that the Suisun Marsh Management Plan will provide up to 7,000 acres of intertidal and associated subtidal habitat in the Delta and Suisun Marsh with or without implementation of the 2000 USFWS BO. This would represent up to 87 percent (7,000 of 8,000 acres of this habitat type referenced in the 2008 USFWS BO.

- 2009 NMFS BO RPA Action I.1.3, Clear Creek Spawning Gravel Augmentation. This effort was initiated in 1996 under the CVPIA Section 3406(b)(12), and is assumed to continue under the No Action Alternative and Second Basis of Comparison. The Clear Creek fisheries habitat restoration program is being implemented by USFWS and Reclamation in accordance with CVPIA (Reclamation 2011a). By the year 2020 the overall goal is to provide 347,288 square feet of usable spawning habitat from Whiskeytown Dam downstream to the former McCormick-Saeltzer Dam, which is the amount that existed before construction of Whiskeytown Dam. Between 1996 and 2009, a total of approximately 130,925 tons of spawning gravel was added to the creek. The interim annual spawning gravel addition target is 25,000 tons per year, but due to a lack of funding, only an average of 9,358 tons has been placed annually since 1996 (Reclamation 2013a). In 2010, the first annual evaluation of spawning gravel implementation and monitoring was submitted to NMFS as required by the NMFS BO. In 2012, Reclamation placed 10,000 tons of spawning gravel at four locations: Guardian Rock/Below N.E.E.D. Camp, Placer Bridge, Clear Creek Crossing/Bridge, and Tule Backwater.

- 2009 NMFS BO RPA Action I.1.4, Spring Creek Temperature Control Curtain Replacement. This action was completed when the temperature control curtain was replaced in 2011, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations.

- 2009 NMFS BO RPA Action I.2.6, Restore Battle Creek for Winter-Run, Spring-Run, and Central Valley Steelhead. The Battle Creek Salmon and Steelhead Restoration Projects under construction to reestablish approximately 42 miles of salmon and steelhead habitat on Battle Creek and an additional 6 miles of habitat on tributaries. The Project is a collaborative effort between Reclamation, USFWS, NMFS, CDFW, Pacific Gas & Electric Company (PG&E), and other groups. Prior to 2030, elements of the project will be completed including removal of five dams, installation of new fish screens and fish ladders, provisions for increased instream flows in Battle Creek, improved access roads and trails, and decommissioned power plant canals that conveyed water between tributaries. The No Action Alternative assumes implementation of this project with or without implementation of the 2009 NMFS BO.

- 2009 NMFS BO RPA Action I.3.1, Operate Red Bluff Diversion Dam with Gates Out. This action was completed when the new Red Bluff Pumping Plant began operation in 2012, and the gates no longer block the flow of water in the Sacramento River, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations.

- 2009 NMFS BO RPA Action I.5, Funding for CVPIA Anadromous Fish Screen Program. This effort was initiated over 20 years ago under the CVPIA Section 3406(b)(21), and is assumed to continue under the No Action Alternative with or without implementation of the 2009 NMFS BO. The No Action Alternative assumes continued implementation of the program to meet the program objectives by 2030.
- 2009 NMFS BO RPA Action I.6.1, Restoration of Floodplain Habitat; and Action I.6.2, Near-Term Actions at Liberty Island/Lower Cache Slough and Lower Yolo Bypass; Action I.6.3, Lower Putah Creek Enhancements; Action I.6.4, Improvements to Lisbon Weir; and Action I.7, Reduce Migratory Delays and Loss of Salmon, Steelhead, and Sturgeon at Fremont Weir and Other Structures in the Yolo Bypass. These actions are addressed in the ongoing Yolo Bypass Salmonid Habitat Restoration and Fish Passage Implementation Plan (Implementation Plan) that has been initiated by Reclamation and DWR. The No Action Alternative and Second Basis of Comparison assume completion of this Implementation Plan by 2030 with or without implementation of the 2009 NMFS BO. The Implementation Plan includes an operable gate at or near the Fremont Weir and modification of the Sacramento Weir to increase the frequency and extent of floodplain inundation in the Yolo Bypass; restoration of at least 20,000 acres of floodplain rearing habitat (excluding tidally-influenced areas); and habitat enhancements in the Yolo Bypass, including measures to avoid stranding or barriers to migration. The No Action Alternative and Second Basis of Comparison assume that an operable gate would be installed in or near the Fremont Weir that would allow for controlled flows from the Sacramento River into the Yolo Bypass when Sacramento River water elevations exceed approximately 17.5 feet (NAVD88). Other portions of Fremont Weir would continue to block flows into the Yolo Bypass until the Sacramento River water elevations exceed 32.8 feet (NAVD88).
- 2009 NMFS BO RPA Action II.1, Lower American River Flow Management. This effort was initiated in 2006 when Reclamation began operating in accordance with the American River Flow Management Standard (FMS), as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. The No Action Alternative and Second Basis of Comparison assume continued operations under the FMS.

3.3.1.3 Future Actions not included in the 2008 USFWS BO and 2009 NMFS BO that Would Have Occurred without Implementation of the Biological Opinions

The No Action Alternative and the Second Basis of Comparison include assumptions unrelated to implementation of the 2008 USFWS BO RPA actions and 2009 NMFS BO RPA actions, including: climate change and sea level rise; continued implementation of ongoing federal, state, and local regulations and policies; development of lands in accordance with general plans in areas served by CVP and SWP water supplies; and reasonable and foreseeable projects that have been approved and are anticipated to be implemented by 2030. The 2008 USFWS BO and the 2009 NMFS BO included assumptions for climate change and sea level rise; continued implementation of ongoing federal, state, and local regulations and policies; development of lands in accordance with general plans in areas served by CVP and SWP water supplies; and reasonable and foreseeable projects. Subsequent to the publication of the BOs, the assumptions for these items have been updated and are included in the No Action Alternative and the Second Basis of Comparison. The assumptions used in this EIS for these items are discussed below.

3.3.1.3.1 Climate Change and Sea Level Rise

Under Section 9503 of the SECURE Water Act (Public Law 111-11, Subtitle F), Reclamation conducted a comprehensive assessment of current information on potential future climate change impacts and implications for long-term water management in the West, as described in Appendix 5A, Modeling Methodology. Projections of future climate in the Sacramento and San Joaquin River basins are summarized, with regard to temperature, precipitation, snowpack, and runoff. Results indicate that temperatures across both river basins may increase steadily, with the basin-average mean annual temperature projected to increase by roughly 5^o to 6^o Fahrenheit (F) during the 21st century. Annual precipitation in the basins should remain geographically variable over the next century, with current projections suggesting that annual basin-wide precipitation may initially stay steady to slightly increasing, to an eventual slight decrease over the region. With regard to snowpack, increased warming is expected to diminish snow accumulation during the cool season and reduce the availability of snowmelt to sustain runoff during the warm season. Reductions in annual runoff are predicted to occur by the latter half of the century. Changes in runoff seasonality are generally projected, with warming leading to more rainfall and runoff in the cool season and less runoff during the spring, affecting seasonal water supplies. One difficulty that arises in taking climate change into account in long-term water resources planning is that the natural variability is often greater than the magnitude of change expected over several decades.

Global and regional sea levels have been increasing steadily over the past century and are expected to continue to increase throughout this century (BCDC 2011). The National Research Council recently released a study of sea level rise on the west coast. Key results indicate that global sea level has risen about 7 inches in the 20th century and the rate of sea level rise is accelerating (NRC 2012). Relative to year 2000 levels, global sea level is projected to rise 3 to 9 inches by 2030, 7 to 19 inches by 2050, and 20 to 55 inches by 2100. Sea level rise along the California coast south of Cape Mendocino are projected to show even greater ranges of potential change. As a result, sea level rise associated with climate change will continue to threaten coastal lands and infrastructure, increase flooding at the mouths of rivers, place additional stress on levees and water resources in the Delta.

Additional information related to development of climate change and sea level rise projections by 2030 are presented in Section 5A.A.5 of Appendix 5A, Section A, CalSim II and DSM2 Modeling.

3.3.1.3.2 Continued Implementation of Ongoing Federal, State, and Local Water Resources Policies

The No Action Alternative and Second Basis of Comparison assume continued implementation of ongoing water resources policies and programs that are not addressed in the 2008 USFWS BO and 2009 NMFS BO, including the following programs.

- Federal Clean Water Act, including completion of Total Maximum Daily Load programs, National Pollutant Discharge Elimination System permits, and Waste Discharge Permits, as described in Chapter 6, Surface Water Quality.
- SWRCB water rights and water quality policies and programs, as described in Chapter 5, Surface Water Resources and Water Supplies.
- Federal Safe Drinking Water Act and California Safe Drinking Water Act policies and programs related to drinking water treatment requirements, as described in Chapter 6, Surface Water Quality.
- Federal Clean Air Act and California Clean Air Act, including completion of the compliance programs in accordance with the State Implementation Plans, as described in Chapter 16, Air Quality and Greenhouse Gas Emissions.
- Flood management policies and programs established by the U.S. Army Corps of Engineers (USACE) except for removal of substantial vegetation from levees per recent USACE requirements (USACE 2009, 2010), Federal Emergency Management Agency, DWR, Central Valley Flood Protection Board, and local flood management agencies, as described in Chapter 5, Surface Water Resources and Water Supplies.

3.3.1.3.3 General Plan Development in CVP and SWP Service Areas

Counties and cities throughout California have adopted general plans which identify land use classifications including those for municipal and industrial uses and those for agricultural uses. Preparation of general plans includes an environmental evaluation under the California Environmental Quality Act to identify adverse impacts to the physical environment and to provide mitigation measures to reduce those impacts to a level of less than significance. Most of the counties where CVP and SWP water supplies are delivered have adopted general plans following the environmental review of the plans and appropriate alternatives. Population projections from those general plan evaluations are provided to the State Department of Finance and are used to project future water needs and the potential for conversion of existing undeveloped lands and agricultural lands. Many of the existing general plans for counties with municipal areas recently have been modified to include land use and population projections through 2030. The No Action Alternative and Second Basis of Comparison assume that land uses, as described in Chapter 13, Land Use, will develop through 2030 in accordance with existing general plans.

3.3.1.3.4 Other Reasonable and Foreseeable Projects and Programs

The No Action Alternative and Second Basis of Comparison assume continued implementation of existing projects and facilities, including water supply and wastewater management facilities, flood management facilities, and recreational facilities.

In addition, the No Action Alternative assumes implementation of the following ongoing projects by 2030. These project descriptions are organized geographically from north to south in the State of California.

Trinity River Restoration Program

The Trinity River Restoration Program is a conducted by eight partners that form the Trinity Management Council, including Reclamation, USFWS, NMFS, U.S. Forest Service, Hoopa Valley Tribe, Yurok Tribe, California Resources Agency, and Trinity County. The Trinity River Flow Evaluation Final Report was adopted in 1999 and the Trinity River Record of Decision (ROD) was signed in 2000 to implement restoration of the physical processes and rehabilitate the Trinity River as foundation for fisheries recovery. The ROD described four restoration methods (flow management through releases from Lewiston Dam, construction of channel rehabilitation sites, augmentation of gravels, and control of fine sediments); infrastructure improvements to accommodate high flow releases from Lewiston Dam; environmental compliance with improvements to riparian vegetation and wetlands, reduced turbidity, and improved water temperatures; and science-based adaptive management. The Trinity River Restoration Program 2011 Annual Report indicated that about half of the projects described in the Flow Evaluation Study had been completed and intensive assessments of the physical responses of the Trinity River and geomorphic assessments of the 40-mile restoration reach had been initiated (TRRP 2012). This project will improve conditions for aquatic species in the Trinity River.

Continued Implementation of the Central Valley Project Improvement Act Provisions

In 1992, the CVPIA (Title 34 of Public Law 102-575) was adopted to include fish and wildlife protection, restoration, enhancement, and mitigation as purposes of the CVP having equal priority with irrigation and domestic water supply uses, and power generation. The purpose of the CVPIA is expressed in six broad statements found in Section 3402 of the Act:

- 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 CVP's operational flexibility;
- To increase water-related benefits provided by the CVP to the state through expanded use of voluntary water transfers and improved water conservation;

- To contribute to the state's interim and long-term efforts to protect the San Francisco Bay/Sacramento-San Joaquin Delta Estuary;
- 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.

The Secretary of the Department of the Interior (DOI) assigned primary responsibility for implementing CVPIA's many provisions to Reclamation and USFWS. Reclamation and USFWS coordinate with other federal agencies, tribes, the State of California, and numerous partners and stakeholders during each fiscal year to plan and implement activities.

The current focus of the CVPIA Program is on fish and wildlife restoration, water management, and conservation activities, authorized in Sections 3406 and 3408 of the Act. These goals fit within four broad resource areas: Fisheries, Water Operations, Refuges and Other Resources (Reclamation 2013c).

The Fisheries Resource Area includes actions to implement the CVPIA "fish-doubling goal" for Chinook Salmon, Rainbow Trout (steelhead), Striped Bass, American Shad, White Sturgeon and Green Sturgeon. The 2001 Final Restoration Plan to implement the CVPIA included 289 actions and evaluations that were determined to be reasonable given numerous technical, legal and implementation considerations. Reclamation and USFWS are implementing these and related actions (Reclamation 2013c). In 2008, the CVPIA Program conducted an independent review of the status of actions to achieve the fish-doubling goal. Following the review, a revised plan was developed to emphasize managing all of the fisheries programs as one program instead of individual actions; utilize a science-based management framework to address problems at a system level; report accomplishments by watershed; and improve transparency by communicating the coordination and decision-making that occurs within the program. The No Action Alternative assumes that the CVPIA Program will continue to be implemented in 2030.

The Water Operations Resource Area includes provisions to supply CVP water to resource locations in flow, quantity, velocity, and timing patterns that would contribute to the biological resources in accordance with Section 3406(b) of CVPIA (Reclamation 2013c). The No Action Alternative assumes that water operations will continue to include measures identified in Section 3406(b).

The Refuges Resources Area includes actions to contribute to the maintenance, restoration and enhancements of wetlands and waterfowl habitat either directly or through contractual agreements with other appropriate parties, firm water supplies of suitable quality to maintain and improve wetland habitat areas on 19 federal, state and private lands. The CVPIA requires Reclamation to provide CVP water to meet "Level 2" water demands and to obtain water supplies to meet "Level 4" water demands (Reclamation 2013c). In 2009, the CVPIA Program conducted an independent review of the refuge water supply program. The report indicated that Level 2 water supplies had become more reliable under CVPIA; however, Level 4 water supplies were not fully obtained. In response, Reclamation entered into an agreement with USFWS and the National Fish and Wildlife Foundation to explore avenues to improve the effectiveness of the water acquisitions, including those for Incremental Level 4; assessed ways to increase the priority for pumping, conveyance and storage of Incremental Level 4 water supplies in CVP facilities; and continued planning for external storage and conveyance facilities to meet refuge water supply needs. The No Action Alternative assumes that refuge water supplies will continue to be provided in 2030.

The Other Resource Area actions are related to terrestrial habitat and species; and water quality and conservation. One of the programs implemented in this resource area includes the Section 3406(b)(1) "other" Habitat Restoration Program, which focuses on protecting native habitats that have been directly and indirectly affected by the CVP's construction and operation (Reclamation 2013c). This is accomplished through the purchase of fee title or conservation easements on lands where threats are significant and restoring lands to native habitat. Another program is the Land Retirement Program, Section 3408 (h), to purchase and retire land from agricultural production to improve water quality and provide for terrestrial habitat restoration. The No Action Alternative assumes that these actions will continue in a manner similar to ongoing operations.

The DOI is continuing to implement CVPIA using an improved science-based decision making process using a scientific framework that connects restoration actions to environmental and population responses across watersheds (Reclamation 2013c). A system-wide science-based approach with performance indices, monitoring, and scientific review of results is used to provide direction as the CVPIA adapts to changing conditions.

Clear Creek Mercury Abatement and Fisheries Restoration Project

The Lower Clear Creek Aquatic Habitat and Waste Discharge Improvement Project was initiated to remove the long-term impacts of mercury contamination in Lower Clear Creek and to create over 5 acres of new wetlands. The mercury sources are dredge-mined tailings from more than 200 historic gold and gravel mines in the watershed. The tailings are located on the properties adjacent to Clear Creek and in gravels historically used for spawning gravel supplementation. This is being completed in accordance with CVPIA actions (WSRCD 2011). This project will improve conditions for aquatic species in Clear Creek and the upper Sacramento River.

Iron Mountain Mine Superfund Site

The Iron Mountain Mine Superfund Site on Spring Creek had discharged acid mine drainage into several creeks that are tributary to Keswick Reservoir and the Sacramento River since the late 1890s. The interim remedies include source control, acid mine drainage collection and treatment, and water management, including water diversions and coordinated releases of contaminated surface water from Spring Creek Debris Dam with dilution flows released from the Spring Creek power plant and Shasta Lake. In 2008, the U.S. Environmental Protection Agency indicated that the interim remedies were operational and had reduced metal loading discharges by 95 percent as compared to pre-project conditions. A final restoration plan for natural resources injured by Iron Mountain Mine operation was adopted in 2002 by USFWS, CDFW, National Oceanic and Atmospheric Administration, Bureau of Land Management, and Reclamation and those programs are being implemented (USEPA 2008). This project will improve water quality and conditions for aquatic species in Spring Creek and the upper Sacramento River.

Mainstem Sacramento River, American River, and Stanislaus River Gravel Augmentation Programs

The Mainstem Sacramento Gravel Augmentation Program is an ongoing Reclamation project that helps meet requirements of Section 3406 (b)(13) of the CVPIA to restore and replenish spawning gravel and rearing habitat for salmonid species. Reclamation began placing salmonid spawning gravel in the Sacramento River approximately 0.25 miles downstream of Keswick Dam in 1997 and subsequently in Salt Creek. The project will place approximately 5,000 tons of gravel into the river and implement riffle supplementation/side-channel excavation to help improve spawning habitat for Chinook Salmon and steelhead (Reclamation and USFWS 2012). This project will improve conditions for aquatic species in the upper Sacramento River.

The Lower American River Salmonid Spawning Gravel Augmentation and Side-Channel Habitat Establishment Program to increase and improve salmon and steelhead spawning and rearing habitat by replenishing spawning gravel and establishing additional side-channel habitat at new restoration sites along the lower American River between Nimbus Dam and Upper Sunrise Recreation Area and at Arden Rapids. Gravel augmentation, side channel excavation, and incorporation of woody material into the main channel to improve Chinook Salmon and steelhead spawning and rearing habitat (Reclamation 2008, 2014e).

Gravel restoration also has been implemented on the lower Stanislaus River since 2004 (Reclamation 2011c).

Nimbus Fish Hatchery Fish Passage Project

A fish passageway from the Nimbus Fish Hatchery to the stilling basin downstream of the Nimbus Dam will be constructed and the diversion weir will be removed. This project will create and maintain a reliable system for collecting adult fish to allow Reclamation to mitigate for loss of access to spawning areas following construction of Nimbus Dam and adequately protect Chinook Salmon and Central Valley steelhead. The project is scheduled to start in 2018 if adequate funding is appropriated. This project will improve conditions for aquatic species in the lower American River and lower Sacramento River.

Folsom Dam Water Control Manual Update

The USACE is developing and evaluating alternatives to change flood management operations of Folsom Dam and Folsom Lake to reduce flood risk to the Sacramento area. Currently, the USACE is completing construction of the new auxiliary spillway at Folsom Dam and is completing an in-depth analysis of recent hydrologic data for the American River watershed upstream of Folsom Dam. The study will result in an updated Water Control Manual following completion of an EIS and an engineering report (USACE et al. 2012). This project could change flow patterns in the American and Sacramento rivers and the Delta.

Federal Energy Regulatory Commission Relicensing for Middle Fork of the American River Project

The Federal Energy Regulatory Commission (FERC) completed a final EIS for the relicensing of the Placer County Water Agency existing 223,753 kilowatt Middle Fork American River Hydroelectric Project. The project is located on the Middle Fork of the American River, Rubicon River, and Duncan and North and South Fork Long Canyon creeks in Placer and El Dorado counties. The re-licensing will provide for continued operation of the project with increased pulse and minimum instream flow releases, defined ramping rates, whitewater boating flow releases, protection of sensitive species, maintenance and enhancement of recreation opportunities, erosion and sedimentation reduction measures, vegetation improvement plans, and recreation management plans (FERC 2012). This project will change flow patterns in the American River and improve conditions for aquatic species in portions of the American River watershed.

Lower Mokelumne River Spawning Habitat Improvement Project

The Mokelumne River is tributary to the Delta and supports five species of anadromous fish. The proposed project will initially include placement of 4,000 to 5,000 cubic yards of suitably sized salmonid spawning gravel annually for a 3-year period at two specific sites, and then provide annual supplementation of 600 to 1,000 cubic yards thereafter. Fall-run Chinook Salmon and steelhead are the primary management focus in the river. Availability of spawning gravel in this section of the Mokelumne River has been determined to be deficient because historic gold and aggregate mining operations removed gravel annually and upstream dams have reduced gravel transport to the area. This area was chosen because it is known to have supported fall-run Chinook Salmon and steelhead spawning in the past and because the substrate is suitable for habitat improvement (USFWS 2009).

This project will improve conditions for aquatic species in the Mokelumne and San Joaquin rivers.

Dutch Slough Tidal Marsh Restoration

The Dutch Slough Tidal Marsh Restoration Project, located near Oakley in Eastern Contra Costa County, will restore wetland and uplands, and provide public access to the 1,200-acre Dutch Slough property. The property is composed of three parcels separated by narrow man-made sloughs. The project is a cooperative partnership between DWR, State Coastal Conservancy, CDFW, City of Oakley, Ironhouse Sanitary District, Reclamation Districts 2137 and 799, Natural Heritage Institute, and landowners. The project will provide ecosystem benefits, including habitat for sensitive species, including winter-run Chinook Salmon Sacramento splittail, and many waterfowl species. It also will be designed and implemented to maximize opportunities to assess the development of those habitats and measure ecosystem responses so that future Delta restoration projects will be more successful. DWR approved the Final Environmental Impact Report (EIR) for the project in March 2010 (NMFS 2013). This project will improve conditions for aquatic and terrestrial species in the Delta through tidal marsh restoration.

Suisun Marsh Habitat Management, Preservation, and Restoration Plan Implementation

On March 2, 1987, the Suisun Marsh Preservation Agreement (SMPA) was signed by DWR, CDFW, Reclamation, and the Suisun Resource Conservation District. The purpose of the agreement was to establish mitigation for impacts on salinity from the SWP, CVP, and other upstream diversions. The SMPA contains provisions for Reclamation and DWR to mitigate the adverse effects on Suisun Marsh channel water salinity from operation of the CVP and SWP and other upstream diversions. The Suisun Marsh Habitat Management, Preservation and Restoration Plan (SMP) was completed in 2014 under the direction of Reclamation, USFWS, CDFW, NMFS, Suisun Resource Conservation District, and CALFED Bay-Delta Program (the Principal Agencies). This group was assisted by regulatory agencies such as the USACE, Bay Conservation and Development Commission, SWRCB, and the San Francisco Bay Regional Water Quality Control Board. The following actions will be implemented under the plan (Reclamation 2014a).

- Restoration of up to 7,000 acres of tidal marsh and protection and enhancement of up to 46,000 acres of managed wetlands through dredging, erosion protection, and installation of fish screens.
- Increased frequency of currently implemented managed wetlands activities.
- Implementation of the Preservation Agreement Implementation Fund (PAI Fund) to improve managed wetland flood and drain capabilities to accommodate high salinity water while maintaining functions and values of managed wetland habitats.

The plan includes environmental commitments and mitigation measures, an adaptive management program, and reporting through annual reports over the 30-year time frame of the plan. This project will improve conditions for aquatic and terrestrial species in the Delta and Suisun Marsh.

Tidal Wetland Restoration in the Delta and Suisun Marsh

In addition to tidal wetlands restoration that would occur in the Suisun Marsh, several programs are being implemented in the Cache Slough portion of the Delta. The 2008 USFWS BO RPA required a program to create or restore a minimum of 8,000 acres of intertidal and associated subtidal habitat in the Delta and Suisun Marsh. As described above, up to 7,000 acres of tidal marsh restoration would occur under the SMP. Other programs have been initiated to restore or expand tidal wetlands, and could provide an additional 3,000 acres of tidal wetlands in the Delta and Suisun Marsh. This additional 3,000 acres could be completed in accordance with the 2008 USFWS BO requirements. The No Action Alternative includes the following restoration programs.

- Yolo Ranch (initial phase), Northwest Field Network 4, and Flyway Farms – 941 and 405 acres, respectively, of tidal influenced lands (SFWCA 2011, 2013).
- Northern Liberty Island Fish Restoration Project – 737 acres (RD 2093 2011).
- Prospect Island Restoration Project – 1,170 acres (based on maps included in CDFW and DWR 2013).
- Calhoun Cut/Lindsey Slough Tidal Habitat Restoration Project – 87 acres (CDFW 2015).

San Joaquin River Restoration Program

The San Joaquin River Restoration Program is a comprehensive long-term effort to restore flows to the San Joaquin River from Friant Dam to the confluence of Merced River and restore a self-sustaining Chinook Salmon fishery in the river while reducing or avoiding adverse water supply impacts from restoration flows. The restoration program is the product of more than 18 years of litigation, which culminated in a Stipulation of Settlement on the lawsuit known as *NRDC, et al., v. Kirk Rodgers, et al.* The settling parties reached agreement on the terms and conditions of the settlement, which was subsequently approved by the District Court on October 23, 2006. The settling parties include the Natural Resources Defense Council, Friant Water Users Authority, and the U.S. Departments of the Interior and of Commerce. The settlement's two primary goals are to:

- Restore and maintain fish populations in "good condition" in the main stem of the 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 to 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 requires specific releases of water from Friant Dam to the confluence of the Merced River, which are designed primarily to meet the various life stage needs for spring- and fall-run Chinook Salmon. The release schedule assumes continuation of the current average Friant Dam release of 116,741 acre-feet, annually, with specific flow requirements depending on the year type. The project was authorized and funded with the passage of San Joaquin River Restoration Settlement Act, part of the Omnibus Public Land Management Act of 2009 (Public Law 111-11). Interim flows began in October, 2009. There are many physical improvements within and near the San Joaquin River that will be undertaken to fully achieve the river restoration goal. The improvements will occur in two separate phases that will focus on a combination of water releases from Friant Dam, as well as structural and channel improvements (Reclamation 2012). This project will improve conditions for aquatic and terrestrial species in the San Joaquin River and the Delta.

This EIS does not address the CVP facilities associated with Millerton Lake, including the Madera and Friant-Kern canals and their service areas, and the San Joaquin River Restoration Program because these facilities are not considered in the consultations related to the 2008 USFWS BO and 2009 NMFS BO.

Stockton Deep Water Ship Channel Demonstration Dissolved Oxygen Project

The Stockton Deep Water Ship Channel Demonstration Dissolved Oxygen Project is a multiple-year study of the effectiveness of elevating dissolved oxygen (DO) concentrations in the channel. The DO concentrations drop as low as 2 to 3 milligrams per liter (mg/L) during warmer and lower water flow periods in the San Joaquin River. The low DO levels can adversely affect aquatic life including the health and migration behavior of anadromous fish (e.g., salmon). The objective of the study is to maintain DO levels above the minimum recommended levels specified in the 2006 Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River basins, as described in Chapter 6, Surface Water Quality.

The project's full-scale aeration system includes two 200-foot-deep u-tube aeration tubes; two vertical turbine pumps capable of pumping over 11,000 gallons of water each; a liquid-to-gas oxygen supply system; and numerous pieces of ancillary equipment and control systems. The system has been sized to deliver approximately 10,000 pounds of oxygen per day into the Deep Water Ship Channel. The aeration system is anticipated to be operated only when channel DO levels are below the Basin Plan DO water quality objectives (approximately 100 days per year). The project study includes an on-going assessment of DO levels in the channel and vicinity and a study of potential adverse effects of low DO on salmon (DWR 2010a). This project will improve water quality in the central and south Delta as compared to historical conditions.

Grasslands Bypass Project

Reclamation is actively engaged with the Grassland Area Farmers who discharge subsurface agricultural drainage waters through the Grassland Bypass Project, which is a significant source of selenium to the San Joaquin River and to the Delta. Reclamation and the Grassland Area Farmers are continuing to reduce the amount of agricultural drainage water produced in the Grassland Drainage Area, preventing the discharge of this water into local Grassland wetland water supply channels, and improving the quality of water in the San Joaquin River. The Grassland Bypass Project is based upon an agreement between Reclamation and the San Luis and Delta-Mendota Water Authority to use a 28-mile segment of the San Luis Drain to convey agricultural subsurface drainage water from the Grassland Drainage Area to Mud Slough (North), a tributary of the San Joaquin River. An extensive monitoring program by the San Francisco Estuary Institute (2013) continues to document the effectiveness of actions such as source control and other measures being taken by the Grassland Area Farmers. These actions by the Grassland Area Farmers are described in Chapter 2 of SFEI (2013). Briefly, these activities have included the Grassland Bypass Project and the San Joaquin River Improvement Project, formation of a regional drainage entity, newsletters and other communication with the farmers, a monitoring program, using State

Revolving Fund loans for improved irrigation systems, installing and using drainage recycling systems to mix subsurface drainage water with irrigation supplies under strict limits, tiered water pricing and a tradable loads programs.

The purposes and objectives of the Grasslands Bypass Project, 2010–2019, are to: 1) extend the San Luis Drain Use Agreement in order to allow the Grassland Basin Drainers time to acquire funds and develop feasible drainwater treatment technology to meet revised Basin Plan objectives and Waste Discharge Requirements by December 31, 2019; 2) continue the separation of unusable agricultural drainage water discharged from the Grassland Drainage Area from wetland water supply conveyance channels for the period 2010–2019; and 3) facilitate drainage management that maintains the viability of agriculture in the project area and promotes continuous improvement in water quality in the San Joaquin River. All discharges of drainage water from the Grassland Drainage Area into wetlands and refuges have been eliminated. The selenium load discharged from the Grassland Drainage Area has been reduced by 61 percent (from 9,600 pounds to 3,700pounds) and the salt load has been reduced by 39 percent (from 187,300 tons to 113,600 tons). Prior to the project, the monthly mean concentration of selenium in Salt Slough was 16 parts per billion. Since implementation of this project, the concentration has been less than the water quality objective of 2 parts per billion. The drainage water is conveyed to Mud Slough. Grasslands Water District and others are currently evaluating alternative plans to comply with Central Valley Regional Water Quality Control Board water quality objectives for selenium and salinity in the San Joaquin River at the end of this project in 2019. One of the alternatives could be zero discharge with complete recycle of the drainwater to salinity-tolerant crops (Reclamation 2009). This project will improve water quality in the San Joaquin River and the central and south Delta.

Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS)

In 2006, the Central Valley Regional Water Quality Control Board, the SWRCB, and stakeholders began a joint effort to address salinity and nitrate problems in California's Central Valley and adopt long-term solutions that will lead to enhanced water quality and economic sustainability. This effort is referred to as the Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS) Initiative. The goal of CV-SALTS is to develop a comprehensive region-wide Salt and Nitrate Management Plan (SNMP) describing a water quality protection strategy that will be implemented through a mix of voluntary and regulatory efforts. The SNMP may include recommendations for numeric water quality objectives, beneficial use designation refinements, and/or other refinements, enhancements, or basin plan revisions.

The SNMP and will serve as the basis for amendments to the three Basin Plans that cover the Central Valley Region (Sacramento River and San Joaquin River Basin Plan, the Tulare Lake Basin Plan and the Sacramento/San Joaquin Rivers Bay-Delta Plan). The basin plan "amendments" will likely establish a comprehensive implementation plan to achieve water quality objectives for salinity (including nitrate) in the Region's surface waters and groundwater. The

SNMP may include recommendations for numeric water quality objectives, beneficial use designation refinements, and/or other refinements, enhancements, or basin plan revisions (CVRWQCB 2015). This project could change water quality and flow patterns in the San Joaquin River.

Municipal Water Supply Projects

Municipal water users in California are required to prepare Urban Water Management Plans (UWMPs) in accordance with the California Urban Water Management Planning Act of 1983. The State Water Conservation Act of 2009 (also known as SBx7-7) required the UWMPs to identify the water demands and water supplies for their service area through the year 2030, and to provide a plan to reduce statewide per capita water use by 20 percent by the year 2020. All of the UWMPs identify conservation measures to reduce water demands by 2020. Many of the UWMPs identify projects that are being planned or implemented to meet water demands in 2030. Water resources projects that have been approved and are being implemented are assumed to be complete by 2030 under the No Action Alternative. There are numerous projects considered in the study area to be included in the No Action Alternative, as described in Appendix 5D, Municipal and Industrial Water Demands and Supplies, including the following major water supply projects.

- Cambria Emergency Water Supply Project desalination project (CCSD 2014).
- Carlsbad Metropolitan Water District water recycling project (Carlsbad MWD 2012)
- Central Basin Municipal Water District Southeast Water Reliability Project (CBMWD 2011).
- City of Los Angeles Department of Water and Power groundwater recharge projects (City of Los Angeles 2011, 2013a).
- City of Oxnard GREAT Program Desalter (City of Oxnard 2013).
- Eastern Municipal Water District water recycling programs (EMWD 2014a, 2014b).
- Fresno Irrigation District groundwater recharge projects (FID 2015).
- Inland Empire Utilities Agency groundwater recharge projects (IEUA 2015).
- Kern County and Antelope Valley-East Kern Water Agency (AVEK 2011).
- Los Angeles County Sanitation Districts expansion of water recycling programs (LACSD 2005).
- San Benito County Water District expansion of water treatment plant to treat CVP water (SBCWD 2014).
- San Diego County Water Authority Carlsbad Seawater Desalination Facility (SDCWA 2014).
- Santa Barbara desalination water treatment plant (KEYT 2015).

- Santa Clara Valley Water District wastewater recycling projects (SCVWD 2012).
- City of Stockton Delta Water Supply Project (City of Stockton 2005).
- Victor Valley Wastewater Reclamation Authority water recycling programs (VVWRA 2015).
- Water Replenishment District Groundwater Reliability Improvement Program and water recycling programs (WRD 2012, 2015).
- West Basin Municipal Water District recycling water programs (WBMWD 2011).
- Western Development and Storage Antelope Valley Water Bank (Reclamation 2010).
- Western Municipal Water District Arlington Desalter Expansion to use saline groundwater (WMD 2015).
- Woodland-Davis Clean Water Agency water treatment plant (WDCWA 2013).

Water Transfer Projects

Water transfer programs have been used historically throughout California, especially among CVP water users to meet both irrigation and municipal water demands either during drought or to replenish stored surface water or groundwater during wet periods (Reclamation 2013b).

Implementation of CVPIA in 1992 facilitated water transfers between CVP water users and between CVP water users and non-CVP water users. The water can be transferred through CVP facilities in a manner that does not harm the operation of the CVP for other users and beneficial uses. CVP facilities also can be used to convey non-CVP water under the Warren Act of 1911. In the first 10 years following adoption of CVPIA, more than 4.3 million acre-feet of water was transferred for agricultural and municipal water uses and more than 396,000 acre-feet was transferred to the DOI for Level 4 Refuge Water Supplies (Reclamation 2004a). Water transfers also occur between the SWP water users and non-SWP water users. SWP facilities can be used to convey the transferred water, including non-SWP water, under DWR conveyance agreements.

Historically, water transfers primarily were in-basin transfers (e.g., Sacramento Valley water seller to Sacramento Valley water user) (Reclamation 2013b; DWR, Reclamation, USFWS and NMFS 2013). However, between 2001 and 2012, water transfers from the Sacramento Valley to the areas located south of the Delta of up to 298,806 acre-feet occurred (not including water transfers under the Environmental Water Account Program in the early 2000s) (DWR, Reclamation, USFWS and NMFS 2013). These transfers occurred in drier years. In 2012 and 2013, the following types of water transfers occurred (DWR and SWRCB 2014).

- Water transfers involving CVP and SWP water:
  - 2012: 47,420 acre-feet of water transfers (43 percent were between agricultural water users, 36 percent were between municipal water users, and 21 percent were between agricultural and municipal water users).
  - 2013: 63,790 acre-feet of water transfers (28 percent were between agricultural water users, and 72 percent were between agricultural and municipal water users).
- Water transfers involving non-CVP and SWP water:
  - 2012: 188,074 acre-feet of water transfers (72 percent were between agricultural water users, 14 percent were from agricultural water users to wildlife refuges, and 14 percent were between agricultural and municipal water users).
  - 2013: 268,370 acre-feet of water transfers (72 percent were between agricultural water users, 1 percent were from agricultural water users to wildlife refuges, and 27 percent were between agricultural and municipal water users).

Until recently, most of the water transfers extended for one or two years. In 2008, one of the first long-term water transfer agreements was approved by the SWRCB for the Lower Yuba River Accord. The plan was designed to protect and enhance fisheries resources in the Lower Yuba River, increase local water supply reliability, provide DWR with increased operational flexibility for protection of Delta fisheries resources, and provide added dry-year water supplies to CVP and SWP water users, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. In 2013, Reclamation approved an overall program for a 25-year period (2014 to 2038) to transfer up to 150,000 acre-feet/year of water from the San Joaquin River Exchange Contractors Water Authority to DOI for refuge water supplies or CVP and SWP water users (Reclamation 2013b). Reclamation is currently evaluating a long-term water transfer program (2015 to 2024) between water sellers in the Sacramento Valley and water users located in the San Francisco Bay Area and south of the Delta (Reclamation 2014b).

Transfer programs generally involve annual crop changes using temporary crop idling or shifting, release of stored water in reservoirs on different patterns for the purchasers' water demands, and/or groundwater substitution (DWR and Reclamation 2014). The transfers must be approved by the CVP and/or SWP if the transfer involves CVP or SWP water or utilizes CVP or SWP facilities. Except for water transfers among CVP water users, water transfers also require approval from the SWRCB. Environmental documentation is required for all water transfers involving CVP and/or SWP water supplies or facilities. Under State law, water transfers cannot result in injury to other legal users of water; unreasonable impacts on fish and wildlife and instream uses; and unreasonable economic or environmental impact on the county in which the transfer water originates.

It is assumed that transfers would continue under the No Action Alternative in a similar manner as have occurred for the past 10 years. It is anticipated that the number of long-term transfer agreements could increase to facilitate annual decisions for water transfers. However, the conditions for each water transfer would be determined on a case-by-case basis.

3.3.2 No Action Alternative

In addition to the common conditions described above, the No Action Alternative also would include existing and future actions described in the 2008 USFWS BO and 2009 NMFS BO that would not occur by 2030 without implementation of the BOs and implementation of the USACE vegetation management operations along levees for flood management in accordance with policies issued by the USACE in 2009 and 2010.

3.3.2.1 Continued Long-Term Operation of the CVP and SWP Facilities

The actions related to the CVP and SWP operations are described in more detail in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations.

In addition to the operational actions, there are several actions that would not have been implemented by 2030 under the No Action Alternative without implementation of the 2008 USFWS BO and 2009 NMFS BO. These actions have not been fully defined at this time; and therefore, would require future engineering and environmental evaluation prior to implementation. These following actions are assumed to be completed under the No Action Alternative, and the objectives outlined in the 2008 USFWS BO and 2009 NMFS BO are assumed to be achieved by 2030.

- 2009 NMFS BO RPA Action I.2.5, Winter-Run Passage and Re-Introduction Program at Shasta Dam.
- 2009 NMFS BO RPA Action II.3, Structural Improvements for Temperature Management on the American River, including installation of a Folsom Dam temperature control device, methods to transport cold water through Lake Natoma, installation of a temperature control device on the El Dorado Irrigation District intake from Folsom Lake, and development of temperature management decision-support tools.
- 2009 NMFS BO RPA Action II.5, Fish Passage at Nimbus and Folsom Dams.
- 2009 NMFS BO RPA Action II.6, Implement Actions to Reduce Genetic Effects of Nimbus and Trinity River Fish Hatchery Operations.
- 2009 NMFS BO RPA Action III.2.1, Increase and Improve Quality of Spawning Habitat with Addition of 50,000 Cubic Yards of Gravel by 2014 and with a Minimum Addition of 8,000 Cubic Yards per Year for the Duration of the Project Actions on Stanislaus River.

- 2009 NMFS BO RPA Action III.2.2, Conduct Floodplain Restoration and Inundation Flows in Winter or Spring to Inundate Steelhead Juvenile Rearing Habitat on One- to Three-Year Schedule on Stanislaus River.
- 2009 NMFS BO RPA Action III.2.3, Restore Freshwater Migratory Habitat for Juvenile Steelhead by Implementing Projects to Increase Floodplain Connectivity and to Reduce Predation Risk During Migration on Stanislaus River.
- 2009 NMFS BO RPA Action III.2.4, Fish Passage at New Melones, Tulloch, and Goodwin Dams.
- 2009 NMFS BO RPA Action IV.4, Tracy Fish Collection Facility Improvements to Reduce Pre-Screen Loss and Improve Screening Efficiency.
- 2009 NMFS BO RPA Action IV.4.2 Skinner Fish Collection Facility Improvements to Reduce Pre-Screen Loss and Improve Screening Efficiency.
- 2009 NMFS BO RPA Action IV.4.3 Tracy Fish Collection Facility and the Skinner Fish Collection Facility Actions to Improve Salvage Monitoring, Reporting and Release Survival Rates.

3.3.2.2 Vegetation Management along Levees

The No Action Alternative also would include vegetation management operations along levees for flood management in accordance with policies issued by the USACE in 2009 and 2010. Historically, the USACE has allowed brush and small trees to be located on the waterside of federal flood management project levees if the vegetation would preserve, protect, and/or enhance natural resources, and/or protect rights of Native Americans, while maintaining the safety, structural integrity, and functionality of the levee (DWR 2011b). After Hurricane Katrina in 2005, the USACE issued a policy and draft policy guidance to remove substantial vegetation from these levees throughout the nation (USACE 2009). This policy requires federally authorized levee systems that have maintenance agreements with the USACE (including Delta levees along the Sacramento and San Joaquin rivers) and other levees that are eligible for the federal Rehabilitation and Inspection Program (Public Law 84-99) to remove vegetation in the following manner.

- Removal of all vegetation from the upper third of the waterside slope of the levee, the top of the levee, landside slope of the levee, or within 15 feet of the toe of the levee on the landside ("toe" is where the levee slope meets the ground surfaces).
- Removal of all vegetation over 2 inches in diameter on the lower two-thirds of the waterside slope of the levee and within 15 feet of the toe of the levee on the waterside along benches above the water surface.

In 2010, the USACE issued a draft policy guidance letter, *Draft Process for Requesting a Variance from Vegetation Standards for Levees and Floodwalls—75 Federal Register 6364-68* (USACE 2010) that included procedures for State and local agencies to request variances on a site-specific basis. DWR has been in negotiations with USACE to remove vegetation on the upper third of the waterside slope, top, and landside of the levees, and continue to allow vegetation on the lower two-thirds of the waterside slope of the levee and along benches above the water surface (DSC 2011). By 2030, it is anticipated that much of the existing vegetation on the upper third of the waterside slopes, tops, landside slopes, and within 15 feet of the landside toe of the levees would be removed.

3.3.3 Second Basis of Comparison

Numerous comments received during the scoping process and subsequently during preparation of the Draft EIS requested that the No Action Alternative not include the 2008 USFWS BO RPA and 2009 NMFS BO RPA. The comments indicated that the EIS should include a “basis of comparison” for the alternatives that was similar to conditions prior to implementation of the RPAs. Scoping comments also indicated that a ”No Action Alternative scenario” without implementation of the RPAs in the 2008 USFWS BO and 2009 NMFS BO could be used to analyze the effects of implementing the RPAs.

Determining an appropriate baseline without the 2008 USFWS BO and 2009 NMFS BO actions and yet continuing to meet all of Reclamation’s statutory and regulatory requirements is a difficult task. Simply analyzing a No Action Alternative that is similar to the project description described in either the 2004 Biological Assessment or 2008 Biological Assessment is insufficient, as each was found to jeopardize listed species (the 2004 Biological Assessment by the District Court in 2007, and the 2008 Biological Assessment by USFWS and NMFS). Either of these operations would be inconsistent with Reclamation’s existing policy and management direction.

Reclamation has provisionally accepted and implemented the 2008 USFWS BO and 2009 NMFS BO actions; therefore, the No Action Alternative, by definition, must include these actions because they represent a continuation of existing policy and management direction. In response to the comments and to provide a basis for comparison of the effects of implementation of the RPAs (per the District Court’s mandate), this EIS includes a “Second Basis of Comparison” that does not include implementation of the RPAs. The Second Basis of Comparison can be used as a basis of comparison for the alternatives that do not include the RPAs. In this way, the action alternatives can be compared against both the No Action Alternative and the Second Basis of Comparison.

3.3.3.1 Continued Long-Term Operation of the CVP and SWP Facilities

The Second Basis of Comparison conditions assume that climate change conditions would have changed between 2015 and 2030. It is anticipated that by 2030, there will be less snowfall over the long-term average conditions and higher mean sea level elevations.

The CVP and SWP operations would be in accordance with water rights permits and licenses issued by the SWRCB and biological opinions issued by the USFWS and NMFS in the early 2000s. The CVP and SWP operations would be closely coordinated through the COA. The ongoing operational management policies of the CVP and SWP under the Second Basis of Comparison would be similar to the operational assumptions described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations, except for the sections identified as "Implementation of the 2008 USFWS BO [and/or 2009 NMFS BO]" (see Section 3A.4.3.4.8) and New Melones Reservoir operations.

The Second Basis of Comparison includes implementation of existing and future actions described in the 2008 USFWS BO and 2009 NMFS BO that would occur by 2030 without implementation of the biological opinions (as described in Section 3.3.1.2). The Second Basis of Comparison also includes implementation of future actions not described in the 2009 NMFS BO that would occur by 2030 without implementation of any alternatives considered in this EIS (as described in Section 3.3.1.3).

The Second Basis of Comparison would not include implementation of future actions described in the 2008 USFWS BO and 2009 NMFS BO that would not occur by 2030 without implementation of the biological opinions, as described below, including operations RPA actions and the following actions.

- 2009 NMFS BO RPA Action I.2.5, Winter-Run Passage and Re-Introduction Program at Shasta Dam.
- 2009 NMFS BO RPA Action II.3, Structural Improvements for Temperature Management on the American River, including installation of a Folsom Dam temperature control device, methods to transport cold water through Lake Natoma, installation of a temperature control device on the El Dorado Irrigation District intake from Folsom Lake, and development of temperature management decision-support tools.
- 2009 NMFS BO RPA Action II.5, Fish Passage at Nimbus and Folsom Dams.
- 2009 NMFS BO RPA Action II.6, Implement Actions to Reduce Genetic Effects of Nimbus and Trinity River Fish Hatchery Operations.
- 2009 NMFS BO RPA Action III.2.1, Increase and Improve Quality of Spawning Habitat with Addition of 50,000 Cubic Yards of Gravel by 2014 and with a Minimum Addition of 8,000 Cubic Yards per Year for the Duration of the Project Actions on Stanislaus River.
- 2009 NMFS BO RPA Action III.2.2, Conduct Floodplain Restoration and Inundation Flows in Winter or Spring to Inundate Steelhead Juvenile Rearing Habitat on One- to Three-Year Schedule on Stanislaus River.
- 2009 NMFS BO RPA Action III.2.3, Restore Freshwater Migratory Habitat for Juvenile Steelhead by Implementing Projects to Increase Floodplain Connectivity and to Reduce Predation Risk During Migration on Stanislaus River.
- 2009 NMFS BO RPA Action III.2.4, Fish Passage at New Melones, Tulloch, and Goodwin Dams.

- 2009 NMFS BO RPA Action IV.4, Tracy Fish Collection Facility Improvements to Reduce Pre-Screen Loss and Improve Screening Efficiency.
- 2009 NMFS BO RPA Action IV.4.2 Skinner Fish Collection Facility Improvements to Reduce Pre-Screen Loss and Improve Screening Efficiency.
- 2009 NMFS BO RPA Action IV.4.3 Tracy Fish Collection Facility and the Skinner Fish Collection Facility Actions to Improve Salvage Monitoring, Reporting and Release Survival Rates.

3.3.3.2 Vegetation Management Along Levees

The Second Basis of Comparison includes vegetation management operations along levees for flood management in accordance with policies issued by the USACE in 2009 and 2010.

3.3.3.3 New Melones Reservoir Operations

Under the Second Basis of Comparison, operations of New Melones Reservoir would be the same as under the No Action Alternative for flood management, water quality, San Joaquin River base flows and pulse flows at Vernalis, and water supply. Because the Second Basis of Comparison represents regulatory environment without the 2008 USFWS and 2009 NMFS BOs, fishery flows would be consistent with the 1997 New Melones Interim Plan of Operations (IPO) without implementation of the Vernalis Adaptive Management Program (VAMP), as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations.

3.4 Development of Reasonable Alternatives

The National Environmental Policy Act (NEPA) regulations and DOI NEPA regulations (43 CFR Section 46.415(b)) require an EIS to include a range of reasonable alternatives that meet the purpose and need of the proposed action, and address one or more significant issues related to the proposed action.

The DOI NEPA regulations also state that the lead agencies should include a consensus-based alternatives consistent with the purpose and need of the proposed project that are proposed by participating persons, organizations, or communities who may be interested in or affected by the proposed project when one exists. No alternatives or alternative concepts submitted to Reclamation during preparation of this EIS were identified as consensus-based.

The range of alternatives was developed for this EIS through the identification of screening criteria based upon the purpose of the action; comparison of alternative concepts identified by Reclamation, stakeholders, and agencies to the screening criteria; and review of the identified range of alternatives to determine if the range of alternatives addresses the significant issues.

3.4.1 Application of Screening Criteria to the Range of Alternative Concepts

The screening criteria developed for this EIS is based upon the purpose of the action, as described in Chapter 2, Purpose and Need for the Action. The purpose of the action is:

- To continue the operation of the CVP, in coordination with operation of the SWP, for the authorized purposes, in a manner that:
  - Is similar to historic operational parameters with certain modifications;
  - Is consistent with Federal Reclamation law; other Federal laws; Federal permits and licenses; State of California water rights, permits, and licenses; and
  - Enables Reclamation and DWR to satisfy their contractual obligations to the fullest extent possible.

A number of alternative concepts were identified during the scoping process and through meetings with stakeholders and agencies during preparation of this EIS. These concepts were compared to the purpose of the action, as summarized in Table 3.1. Most of the concepts were incorporated into alternatives to be evaluated in detail in this EIS. Further discussion of concepts not included in the alternatives evaluated in detail in this EIS is presented in Section 3.4.8, Alternatives Considered but Not Evaluated in Detail.

Table 3.1 Application of Screening Criteria to Alternative Concepts Identified for Consideration in the EIS

Alternative Concept	Consistent with Purpose for the Action	Addresses One or More Significant Issues	Include in One or More of the Alternatives Evaluated in the Draft EIS
Concept 1. CVP and SWP Operations without actions defined in the 2008 USFWS BO RPA and 2009 NMFS BO RPA	Possibly	Yes	Yes, included in Alternatives 1, 3, and 4
Concept 2. Modify actions defined in the 2008 USFWS BO RPA and 2009 NMFS BO RPA in a manner that would increase CVP and SWP deliveries	Possibly	Yes	Yes, included in Alternatives 1, 3, and 4
Concept 3. Modify actions defined in the 2008 USFWS BO RPA and 2009 NMFS BO RPA in a manner that would reduce reverse flows and increase Delta outflow in the spring.	Possibly	Yes	Yes, included in Alternative 5

Alternative Concept	Consistent with Purpose for the Action	Addresses One or More Significant Issues	Include in One or More of the Alternatives Evaluated in the Draft EIS
Concept 4. Modify actions defined in the 2008 USFWS BO RPA and 2009 NMFS BO RPA in a manner that would increase primary productivity and flood supply for aquatic resources	Possibly	Yes	Yes, included in Alternatives 1, 3, 4, and 5
Concept 5. Modify actions defined in the 2008 USFWS BO RPA and 2009 NMFS BO RPA in a manner that would modify the triggers for OMR criteria to protect Delta Smelt as follows: a) Reduce OMR criteria to a level between -5,000 cfs and -3,500 cfs only when appropriate based on analysis of turbidity levels and normalized salvage data in the south Delta b) Reduce OMR to no more negative than -5,000 cfs when more than 25 percent of the Delta Smelt collected in the spring kodiak or 20 mm trawl are located in the south Delta or the adult cumulative salvage index immediately preceding spawning is high; lift this restriction if Qwest is >12,000 cfs and/or secchi depth in the south Delta is >85 cm Do not implement RPA actions in the 2008 USFWS BO or 2009 NMFS BO	Possibly	Yes	Yes, included in Alternative 3

Alternative Concept	Consistent with Purpose for the Action	Addresses One or More Significant Issues	Include in One or More of the Alternatives Evaluated in the Draft EIS
Concept 6. Modify actions defined in the 2009 NMFS BO RPA related to the Interim Criteria for the San Joaquin River Inflow:Export ratio as follows for April 1 through May 30: Flows in San Joaquin River at Vernalis (7-day running average shall not be less than 7 percent of the target requirement) shall be based on the New Melones Index (as described in 2009 NMFS BO RPA Action IV.2.1) as follows for January 1 through June 15: a) If the Index is 999 TAF or less - no minimum flow requirement b) If the Index is 1000-1399 TAF - minimum flow is the greater of the SWRCB D-1641 requirement or 1500 cfs c) If the Index is 1400-1999 TAF - minimum flow is the greater of the SWRCB D-1641 requirement or 3000 cfs d) If the Index is 2000-2499 TAF - minimum flow is 4500 cfs e) If the Index is above 2499 TAF - minimum flow is 6000 cfs Do not implement RPA actions in the 2008 USFWS BO or 2009 NMFS BO	Possibly	Yes	No, this criteria is not implementable following the completion of the Vernalis Adaptive Management Program. Other flow criteria for the San Joaquin River at Vernalis are included in the range of alternatives, however this concept is informed the development of other alternative concepts evaluated in this EIS.

Alternative Concept	Consistent with Purpose for the Action	Addresses One or More Significant Issues	Include in One or More of the Alternatives Evaluated in the Draft EIS
Concept 7. Implement predator control programs for Black Bass, Striped Bass, and Pikeminnow to protect salmonids and Delta Smelt as follows: a) Black Bass catch limit changed to allow catch of 12-inch fish with a bag limit of 10 b) Striped Bass catch limit changed to allow catch of 12-inch fish with a bag limit of 5 c) Establish a Pikeminnow sport-fishing reward program with a 8-inch limit at $2/fish	Yes	Yes	Yes, included in Alternatives 3 and 4
Concept 8. Restore or create at least 10,000 acres of tidally influenced seasonal or perennial wetlands. Do not implement other wetlands restoration RPA actions in the 2008 USFWS BO or 2009 NMFS BO	Yes	Yes	Yes, included in Alternatives 3 and 4

Alternative Concept	Consistent with Purpose for the Action	Addresses One or More Significant Issues	Include in One or More of the Alternatives Evaluated in the Draft EIS
Concept 9. Establish a trap and haul program for juvenile salmonids entering the Delta from the San Joaquin River in March through June as follows: a) Begin operation of downstream migrant fish traps upstream of the Head of Old River on the San Joaquin River b) "Barge" all captured juvenile salmonids through the Delta, release at Chipps Island. c) Tag subset of fish in order to quantify effectiveness of the program d) Attempt to capture 10 percent to 20 percent of outmigrating juvenile salmonids	Yes	Yes	Yes, included in Alternatives 3 and 4
Concept 10. Work with Pacific Fisheries Management Council, CDFW, and NMFS to minimize harvest mortality of natural origin Central Valley Chinook Salmon, including fall-run Chinook Salmon, by evaluating and modifying ocean harvest for consistency with Viable Salmonid Population Standards; including harvest management plan to show that abundance, productivity, and diversity (age-composition) are not appreciably reduced	Maybe	Yes	Yes, included in Alternative 3

Alternative Concept	Consistent with Purpose for the Action	Addresses One or More Significant Issues	Include in One or More of the Alternatives Evaluated in the Draft EIS
Concept 11. Work with Pacific Fisheries Management Council, CDFW, and NMFS to impose salmon harvest restrictions to reduce by-catch of winter-run and spring-run Chinook Salmon to less than 10 percent of age-3 cohort in all years	Maybe	Yes	Yes, included in Alternative 4
Concept 12. Limiting floodplain development to protect salmonids and Delta Smelt by implementing the following actions: a) Incorporate guidance into flood hazard mapping to help communities comply with the ESA b) Require communities to demonstrate ESA compliance for all flood plain map revisions c) Prioritize consideration of ESA listed species and critical habitat when selecting flood insurance studies d) Develop and implement floodplain management criteria e) Refine community rating system to provide credits for natural and beneficial functions f) Prohibit new development and substantial improvements to existing development within any designated floodway or within 170 feet of the ordinary high water line of any floodway	Possibly	Yes	Yes, included in Alternative 4

Alternative Concept	Consistent with Purpose for the Action	Addresses One or More Significant Issues	Include in One or More of the Alternatives Evaluated in the Draft EIS
Concept 13. Do not implement USACE requirements for vegetation on levees, and instead bar removal of vegetation from levees, require planting of trees and shrubs on levees, and armor levees with vegetation, woody material, and root re-enforcement material instead of riprap	Possibly	Yes	Yes, included in Alternative 4
Concept 14. Advance the timing of upgrades at the Sacramento Regional Wastewater Treatment Plant to 2017; and implement advanced treatment technologies at the Fairfield-Suisun Sewer District treatment plant to reduce nutrients in the effluent	Yes	Yes	No, these actions are under construction and will be complete by 2030, per the requirements of the SWRCB and the related Regional Water Quality Control Boards
Concept 15. Expand the current period of time for water transfers addressed in the operations consulted on in the 2008 USFWS BO and 2009 NMFS BO from July through September to year-round	Possibly	Yes	Yes, included in Alternative 4
Concept 16. Include measures to support Federal and state fish-doubling goals, including the goals of CVPIA	Yes	Yes	Yes, included in Alternatives 1, 2, 3, 4, and 5 as part of ongoing implementation of CVPIA
Concept 17. Operate the CVP and SWP to avoid “dead-pool” conditions in Shasta Lake, Folsom Lake, and Lake Oroville	Possibly	Yes	Yes, included in Alternatives 1, 2, 3, 4, and 5 as part of overall CVP and SWP operations

Alternative Concept	Consistent with Purpose for the Action	Addresses One or More Significant Issues	Include in One or More of the Alternatives Evaluated in the Draft EIS
Concept 18. Change CVP water operations to meet all in-basin water demands for the Trinity, Sacramento, American, and Stanislaus rivers watersheds before meeting other CVP water demands	No	Yes	No, this concept would not be consistent with the purpose for the action
Concept 19. Implement operations of the New Melones Reservoir in accordance with the 2012 Oakdale Irrigation District and South San Joaquin Irrigation District Operations Plan	Possibly	Yes	Yes, included in Alternative 3
Concept 20. Reduce reliance of the CVP and SWP water users on water exported from the Delta through development of regional and local water supplies	Possibly	Yes	Yes, included in Alternatives 1, 2, 3, 4, and 5 as part of overall statewide water operations
Concept 21. Changes to methods used to monitor and predict OMR flow criteria, including exclusion of Contra Costa Water District diversions from the calculations	Possibly	Maybe	No, this EIS analyzes overall operational concepts for the CVP and SWP. Specific methods to monitor and predict operations will be developed under separate efforts by Reclamation
Concept 22. Prioritize use of CVPIA restoration funds within watersheds in accordance with the amount of restoration funds collected in each watershed (e.g., the most funds would be highest in the watershed that generates the highest CVPIA restoration fund based upon water sales)	No	No	No, would not be consistent with CVPIA

Alternative Concept	Consistent with Purpose for the Action	Addresses One or More Significant Issues	Include in One or More of the Alternatives Evaluated in the Draft EIS
Concept 23. Completely cease operations of the CVP and SWP facilities	No	No	No, this concept would not be consistent with the purpose for the action

Note:
Concepts identified as "possibly consistent with the purpose of the action" would require development of additional details and evaluation to determine if the concept is consistent with the stated purpose for the action, as described in Chapter 2, Purpose and Need for the Action. Concepts identified as "possibly consistent with the purpose of the action" were integrated into one or more of the alternatives evaluated in this EIS.

Based upon the comparison of screening criteria to the alternative concepts developed by Reclamation 17 of the 23 alternative concepts would be included in one or more of the alternatives evaluated in this EIS. The next step in the development of the alternatives is to combine the alternative concepts into specific alternatives and determine if the range of alternatives is adequate to address the significant issues in implementing a program that supports the purpose of the action.

3.4.2 Identification of Alternatives

The 17 alternative concepts were compiled into five alternatives. Development of the alternatives was informed by comments received about the alternative concepts. For example, numerous comments were received to evaluate an alternative that included assumptions identical to the Second Basis of Comparison assumptions in which the 2008 USFWS BO and 2009 NMFS BO would not be implemented. One of the scoping comments identified specific alternatives that included several alternative concepts included in Table 3.1; however, some of the specified alternative concepts were not consistent with assumptions for the Year 2030 and were modified to reflect implementable concepts.

Several of the alternative concepts are consistent with the No Action Alternative assumptions related to actions that would have occurred with or without implementation of the 2008 USFWS BO and 2009 NMFS BO. Therefore, the following alternative concepts are included under the No Action Alternative, Second Basis of Comparison, and all other alternatives.

- Alternative Concept 8 to restore or create at least 10,000 acres of tidally-influenced seasonal or perennial wetlands.
- Alternative Concept 16 to support the fish-doubling goals under CVPIA and state ecosystem restoration programs.
- Alternative Concept 17 to operate the CVP and SWP to avoid dead-pool conditions in the CVP and SWP reservoirs, to the extent possible based upon hydrologic conditions.

- Alternative Concept 20 to increase regional and local water supplies that could be used when CVP and SWP water supplies are reduced due to hydrologic and regulatory restrictions.

Using these concepts, the alternative concepts were combined into Alternatives 1 through 5 in a manner to avoid conflicts between concepts within an alternative.

The range of alternatives in the EIS includes the No Action Alternative and Alternatives 1 through 5, as described below.

3.4.3 No Action Alternative

The No Action Alternative, the Preferred Alternative, is described in Section 3.3.2, of this chapter.

3.4.4 Alternative 1

Alternative 1 was created because many comments requested an alternative that reflected conditions without implementation of the 2008 USFWS BO and the 2009 NMFS BO. Since the Second Basis of Comparison is not a true alternative, in accordance with NEPA guidelines, Reclamation could not select Second Basis of Comparison as a preferred alternative. Therefore, Alternative 1 was defined as being identical to the Second Basis of Comparison, as defined in Section 3.3.2.

3.4.5 Alternative 2

Alternative 2 was first included in the Notice of Intent and identified as an initial proposed action that included the operational actions of the 2008 USFWS BO and 2009 NMFS BO. Alternative 2 does not include RPA actions that would require future studies and environmental documentation to define recommended actions (generally, structural actions).

The definition of Alternative 2 is based upon the following assumptions that are briefly described below.

- Continued long-term operation of the CVP and SWP in accordance with ongoing management policies, criteria, and regulations, including water right permits and licenses issued by the SWRCB and implementation of the 2008 USFWS BO and 2009 NMFS BO, as described under the No Action Alternative.
- Implementation of existing and future actions described in the 2008 USFWS BO and 2009 NMFS BO that would occur by 2030 without implementation of the BOs, as described above for the No Action Alternative in Sections 3.4.1.2 and 3.4.1.3.
- Implementation of future actions not described in the 2009 NMFS BO that would occur by 2030 without implementation of any alternatives considered in this EIS.

Alternative 2 conditions assume that climate change conditions would have changed between 2015 and 2030. It is anticipated that by 2030, there will be less snowfall over the long-term average conditions and higher mean sea level elevations.

Alternative 2 would not include actions in the 2008 USFWS BO and 2009 NMFS BO that have not been fully defined at this time; and therefore, would require future engineering and environmental evaluation prior to implementation. These following actions are not included in Alternative 2.

- 2009 NMFS BO RPA Action I.2.5, Winter-Run Passage and Re-Introduction Program at Shasta Dam.
- 2009 NMFS BO RPA Action II.3, Structural Improvements for Temperature Management on the American River.
- 2009 NMFS BO RPA Action II.5, Fish Passage at Nimbus and Folsom Dams.
- 2009 NMFS BO RPA Action II.6, Implement Actions to Reduce Genetic Effects of Nimbus and Trinity River Fish Hatchery Operations.
- 2009 NMFS BO RPA Action III.2.1, Increase and Improve Quality of Spawning Habitat with Addition of Gravel.
- 2009 NMFS BO RPA Action III.2.2, Conduct Floodplain Restoration and Inundation Flows in Winter or Spring to Inundate Steelhead Juvenile Rearing Habitat on Stanislaus River.
- 2009 NMFS BO RPA Action III.2.3, Restore Freshwater Migratory Habitat for Juvenile Steelhead on Stanislaus River.
- 2009 NMFS BO RPA Action III.2.4, Fish Passage at New Melones, Tulloch, and Goodwin Dams.
- 2009 NMFS BO RPA Action IV.4, Tracy Fish Collection Facility Improvements to Reduce Pre-Screen Loss and Improve Screening Efficiency.
- 2009 NMFS BO RPA Action IV.4.2 Skinner Fish Collection Facility Improvements to Reduce Pre-Screen Loss and Improve Screening Efficiency.
- 2009 NMFS BO RPA Action IV.4.3 Tracy Fish Collection Facility and the Skinner Fish Collection Facility Actions to Improve Salvage Monitoring, Reporting and Release Survival Rates.

3.4.5.1 Continued Long-Term Operation of the CVP and SWP Facilities

The CVP and SWP operations and ongoing operational management policies of the CVP and SWP under Alternative 2 would be identical to the operational assumptions described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations.

3.4.5.2 Actions in the 2008 USFWS BO and 2009 NMFS BO that Would Have Occurred without Implementation of the Biological Opinions

Actions included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred with or without the BOs, would be identical under Alternative 2 as under the No Action Alternative and the Second Basis of Comparison.

3.4.5.3 Future Actions not included in the 2008 USFWS BO and 2009 NMFS BO that Would Have Occurred without Implementation of the Biological Opinions

Alternative 2 also includes assumptions unrelated to implementation of the 2008 USFWS BO and 2009 NMFS BO, including: climate change and sea level rise; development of lands in accordance with general plans in areas served by CVP and SWP water supplies; and reasonable and foreseeable projects that have been approved and are anticipated to be implemented by 2030. These items included in Alternative 2 are identical as under the No Action Alternative and the Second Basis of Comparison.

3.4.5.4 Vegetation Management Along Levees

Alternative 2 includes vegetation management operations along levees for flood management in accordance with policies issued by the USACE in 2009 and 2010.

3.4.6 Alternative 3

Alternative 3 was developed based upon a scoping comment from the Coalition for a Sustainable Delta which identified "RPA Alternative 1," and a scoping comment received from Oakdale Irrigation District (OID) and South San Joaquin Irrigation District (SSJID) (included in the Scoping Report in Appendix 23A of this EIS). The definition of Alternative 3 is based upon the following assumptions that are briefly described below.

- Continued long-term operation of the CVP and SWP in accordance with ongoing management policies, criteria, and regulations, including water right permits and licenses issued by the SWRCB; without the operational requirements of the 2008 USFWS BO and the 2009 NMFS BO; plus implementation of the 2012 operations plan for New Melones Reservoir proposed by OID and SSJID.
- Implementation of actions described in the Coalition for a Sustainable Delta scoping comment letter related to "RPA Alternative 1."
- Implementation of existing and future actions described in the 2008 USFWS BO and 2009 NMFS BO that would occur by 2030 without implementation of the BOs, as described above for the No Action Alternative in Sections 3.4.1.2 and 3.4.1.3.
- Implementation of future actions not described in the 2009 NMFS BO that would occur by 2030 without implementation of any alternatives considered in this EIS.

Alternative 3 would not include implementation of actions described in the 2008 USFWS BO and 2009 NMFS BO that would not occur by 2030 without implementation of the BOs.

Alternative 3 conditions assume that climate change conditions would have changed between 2015 and 2030. It is anticipated that by 2030, there will be less snowfall over the long-term average conditions and higher mean sea level elevations.

3.4.6.1 Continued Long-Term Operation of the CVP and SWP Facilities

The CVP and SWP operations and ongoing operational management policies of the CVP and SWP under Alternative 3 would be similar to the operational assumptions under the Second Basis of Comparison with the following changes to water demand assumptions, OMR criteria, and operations of New Melones Reservoir to meet SWRCB D-1641 flow requirements on the San Joaquin River at Vernalis.

Alternative 3 would include additional demands for American River water supplies as compared to the No Action Alternative or Second Basis of Comparison. The additional demands would provide water supplies of up to 17 TAF/year under a Warren Act Contract for El Dorado Irrigation District and 15 TAF/year under a long-term CVP water service contract with El Dorado County Water Agency. During the review of the numerical modeling analyses used in this EIS, it was discovered that the demands for these El Dorado Irrigation District and the El Dorado County Water Agency contracts were not included in the CalSim II modeling analysis for Alternative 3 as presented in Chapters 5 through 21. A sensitivity analysis using the CalSim II model to compare the results of the analysis with and without these demands is presented in Appendix 5B of this EIS for Alternative 3. The results of the sensitivity analysis have been used in conjunction with the results presented in Chapters 5 through 21 to analyze the effects of including the CVP water service contract for El Dorado County Water Agency in Alternative 3.

3.4.6.1.1 Old and Middle River Criteria

The OMR flow criteria under Alternative 3 are based on concepts addressed in the 2008 USFWS BO and 2009 NMFS BO related to adaptive restrictions for temperature, turbidity, salinity, and presence of Delta Smelt. The OMR flow criteria in the Alternative 3 are similar to those of the No Action Alternative, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations, with the exception of the following changes:

- Reduce OMR criteria to a level between -5,000 cfs and -3,500 cfs only when appropriate based on analysis of turbidity levels and normalized salvage data in the south Delta
- Reduce OMR to no more negative than -5,000 cfs when more than 25 percent of the Delta Smelt collected in the spring kodiak or 20 mm trawl are located in the south Delta or the adult cumulative salvage index immediately preceding

spawning is high; lift this restriction if Qwest is >12,000 cfs and/or secchi depth in the south Delta is >85 cm

For the purpose of quantitative analysis in this EIS, the numerical model represented this concept with the following assumptions.

- Action 1 that protects the pre-spawning adult Delta Smelt from entrainment is modified to limit exports such that the average daily OMR flow is no more negative than -3,500 cfs for a total duration of 14 days, with a 5-day running average no more negative than -4,375 cfs (within 25 percent of the monthly criteria).
- Action 2 that protects adult Delta Smelt within the Delta from entrainment is modified to limit exports so that the average daily OMR flow is no more negative than -3,500 or -7,500 cfs depending on the previous month's ending X2 location (-3,500 cfs if X2 is east of Roe Island, or -7,500 cfs if X2 is west of Roe Island), with a 5-day running average within 25 percent of the monthly criteria (no more negative than -4,375 cfs if X2 is east of Roe Island, or -9,375 cfs if X2 is west of Roe Island).
- Action 3 that protects larval and juvenile Delta Smelt from entrainment is modified to limit exports so that the average daily OMR flow is no more negative than -1,250, -3,500, or -7,500 cfs, depending on the previous month's ending X2 location (-1,250 cfs if X2 is east of Chipps Island, -7,500 cfs if X2 is west of Roe Island, or -3,500 cfs if X2 is between Chipps and Roe Island, inclusively), with a 5-day running average within 25 percent of the monthly criteria (no more negative than -1,562 cfs if X2 is east of Chipps Island, -9,375 cfs if X2 is west of Roe Island, or -4,375 cfs if X2 is between Chipps and Roe Island).
- Temporal off-ramp for Action 3 is assumed to occur no later than June 15 (changed from June 30).
- An off-ramp based on QWest (westerly flow on the San Joaquin River past Jersey Point calculated as a combination of San Joaquin River at Blind Point, Three Mile Slough and Dutch Slough) is assumed. If Qwest is greater than 12,000 cfs, then the Action 3 is discontinued. Because Action 2 is defined to occur between Actions 1 and 3, the Qwest off-ramp also results in discontinuation of Action 2 if it happens before Action 3 is triggered. In monthly CalSim II modeling, previous month's QWest value is used for determining the off-ramp, therefore if the off-ramp occurs within the previous month, actions in that previous month are assumed to continue until the end of the month.

3.4.6.1.2 New Melones Operations Criteria

Alternative 3 assumes that the flood control operations for the New Melones Reservoir would be the same as under the No Action Alternative. However, New Melones Reservoir would be operated for different fishery flows, water quality flows, and San Joaquin River base flows and pulse flows at Vernalis.

Fishery

In the Alternative 3 simulation, fishery flows are modeled per the OID and SSJID 2012 operations proposal, as summarized in Tables 3.2 through 3.4. These flows include an outmigration pulse flow from April 1 through May 15. Total annual volume dedicated to fishery flows vary from 174 to 318 TAF depending on the hydrologic conditions defined by the New Melones water supply forecast (the end-of-February New Melones Storage, plus the March - September forecast of inflow to the reservoir).

Table 3.2 Annual Fishery Flow Allocation in New Melones

Melones Water Supply Forecast (TAF)	Fishery Base Flows (TAF)
0 to 1,800	174
1,801 to 2,500	235
>2,500	318

Table 3.3 Monthly "Base" Flows for Fisheries Purposes Based on the Annual Fishery Volume

Annual Fishery Flow Volume (TAF)	Monthly Fishery Base Flows (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
235	252	300	300	150	173	200	200	200	200	200	200	200
318	300	300	300	300	300	300	1,500	850	200	200	200	200

Table 3.4 April 1 through May 31 "Pulse" Flows for Fisheries Purposes Based on the Annual Fishery Volume

Melones Water Supply Forecast (TAF)	Fishery Pulse Flows (CFS) April 1 –May 31
0 to 1,800	750
1,801 to 2,500	1,500
>2,500	1,500

Water Quality

Alternative 3 assumes that no water is released from New Melones Reservoir to meet the SWRCB D-1641 water quality criteria in the San Joaquin River. Water is released to meet the SWRCB D-1422 DO criteria; however, the compliance point is moved from Ripon to the Orange Blossom Bridge under the Alternative 3.

Bay-Delta Flows

Alternative 3 assumes that no water is released from New Melones Reservoir to meet the SWRCB D-1641 Bay-Delta flow requirements on the San Joaquin River at Vernalis for base flows or pulse flows.

3.4.6.2 Actions Related to Predation Control, Wetlands Restoration, Juvenile Salmonid Trap and Haul Program, and Chinook Salmon Ocean Harvest

Alternative 3 includes the following actions as described in "RPA Alternative 1" in the Coalition for a Sustainable Delta scoping comment.

- Implement predator control programs for Black Bass, Striped Bass, and Pikeminnow to protect salmonids and Delta Smelt as follows:
    - Black Bass catch limit changed to allow catch of 12-inch fish with a bag limit of 10
    - Striped Bass catch limit changed to allow catch of 12-inch fish with a bag limit of 5
    - Establish a Pikeminnow sport-fishing reward program with a 8-inch limit at $2/fish
- Restore or create at least 10,000 acres of tidally influenced seasonal or perennial wetlands. These conditions are the same as under the No Action Alternative and Second Basis of Comparison.
- Establish a trap and haul program for juvenile salmonids entering the Delta from the San Joaquin River in March through June as follows:
    - Begin operation of downstream migrant fish traps upstream of the Head of Old River on the San Joaquin River
    - "Barge" all captured juvenile salmonids through the Delta, release at Chipps Island.
    - Tag subset of fish in order to quantify effectiveness of the program
    - Attempt to capture 10 percent to 20 percent of out-migrating juvenile salmonids
- Work with Pacific Fisheries Management Council, CDFW, and NMFS to minimize harvest mortality of natural origin Central Valley Chinook Salmon, including fall-run Chinook Salmon, by evaluating and modifying ocean harvest for consistency with Viable Salmonid Population Standards; including harvest management plan to show that abundance, productivity, and diversity (age-composition) are not appreciably reduced.

Any changes in harvest limitations would require review and approval from the California Fish and Game Commission; and for some species, the Pacific Fisheries Management Council.

3.4.6.3 Actions in the 2008 USFWS BO and 2009 NMFS BO that Would Have Occurred without Implementation of the Biological Opinions

Actions included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred with or without the BOs, would be identical under Alternative 3 as under the No Action Alternative and the Second Basis of Comparison.

3.4.6.4 Future Actions not included in the 2008 USFWS BO and 2009 NMFS BO that Would Have Occurred without Implementation of the Biological Opinions

Alternative 3 also includes assumptions unrelated to implementation of the 2008 USFWS BO and 2009 NMFS BO, including: climate change and sea level rise; development of lands in accordance with general plans in areas served by CVP and SWP water supplies; and reasonable and foreseeable projects that have been approved and are anticipated to be implemented by 2030. These items included in Alternative 3 are identical as under the No Action Alternative and the Second Basis of Comparison.

3.4.6.5 Vegetation Management Along Levees

Alternative 3 includes vegetation management operations along levees for flood management in accordance with policies issued by the USACE in 2009 and 2010.

3.4.7 Alternative 4

Alternative 4 was developed based upon a scoping comment from the Coalition for a Sustainable Delta which identified “RPA Alternative 2” (included in the Scoping Report in Appendix 23A of this EIS). The definition of Alternative 4 is based upon the following assumptions that are briefly described below.

- Continued long-term operation of the CVP and SWP in accordance with ongoing management policies, criteria, and regulations, including water right permits and licenses issued by the SWRCB; without the operational requirements of the 2008 USFWS BO and the 2009 NMFS BO, as described under Second Basis of Comparison.
- Implementation of actions described in the Coalition for a Sustainable Delta scoping comment letter related to “RPA Alternative 2.”
- Implementation of existing and future actions described in the 2008 USFWS BO and 2009 NMFS BO that would occur by 2030 without implementation of the BOs, as described above for the No Action Alternative in Sections 3.4.1.2 and 3.4.1.3.
- Implementation of future actions not described in the 2009 NMFS BO that would occur by 2030 without implementation of any alternatives considered in this EIS.

Alternative 4 would not include implementation of actions described in the 2008 USFWS BO and 2009 NMFS BO that would not occur by 2030 without implementation of the BOs.

The "RPA Alternative 2" also included a provision to "Advance the timing of upgrades at the Sacramento Regional Wastewater Treatment Plant to 2017; and implement advanced treatment technologies at the Fairfield-Suisun Sewer District treatment plant to reduce nutrients in the effluent." However, both of these actions would be complete by 2030, the study period considered in this EIS. The Sacramento Regional Wastewater Treatment Plant must comply with the National Pollutant Discharge Elimination System permit issued on December 9, 2010 by the Central Valley Regional Water Quality Control Board to reduce nutrients in the effluent discharged to the Sacramento River by 2020 (SRCSD 2012). The Fairfield Suisun Sewer District must comply with similar permit conditions issued by the San Francisco Bay Regional Water Quality Control Board in March 2015 (SFRRWQCB 2015). Because the Environmental Consequences analysis in this EIS is conducted as a "snapshot" in time at 2030, inclusion of a provision to require compliance with the discharge requirements prior to 2020 could not be evaluated.

Alternative 4 conditions assume that climate change conditions would have changed between 2015 and 2030. It is anticipated that by 2030, there will be less snowfall over the long-term average conditions and higher mean sea level elevations.

3.4.7.1 Continued Long-Term Operation of the CVP and SWP Facilities

The ongoing operational management policies of the CVP and SWP under Alternative 4 would be identical to operations described under the Second Basis of Comparison.

3.4.7.2 Actions Related to Floodplain Protection, Levee Vegetation, Predation Control, Wetlands Restoration, Juvenile Salmonid Trap and Haul Program, and Chinook Salmon Ocean Harvest

Alternative 4 includes the following actions as described in "RPA Alternative 1" in the Coalition for a Sustainable Delta scoping comment.

- Limiting floodplain development to protect salmonids and Delta Smelt by implementing the following actions:
  - Incorporate guidance into flood hazard mapping to help communities comply with the ESA
  - Require communities to demonstrate ESA compliance for all flood plain map revisions
  - Prioritize consideration of ESA listed species and critical habitat when selecting flood insurance studies
  - Develop and implement floodplain management criteria
  - Refine community rating system to provide credits for natural and beneficial functions

  - Prohibit new development and substantial improvements to existing development within any designated floodway or within 170 feet of the ordinary high water line of any floodway

- Modify the requirements of the USACE related to removal of vegetation on levees. USACE requires removal of vegetation on levees. DWR and USACE have been working to develop a plan that would allow for the continuation of existing vegetation on levees until levee maintenance or repairs requires removal of the vegetation. Under Alternative 4, trees and shrubs would be planted along the levees; and vegetation, woody material, and root re-enforcement material would be installed on the levees instead of riprap for erosion protection.
- Implement predator control programs for Black Bass, Striped Bass, and Pikeminnow to protect salmonids and Delta Smelt as follows:
  - Black Bass catch limit changed to allow catch of 12-inch fish with a bag limit of 10
  - Striped Bass catch limit changed to allow catch of 12-inch fish with a bag limit of 5
  - Establish a Pikeminnow sport-fishing reward program with a 8-inch limit at $2/fish
- Restore or create at least 10,000 acres of tidally influenced seasonal or perennial wetlands. These conditions are the same as under the No Action Alternative and Second Basis of Comparison.
- Establish a trap and haul program for juvenile salmonids entering the Delta from the San Joaquin River in March through June as follows:
  - Begin operation of downstream migrant fish traps upstream of the Head of Old River on the San Joaquin River
  - "Barge" all captured juvenile salmonids through the Delta, release at Chipps Island.
  - Tag subset of fish in order to quantify effectiveness of the program
  - Attempt to capture 10 percent to 20 percent of outmigrating juvenile salmonids
- Work with Pacific Fisheries Management Council, CDFW, and NMFS to impose salmon harvest restrictions to reduce by-catch of winter-run and spring-run Chinook Salmon to less than 10 percent of age-3 cohort in all years.

Any changes in harvest limitations would require review and approval from the California Fish and Game Commission; and for some species, the Pacific Fisheries Management Council.

3.4.7.3 Actions in the 2008 USFWS BO and 2009 NMFS BO that Would Have Occurred without Implementation of the Biological Opinions

Actions included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred with or without the BOs, would be identical under Alternative 4 as under the No Action Alternative and the Second Basis of Comparison.

3.4.7.4 Future Actions not included in the 2008 USFWS BO and 2009 NMFS BO that Would Have Occurred without Implementation of the Biological Opinions

Alternative 4 also includes assumptions unrelated to implementation of the 2008 USFWS BO and 2009 NMFS BO, including: climate change and sea level rise; development of lands in accordance with general plans in areas served by CVP and SWP water supplies; and reasonable and foreseeable projects that have been approved and are anticipated to be implemented by 2030. These items included in Alternative 4 are identical as under the No Action Alternative and the Second Basis of Comparison.

3.4.8 Alternative 5

Alternative 5 is similar to the No Action Alternative with positive OMR criteria in April and May which causes increased Delta outflow; and use of the SWRCB D-1641 pulse flow at Vernalis. Alternative 5 was developed considering comments from environmental interest groups during the scoping process. Alternative 5 also provides another method to operate the New Melones Reservoir as compared to the other alternatives.

The definition of Alternative 5 is based upon the following assumptions that are briefly described below.

- Continued long-term operation of the CVP and SWP in accordance with ongoing management policies, criteria, and regulations, including water right permits and licenses issued by the SWRCB; and the operational requirements of the 2008 USFWS BO and the 2009 NMFS BO.
- Implementation of existing and future actions described in the 2008 USFWS BO and 2009 NMFS BO that would occur by 2030 without implementation of the BOs, as described above for the No Action Alternative in Sections 3.4.1.2 and 3.4.1.3.
- Implementation of actions described in the 2008 USFWS BO and 2009 NMFS BO that would not occur by 2030 without implementation of the BOs.
- Implementation of future actions not described in the 2009 NMFS BO that would occur by 2030 without implementation of any alternatives considered in this EIS.

Alternative 5 conditions assume that climate change conditions would have changed between 2015 and 2030. It is anticipated that by 2030, there will be less snowfall over the long-term average conditions and higher mean sea level elevations.

3.4.8.1 Continued Long-Term Operation of the CVP and SWP Facilities

The CVP and SWP operations and ongoing operational management policies of the CVP and SWP under Alternative 5 would be similar to the operational assumptions under the No Action Alternative with the following changes to water demand assumptions, OMR criteria, and operations of New Melones Reservoir to meet SWRCB D-1641 flow requirements on the San Joaquin River at Vernalis.

3.4.8.1.1 Water Demands

Alternative 5 would include additional water demands for users of water from the American River watershed as compared to the No Action Alternative or Second Basis of Comparison. Under Alternative 5, up to 17 TAF/year would be provided to the El Dorado Irrigation District under a Warren Act Contract to allow water to be conveyed through Folsom Lake; and up to 15 TAF/year would be provided to El Dorado County Water Agency under a separate long-term CVP water service contract. During the review of the numerical modeling analyses used in this EIS, it was discovered that the demands for these El Dorado Irrigation District and the El Dorado County Water Agency contracts were not included in the CalSim II modeling analysis for Alternative 3 as presented in Chapters 5 through 21. A sensitivity analysis using the CalSim II model to compare the results of the analysis with and without these demands is presented in Appendix 5B of this EIS for Alternative 3. The results of the sensitivity analysis have been used in conjunction with the results presented in Chapters 5 through 21 to analyze the effects of including the CVP water service contract for El Dorado County Water Agency in Alternative 3.

3.4.8.1.2 Old and Middle River Criteria

The OMR flow criteria under Alternative 5 is similar to the assumptions under the No Action Alternative and based on concepts addressed in the 2008 USFWS BO and 2009 NMFS BO plus a requirement for positive OMR (no reverse flows) in April and May of all water year types.

3.4.8.1.3 New Melones Operations Criteria

Alternative 5 assumptions for New Melones Reservoir operations are similar to assumptions under the No Action Alternative except for SWRCB D-1641 requirements for the San Joaquin River pulse flows at Vernalis, as summarized in Table 3.5.

Table 3.5 Bay-Delta Vernalis Flow Objectives (average monthly cfs)

60-20-20 Index	Pulse Flow Required if X2 is West of Chipps Island	Pulse Flow required if X2 is East of Chipps Island
Wet	8,620	7,330
Above Normal	7,020	5,730
Below Normal	5,480	4,620
Dry	4,880	4,020
Critical	3,540	3,110

3.4.8.2 Actions in the 2008 USFWS BO and 2009 NMFS BO that Would Have Occurred without Implementation of the Biological Opinions

Actions included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred with or without the BOs, would be identical under Alternative 5 as under the No Action Alternative and the Second Basis of Comparison.

3.4.8.3 Actions in the 2009 NMFS BO that Would Not Have Occurred without Implementation of the Biological Opinions

Actions included in the 2008 USFWS BO and 2009 NMFS BO that would not have occurred without the BOs, would be identical under Alternative 5 as under the No Action Alternative.

3.4.8.4 Future Actions not included in the 2008 USFWS BO and 2009 NMFS BO that Would Have Occurred without Implementation of the Biological Opinions

Alternative 5 also includes assumptions unrelated to implementation of the 2008 USFWS BO and 2009 NMFS BO, including: climate change and sea level rise; development of lands in accordance with general plans in areas served by CVP and SWP water supplies; and reasonable and foreseeable projects that have been approved and are anticipated to be implemented by 2030. These items included in Alternative 5 are identical as under the No Action Alternative and the Second Basis of Comparison.

3.4.8.5 Vegetation Management Along Levees

Alternative 5 includes vegetation management operations along levees for flood management in accordance with policies issued by the USACE in 2009 and 2010.

3.4.9 Alternatives Considered but Not Evaluated in Detail

As described above, 6 of the 23 alternative concepts identified for inclusion in the alternatives to be evaluated in this EIS were eliminated for further evaluation for several reasons, as described below.

3.4.9.1 Alternative Concept 6: Modify Flows in San Joaquin River at Vernalis

The 2009 NMFS BO included two phases related to implementation of the San Joaquin River Inflow to Export Ratio. The first phase, to be implemented in 2010 and 2011, assumed CVP and SWP operations under the Vernalis Adaptive Management Plan (VAMP) which provided for Reclamation to purchase water from non-CVP water users in the San Joaquin River watershed. The second phase was designed to be implemented following the completion of VAMP when Reclamation could no longer purchase water to meet flow requirements of the SWRCB D-1641 in the Delta.

Alternative Concept 6 recommended an operations that CVP could not meet without VAMP authorizations. Therefore, Alternative Concept 6 did not meet the provision in the purpose of the action to be “consistent with Federal Reclamation law; other Federal laws; Federal permits and licenses; State of California water rights, permits, and licenses." Alternative Concept 6 was not retained for analysis in the EIS.

3.4.9.2 Alternative Concept 14: Advance the Timing of Upgrades at Wastewater Treatment Plants

Alternative Concept 14 would advance the timing of upgrades at the Sacramento Regional Wastewater Treatment Plant to 2017; and implement advanced treatment technologies at the Fairfield-Suisun Sewer District treatment plant to reduce nutrients in the effluent." However, both of these actions would be complete by 2030, the study period considered in this EIS. The Sacramento Regional Wastewater Treatment Plant must comply with the National Pollutant Discharge Elimination System permit issued on December 9, 2010 by the Central Valley Regional Water Quality Control Board to reduce nutrients in the effluent discharged to the Sacramento River by 2020 (SRCSD 2012). The Fairfield Suisun Sewer District must comply with similar permit conditions issued by the San Francisco Bay Regional Water Quality Control Board in March 2015 (SFRRWQCB 2015).

Because the Environmental Consequences analysis in this EIS is conducted as a "snapshot" in time at 2030, inclusion of a provision to require compliance with the discharge requirements prior to 2020 would not be evaluated. Therefore, Alternative Concept 14 was not retained for analysis in the EIS.

3.4.9.3 Alternative Concept 18: Change to CVP Operations to Meet In-Basin Water Demands prior to Meeting other CVP Water Demands

Alternative Concept 18 would require operations of the CVP to meet in-basin water demands in the Trinity, Sacramento, American, and Stanislaus rivers watersheds prior to use of the CVP water in other portions of the service area. However, the CVP is operated as integrated system to satisfy statutory, regulatory, and contractual obligations to the fullest extent possible, in accordance with the purpose of the action. Therefore, Alternative Concept 18 was not retained for analysis in the EIS.

3.4.9.4 Alternative Concept 21: Change methods used to monitor and predict OMR criteria

Alternative Concept 21 addresses an item that is related to methods to implement OMR monitoring and projections. The alternatives considered in this EIS address approaches to continued operation of the CVP and SWP. Methods to monitor and predict criteria used in CVP and SWP operations are considered by Reclamation as part of the operations of the CVP. Changes in methods used to monitor and predict OMR values can be applied to any of the alternatives considered in this EIS; and would not result in differentiations between alternatives. Therefore, Alternative Concept 21 was not retained for analysis in the EIS.

3.4.9.5 Alternative 22: Prioritize Use of CVPIA Restoration Funds in the Watersheds that Generated the Funds

As described above, the locations of CVPIA restoration activities are determined based upon scientific framework throughout the CVP service area that connects restoration actions to environmental and population responses across watersheds (Reclamation 2013c). A system-wide science-based approach with performance indices, monitoring, and scientific review of results is used to provide direction as the CVPIA adapts to changing conditions. Changing the approach from the current CVPIA implementation plan could be considered to be inconsistent with Federal law. Therefore, Alternative Concept 22 was not retained for analysis in the EIS.

3.4.9.6 Alternative 23: Completely Cease Operations of the CVP and SWP

Complete cessation of CVP and SWP operations would not be consistent with the requirement of the purpose of the action to operate the CVP and SWP in a manner that is similar to historic operational parameters with certain modifications; and it would not be consistent with Federal Reclamation law; other Federal laws; Federal permits and licenses; State of California water rights, permits, and licenses related to delivery of water by CVP and SWP to water rights holder and related to flood management operations at the CVP and SWP reservoirs. Therefore, Alternative Concept 23 was not retained for analysis in the EIS.

3.5 Assumptions for Cumulative Effects Analysis

The CEQ regulations define cumulative effects as the impact on environmental, human, and community resources that results from the incremental impact of the proposed project when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or persons undertakes such actions. Cumulative effects can result from individually minor but collectively significant actions taking place over time (40 CFR 1508.7, 1508.25.) Future cumulative impacts should not be speculative but should be based upon known or reasonably foreseeable long-range plans, regulations, operating agreements, or other information that establishes them as reasonably foreseeable.

The reasonably foreseeable future actions included in the cumulative effects analysis are summarized below. The projects and actions are organized into:

- Water Supply and Water Quality Projects and Actions potentially affected by long-term operation of the SWP and CVP (organized geographically from north to south)
- Ecosystem Improvement Projects and Actions potentially affected by long-term operation of the SWP and CVP or potentially affecting resources analyzed in this EIS (organized geographically from north to south)

3.5.1 Water Supply and Water Quality Projects and Actions

There are numerous water supply and water quality projects and actions that could be potentially affected by changes in the coordinated long-term operation of the CVP and SWP, or could affect the CVP and SWP operations. Major future water supply and water quality projects and actions are discussed below.

3.5.1.1 Bay-Delta Water Quality Control Plan Update

In accordance with the federal Clean Water Act and the Porter-Cologne Water Quality Control Act, basin plans must be developed for each hydrologic area. Each basin plan must contain water quality objectives to ensure the reasonable protection of beneficial uses, as well as a program of implementation for achieving those objectives. Federal regulations require each state to adopt water quality standards to protect the public health or welfare, enhance the quality of water, and serve the purposes of the Clean Water Act. In California, the beneficial uses and water quality objectives form the basis of the water quality control standards. In the Sacramento-San Joaquin Bay Delta, water quality and flow objectives to meet water quality criteria are included in the Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary (Bay-Delta WQCP) (SWRCB 2006). The SWRCB and the Central Valley and San Francisco Regional Water Quality Control Boards are in the process of updating the Bay-Delta WQCP. The updates, or amendments, are being prepared in two phases. Initially, the SWRCB and Regional Water Quality Control Boards are evaluating new flow objectives for the Lower San Joaquin River and the tributaries of Stanislaus, Tuolumne, and Merced rivers; and southern Delta salinity objectives. The second phase is evaluating changes to other portions of the Bay-Delta WQCP including Delta outflows, SWP and CVP export restrictions, and other requirements in the Bay-Delta to protect fish and wildlife beneficial uses. A third phase will consider and assign responsibility for implementing measures to achieve the water quality objectives established in the first two phases (SWRCB 2012).

Ongoing programs to adopt and implement total maximum daily loads are described in Chapter 6, Surface Water Quality.

3.5.1.2 Bay Delta Conservation Plan and the California Water Fix

The Bay Delta Conservation Plan (BDCP) and the California WaterFix are being developed by Federal and State agencies and other stakeholders to achieve the dual goals of a reliable water supply for California and a healthy California Bay Delta ecosystem that supports the State’s economy. The program would construct a new conveyance facility and modify operation of existing CVP and SWP Delta facilities; and reduce ecological stressors that impair the function or the use of the Delta by aquatic and terrestrial resources.

The Recirculated Draft EIR/Supplemental Draft EIS (RDEIR/SDEIS) was issued by DWR and Reclamation. The RDEIR/SDEIS evaluated new alternatives in addition to the alternatives included in the Public Draft EIR/EIS that combined ecosystem restoration approaches and Delta conveyance approaches. During the last 50 years, several broad conveyance approaches 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 EIR/EIS process. These alternatives included use of an isolated facility that would convey water around or under the Delta for local supply and export through a hydraulically isolated channel or pipeline and with continual use of the existing south Delta intakes (dual conveyance alternatives); and continuation of the use of the through-Delta conveyance with channel modifications.

3.5.1.3 Shasta Lake Water Resources Investigation

The Shasta Lake Water Resources Investigation is currently being conducted by Reclamation to determine the type and extent of federal interest in a multiple purpose plan to modify Shasta Dam and Reservoir to increase the survival of anadromous fish populations in the upper Sacramento River; increase water supplies and water supply reliability for agricultural, municipal, industrial, and environmental purposes (Reclamation 2013d). To the extent possible through meeting these objectives, alternatives evaluated in the EIS included features to benefit other identified water and related resource needs including ecosystem conservation and enhancement, improve hydropower generation capability, flood damage reduction, maintain and increase recreation opportunities, and maintain or improve water quality conditions in the Sacramento River and the Delta consistent with the objectives of the CALFED Bay-Delta Program. Alternatives for expansion of Shasta Lake included, among other features, raising the dam from 6.5 to 18.5 feet above current elevation, which would result in additional storage capacity of 256,000 to 634,000 acre-feet, respectively. The increased capacity would improve water supply reliability and increase the cold water pool, which would provide improved water temperature conditions for anadromous fish in the Sacramento River downstream of the dam. The Final EIS, published in December 2014, identified the preferred alternative to include an 18.5 foot raise of Shasta Dam to provide an additional 634,000 acre-feet of storage with augmentation of spawning gravel programs and restoration of riparian, floodplain, and side channel habitat in the upper Sacramento River (Reclamation 2014g).

3.5.1.4 North of Delta Offstream Storage Investigation

The North-of-the-Delta Offstream Storage Investigation evaluates the feasibility of offstream storage in the northern Sacramento Valley for improved water supply and water supply reliability, improved water quality, and enhanced survival of anadromous fish and other aquatic species (DWR 2013). Specific primary planning objectives are to: 1) increase water supplies to meet existing contract requirements, including improved water supply reliability, and provide greater flexibility in water management for agricultural, environmental, and municipal and industrial users; 2) increase the survival of anadromous fish populations in the Sacramento River, as well as the survivability of other aquatic species; and 3) improve drinking water quality in the Delta. To the extent possible through meeting these objectives, alternatives include ecosystem conservation and enhancement, provide ancillary hydropower generation capability to the statewide power grid, and create incremental flood damage reduction opportunities in support of major northern California flood-control reservoirs consistent with the objectives of the CALFED Bay Delta Program. All alternatives include construction of a dam and reservoir near Sites, located to the west of Maxwell (California), with various facilities and configurations for conveyance into and out of the reservoir, which would result in additional storage capacity ranging from 1200 to 1900 TAF.

3.5.1.5 Federal Energy Regulatory Commission License Renewals

There are 22 hydroelectric generation FERC permits that will expire prior to 2030 (FERC 2015). Fifteen projects in the Sacramento River watershed include one on the Pit River (upstream of Shasta Lake), six on the Feather River, four on the Yuba River, one on the Bear River, one on the American River, and one each on Cow and Battle creeks. Projects in the San Joaquin River watershed include four on the San Joaquin River, one on the Stanislaus River, two on the Merced River, and one on the Tuolumne River. The FERC must complete analyses under NEPA and ESA to consider the effects of the hydropower operations on the environment, including flow regimes, water quality, fish passage, recreation, aquatic and riparian habitat, and special status species.

3.5.1.5.1 Federal Energy Regulatory Commission License Renewal for SWP Oroville Project

The Oroville Facilities, as part of SWP, are also operated for flood management, power generation, water quality improvement in the Delta, recreation, and fish and wildlife enhancement. The objective of the relicensing process was to continue operation and maintenance of the Oroville Facilities for electric power generation, along with implementation of any terms and conditions to be considered for inclusion in a new FERC hydroelectric license. The initial FERC license for the Oroville Facilities, issued on February 11, 1957, expired on January 31, 2007. The Final EIR/EIS were completed in 2007 (FERC 2007). At this time, the revised BOs and FERC license have not been issued.

3.5.1.5.2 Federal Energy Regulatory Commission Relicensing for Yuba River Watershed Hydroelectric Projects

The Nevada Irrigation District is applying for a new license for the Yuba-Bear Project (FERC Project No. 2266), and PG&E are applying for the Drum-Spaulding Project (FERC Project No. 2310). The Yuba-Bear Project is located on the Middle and South Yuba rivers, Bear River, and Jackson and Canyon creeks (FERC 2013). Concurrently, PG&E is applying for a license renewal for the Drum-Spaulding Project which is located on the Bear and Yuba rivers. Operations of the two projects are coordinated in many factors. The FERC relicensing processes for these two projects in underway.

3.5.1.5.3 FERC Relicense Renewal for Turlock Irrigation District and Modesto Irrigation District Don Pedro Project

The Don Pedro Project is located on the Tuolumne River in Tuolumne County. The initial license was issued for operations between 1971 and 1991 followed by requirements to evaluate fisheries water needs in the Tuolumne River.

In 1987, after the Turlock Irrigation District and Modesto Irrigation District applied to amend their license to add a fourth generating unit, FERC approved an amended fish study plan with possible changes in 1998. In 1996, FERC amended the license to implement amended minimum flow criteria and require fish monitoring studies for completion in 2005. In 2002, NMFS requested that FERC initiate formal consultation on the effects of the Don Pedro Project on Central Valley steelhead. The FERC approved the Summary Report on fisheries in 2008. In 2009, NMFS, USFWS, CDFW, and several environmental interest groups filed requests for rehearing on the license. FERC denied portions of the request but required instream flow studies to be conducted and required NMFS to be included for consultation on any authorized changes to minimum flow release schedules.

The FERC also directed the appointment of an administrative law judge to assist in assessing the need for and feasibility for interim measures prior to relicensing. A final report was completed in 2010. Following the completion of the report and a monitoring plan by the affected districts, FERC approved an order modifying and approving instream flow and monitoring study plans. A final license application, including an Environmental Report, was submitted to FERC in April 2014 (TID and MID 2014). The current license expires in 2016.

The objective of the relicensing process is to continue operation and maintenance of the Don Pedro Project facilities for electric power generation, along with implementation of any terms and conditions to be considered for inclusion in a new FERC hydroelectric license.

3.5.1.5.4 FERC Relicense Renewal for Merced Irrigation District’s Merced River Hydroelectric Project

The Merced River Hydroelectric Project is located on the Merced River in Mariposa County and includes both Lake McClure and McSwain Reservoir, two powerhouses (New Exchequer and McSwain), and recreation facilities. The initial FERC license expires on February 28, 2014. The objective of the relicensing process is to continue operation and maintenance of the Merced River Hydroelectric Project facilities for electric power generation, along with implementation of any terms and conditions to be considered for inclusion in a new FERC hydroelectric license (Merced ID 2013).

3.5.1.6 El Dorado Water and Power Authority Supplemental Water Rights Project

The El Dorado Water and Power Authority (EDWPA) proposes to establish permitted water rights allowing diversion of water from the American River basin to meet planned future water demands in the El Dorado Irrigation District and Georgetown Divide Public Utility District service areas and other areas located within El Dorado County that are outside of these service areas. The EDWPA filed petitions with the SWRCB for partial assignment of State Filed Applications 5644 and 5645, and accompanying applications allowing for the total withdrawal and use of 40,000 acre-feet per year, consistent with the diversion and storage locations allowed under the El Dorado-Sacramento Municipal Utility District Cooperation Agreement (EDWPA 2010).

3.5.1.7 Semitropic Water Storage District Delta Wetlands

In 1987, Delta Wetlands, a California Corporation, proposed a project for water storage and wildlife habitat enhancement on four privately owned islands in the Delta. The four islands were Bacon Island and Bouldin Island in San Joaquin County and Holland Tract and Webb Tract in Contra Costa County, encompassing approximately 23,000 acres. The Delta Wetlands Project would store water on two Reservoir Islands (Bacon Island and Webb Tract) for subsequent release into the Delta, and habitat enhancement to compensate for wetland and wildlife effects of the water storage operations with a Habitat Management Plan on two Habitat Islands (Bouldin Island and Holland Tract).

In 2007, the Delta Wetlands Project partnered with the Semitropic Water Storage District (Semitropic WSD) to: 1) provide water to Semitropic WSD to augment its water supply, and 2) bank water within the Semitropic Groundwater Storage Bank and Antelope Valley Water Bank. The designated places of use for Delta Wetlands Project water would include: Semitropic WSD; Member Agencies of the Metropolitan Water District of Southern California, the Western Municipal Water District of Riverside County, and select service areas of the Golden State Water Company. The project would include improvements of 27 miles of levees and screened diversions to divert water during high-flow periods in the winter months of December through March into Webb Tract (100,000 acre-feet of storage) and Bacon Island (115,000 acre-feet of storage). The water would not be diverted in a manner that would adversely affect senior legal water rights holders, including the SWP and CVP. Stored water would be discharged into False River (from Webb Tract) and Middle River (from Bacon Island) for export when excess SWP or CVP diversion capacity is available, in the summer and fall months of July through November. Any water that could not be exported from the Delta in a given year would be available to increase Delta outflow in the fall months of September through November. Semitropic WSD issued a Draft EIR in 2010 and a Final EIR in 2011 (SWSD 2011).

3.5.1.8 North Bay Aqueduct Alternative Intake

DWR is evaluating the implementation of an alternative intake on the Sacramento River upstream of the Sacramento Regional Wastewater Treatment Plant, and conveyance facility to connect the intake with the existing North Bay Aqueduct. The proposed alternative intake would be operated in conjunction with the existing North Bay Aqueduct intake at Barker Slough. The proposed project would be designed 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 (DWR 2011a).

The proposed project would include construction and operation of a 240 cfs capacity intake with state-of-the-art positive barrier fish screens, pumping plant, sediment basins, and ancillary support facilities located on the west side of the Sacramento River near south Sacramento. The conveyance facility would include an approximately 30 mile long, 72 to 84-inch diameter underground steel and/or concrete pipeline to convey the water from the alternate intake to the existing North Bay Aqueduct. Two options are proposed for the location of the alternate intake facility. Alternate intake site 1 is located on the outside edge of Garcia Bend of the Sacramento River (on the west bank), approximately 500 feet south of the boundary of the City of West Sacramento. Alternate intake site 2 is located immediately south of the outside edge of Garcia Bend of the Sacramento River (on the west bank), approximately 2,500 feet south of the boundary of the City of West Sacramento. The intake and pumping plant facility would be constructed on the water side of the Sacramento River levee and the remaining components would be constructed on the land side of the levee. The intake would extend about 100 feet from the top of the levee into the river. The exact amount of this extension would depend on the site option selected. A fish screen would be installed on the face of the intake structure to prevent fish from swimming or being drawn into the intake and it would be designed to meet CDFW, NMFS, and USFWS criteria. The dimensions of the fish screen would be based on an anticipated approach velocity of 0.2 feet per second at the fish screen. Flow-control louvers behind the screen would control flow rates through the screen to assure uniform water velocity across the screen. Normal operation would keep the top of the screen below low water elevation. A reduction in pumping would occur any time the screens are not submerged or the water velocities increased. Above the screen would be concrete panels which extend to the 200 year flood elevation. A log boom would be installed in front of the fish screen to block large debris from blocking or damaging the intake. The intake would be equipped with an automatic fish screen cleaning system.

3.5.1.9 Los Vaqueros Reservoir Expansion Phase 2

Los Vaqueros Reservoir is an off-stream reservoir in the Kellogg Creek watershed to the west of the Delta. The Los Vaqueros Reservoir initial construction was completed in 1997 as a 100 TAF off-stream storage reservoir owned and operated by Contra Costa Water District to improve delivered water quality and emergency storage reliability to their customers. In 2012, the Los Vaqueros Reservoir was expanded to a total storage capacity of 160,000 acre-feet (Phase 1) to provide additional water quality and supply reliability benefits, and to adjust the timing of its Delta water diversions to accommodate the life cycles of Delta aquatic species, thus reducing species impact and providing a net benefit to the Delta environment. As part of the Storage Investigation Program described in the CALFED Bay Delta Program Record of Decision, additional expansion up to 275 TAF (Phase 2) is being evaluated by Contra Costa Water District, DWR, and Reclamation. The alternatives considered in the evaluation also consider methods to convey water from Los Vaqueros Reservoir to the South Bay Aqueduct to provide water to Zone 7 Water Agency, Alameda County Water District, and Santa Clara Valley Water District (Reclamation, CCWD, and Western 2010).

3.5.1.10 Upper San Joaquin River Basin Storage Investigation

The Upper San Joaquin River Basin Storage Investigation is being conducted by Reclamation and DWR to evaluate alternative plans to increase Upper San Joaquin River Storage to enhance the San Joaquin River restoration efforts and improve water supply reliability for agricultural, municipal and industrial, and environmental uses in the Friant Division, the San Joaquin Valley, and other regions of the state. The investigation is evaluating integration of conjunctive management and water transfer concepts into plan formulations. Additional storage is also expected to provide incidental flood damage reduction benefits (Reclamation 2014c).

Reclamation is analyzing alternatives for a new dam and a 1,260 TAF reservoir along the San Joaquin upstream of Millerton Lake in an area known as Temperance Flat. Primary planning objectives are to: 1) increase water supply reliability, and 2) enhance flow and temperature conditions to support the San Joaquin River Restoration Program. Operation variables include reservoir carryover, new or shifting water supply beneficiaries, and alternative conveyance routes.

3.5.1.11 Central Valley RWQCB Irrigated Lands Regulatory Program

The Irrigated Lands Regulatory Program regulates discharges from irrigated agricultural lands. Its purpose is to prevent agricultural discharges from impairing the waters that receive the discharges. The California Water Code authorizes the SWRCB and Regional Water Quality Control Boards to conditionally waive waste discharge requirements if this is in the public interest. On this basis, the Los Angeles, Central Coast, Central Valley, and San Diego regional water quality control boards have issued conditional waivers of waste discharge requirements to growers that contain conditions requiring water quality monitoring of receiving waters. In 2010, the Central Valley Regional Water Quality Control Board proposed to expand the requirements to groundwater especially for regulation of discharges with higher concentrations of nutrients (CVRWQCB 2011). Participation in the waiver program is voluntary; however, non-participant dischargers must file a permit application as an individual discharger, stop discharging, or apply for coverage by joining an established coalition group. The waivers must include corrective actions when impairments are found.

3.5.1.12 San Luis Reservoir Low Point Improvement Project

The San Luis Reservoir Low Point Improvement Project is proposed by Reclamation, the Santa Clara Valley Water District, and the San Luis and Delta Mendota Water Authority. As part of this project, Reclamation is investigating three alternatives to address the 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 300,000 acre-feet during late summer in dry water years, resulting in large algal blooms. The alternatives being considered are to 1) expand the 6,000 acre-feet Pacheco Reservoir to 80,000 acre-feet or 130,000 acre-feet, 2) lower the San Felipe Intake at San Luis Reservoir, or 3) implement a combination comprehensive plan. The combination comprehensive plan would involve increasing groundwater recharge and recovery capacity, implementing desalination measures, re-operating Santa Clara Valley Water District's raw- and treated-water systems, and implementing institutional measures. If Pacheco Reservoir were to be enlarged, the reservoir would be filled with Delta water; thus, additional impacts on Delta aquatic species (e.g., juvenile salmonids and Delta Smelt) could result from an increase in Delta exports. The environmental scoping report for the San Luis Reservoir Low Point Improvement Project was released in January 2009 and the plan formulation report was published in January 2011 (Reclamation et al. 2011).

3.5.1.13 Westlands v. United States Settlement

In August 2015, Westlands Water District and the United States agreed upon a settlement involving several litigations, as described below. The settlement is contingent upon Congressional authorization of enabling legislation (Reclamation 2015). The following information provides a summary from the Reclamation news release in October 2015.

In 2000, the court in *Firebaugh Canal Co v. United States*, issued an Order requiring the Secretary of the Interior to provide drainage service to lands served by the San Luis Unit of the Central Valley Project. In 2007 Reclamation signed a Record of Decision selecting a drainage plan and finding that the cost of providing drainage for lands served by the San Luis Unit. Reclamation began implementing the selected drainage plan in a portion of Westlands Water District in 2010 on a court-ordered schedule.

In 2011, individual landowners within Westlands Water District filed a takings claim against the United States alleging that failure to provide drainage service has caused a physical taking of their lands without just compensation in violation of the Fifth Amendment (*Etchegoinberry v. United States*). The Court of Federal Claims denied the government's motion to dismiss the complaint.

In January 2012, Westlands filed a breach of contract case alleging that the government's failure to provide drainage service to the Westlands Water District service area constituted a breach of Westlands Water District 1963 Water Service and 1965 Repayment contracts (including the interim renewal of those contracts). The case is currently pending.

Under the proposed terms of the Settlement, Westlands Water District will:

- Permanently retire not less than 100,000 acres of land from production. Westlands Water District will agree to permanently retire a total of not less than 100,000 acres of lands within its boundaries utilizing those lands only for the following purposes:
    - Management of drain water, including irrigation of reuse areas;
    - Renewable energy projects;
    - Upland habitat restoration projects; or
    - Other uses subject to the consent of the United States.

- Cap contract deliveries at 75 percent of its CVP contact amount (from 1.193 million acre-feet to 895 thousand acre-feet). Any water above this 75 percent cap, that would have been delivered to Westlands Water District, would instead be available to the United States for other public purposes under the CVP.
- Assume all responsibility for drainage in accordance with all legal requirements under state and federal law. Westlands Water District would become legally responsible for the management of drainage water within its boundaries, in accordance with federal and California law.
- Indemnify the United States for any damages and pay compensation for claims arising out of the *Etchegoinberry litigation*. Under the Settlement Westlands Water District will indemnify the United States for any claims (past, present and future) arising out of a failure to provide drainage service with Westlands Water District. Westlands Water District would also intervene in the *Etchigoinberry* case for Settlement purposes and would pay compensation to individual landowners.
- Continue to wheel water to Lemoore Naval Air Station. As part of the overall Settlement, CVP water will be made available to Lemoore Naval Air Station and Westlands Water District would agree to wheel all CVP water made available to Lemoore under the same terms and conditions as Westlands Water District wheels water to other Westlands Water District's contractors.
- Be relieved from potential drainage repayment. If the United States were to expend significant funds to provide a drainage solution, Reclamation would seek repayment from Westlands Water District (over 50 years, with no interest, commencing after completion of each separable element). By taking responsibility for drainage, Westlands Water District would also eliminate responsibility for repayment.

Under the Terms of the Settlement, the United States will:

- Be relieved of all statutory obligations to provide drainage. The Settlement Agreement would relieve the Department of the Interior from all drainage obligations imposed by the San Luis Act, including implementation of the 2007 ROD, which is estimated to cost approximately $3.5 billion ($513 million authorized). Westlands Water District will agree to dismiss with prejudice the *Westlands v. U.S.* breach of contract litigation and will join the U.S. in petitioning for vacatur of the 2000 Order Modifying Partial Judgment in the *Firebaugh* case directing implementation of drainage service and control schedules.
- Receive a waiver of claims for potential damages due to a failure to provide drainage service. Westlands Water District will agree to provide for the release, waiver and abandonment of all past, present and future claims arising from the government's failure to provide drainage service under the San Luis Act, including those by individual landowners within Westlands Water District's service area, and would further agree to indemnify the United States

for any and all claims relating to the provision of drainage service or lack thereof within the Westlands service area.

- Relieve Westlands Water District repayment obligation for CVP construction charges to date (approximately $375 million). Westlands Water District will be relieved of its current, unpaid capitalized construction costs for the CVP, the present value of which is currently estimated to be $375 million. Under the Settlement, Westlands Water District will still be responsible for Operation and Maintenance, the payment of restoration fund charges pursuant to the CVPIA, and for future CVP construction charges.
- Convert Westlands Water District water service contract into a repayment contract. The Secretary will convert Westlands Water District's current 9(e) water service contract to a 9(d) repayment contract consistent with existing key terms and conditions. As a "paid out" contractor, the benefit of this conversion is permanent right to a stated share of CVP water. However, the terms and conditions of the contract—including the so called "shortage clause" – will otherwise be the same as in the current 9(e) contract.
- Retain the right to cease water deliveries if Westlands Water District fails to meet its drainage obligation. Language in the Settlement makes the United States' obligation to provide water to Westlands under the 9(d) Repayment Contract conditional upon Westlands Water District's fulfillment of its obligations to manage drainage water within its service area.
- Issue a water service contract to Lemoore Naval Air Station. As part of the overall Settlement, the United States is authorized to enter into a water service contract with Lemoore Naval Air Station to provide a guaranteed quantity of CVP water to meet the needs of the Naval Air Station associated with air operations and Westlands Water District will agree to wheel all CVP water made available to Lemoore.

3.5.1.14 Contra Loma Reservoir and Recreation Resource Management Plan

The Contra Loma Recreation Resource Management Plan is a long-term plan to guide management of the resources on the federal lands within the 80-acre Contra Loma Reservoir and surrounding 661 acres of recreation areas in Contra Loma Regional Park and Antioch Community Park (Reclamation 2014f). The East Bay Regional Park District manages the federal lands and public recreation facilities under an agreement with Reclamation. The proposed plan is to expand recreational use and facilities to increase recreational demands, including establishment of an additional all-weather sports field, fishermen's shelter, playground structure, a disc golf course, and expanded swim lagoon and trails.

3.5.1.15 San Luis Reservoir State Recreation Area Resource Management Plan/General Plan

The Resource Management Plan addressed recreational plans for the San Luis Reservoir State Recreation Area and adjacent lands in Merced County that are owned by Reclamation and managed by the California Department Parks and

Recreation, DWR, and CDFW (Reclamation and CDPR 2013). The plan would focus on boating management, cultural resources management, vegetation management, enhanced trails management, expanded visitor experiences and education opportunities, and road and utility upgrades.

3.5.1.16 Future Water Supply Projects

Many of the future projects would directly increase regional and local water supplies through groundwater storage and recovery programs, improved conveyance that connects water supplies from different water agencies, recycled water projects, and desalination projects. Water resources projects that have been approved and are being implemented were previously described in this chapter under the No Action Alternative. The following major water supply projects are currently being evaluated and are considered under the Cumulative Effects analysis.

- Future Groundwater Storage and Recovery Projects
  - City of Roseville (City of Roseville 2012)
  - Mokelumne River Water & Power Authority (MORE 2015)
  - Northeastern San Joaquin County Groundwater Banking Authority (NSJCGBA 2011)
  - Stockton East Water District (SEWD 2012)
  - Madera Irrigation District (Reclamation 2011b)
  - Kings River Conservation District (KRCD 2012b)
  - Buena Vista Water Storage District and Rosedale Rio Bravo Water Storage District (BVWSD 2015)
  - City of Los Angeles (City of Los Angeles 2010, 2013b)
  - Los Angeles County (Los Angeles County 2013b)
  - City of San Diego (City of San Diego 2009a, 2009b)
  - Rancho California Water District (RCWD 2011, 2012)
  - Eastern Municipal Water District (EMWD 2014c)
  - Jurupa Community Services District (JCSD et al. 2010)
- Major Conveyance Projects
  - Bay Area Regional Water Supply Reliability (CCWD 2014, EBMUD 2014)
  - Friant-Kern Canal and Madera Canal Capacity Restoration Projects (SJRRP 2011, 2015)
  - Los Banos Creek Water Resources Management Plan (SJRECWA 2012)
  - Sacramento River Water Reliability Project (Reclamation 2004b)

- Major Recycle Water Projects (more than 10,000 acre-feet/year)
  - City of Fresno (City of Fresno 2011)
  - City of Los Angeles (City of Los Angeles 2005)
  - Central Basin Municipal Water District (CBMWD 2010)
  - Foothill Municipal Water District (MWDSC 2010)
  - Upper San Gabriel Valley Municipal Water District (USGVMWD 2013)
  - West Basin Municipal Water District (WBMWD 2011, 2015a)
  - Olivenhain Municipal Water District (OMWD 2015)
  - Eastern Municipal Water District (EMWD 2014c)
  - Inland Empire Utilities Agency (IEUA 2014)
  - Palmdale Water District (PWD 2010)
  - East Valley Water Reclamation Authority (Antelope Valley 2013)
- Major Future Coastal Desalination Water Projects
  - San Francisco Bay Area Regional Desalination Project (BARDP 2015)
  - City of Santa Barbara (City of Santa Barbara 2015)
  - Camrosa Water District (CWD 2015)
  - City of Long Beach (City of Long Beach 2015)
  - City of Huntington Beach (City of Huntington Beach 2010)
  - City of Oceanside (City of Oceanside 2012)
  - City of Carlsbad (City of Carlsbad 2006)
  - West Basin Municipal Water District (WBMWD 2015b)
  - Metropolitan Water District of Orange County (MWDOC 2015)
  - San Diego County Water Authority in the Southern California Region (SDCWA 2009, 2015)
- Long-term and short-term Water Transfers to provide water to municipal, agricultural, and ecosystem water users, including wildlife refuges including programs that transfer water from northern California to the San Joaquin Valley and southern California across the Delta (Reclamation and SLDMWA 2015; BWGWD 2015).

3.5.2 Ecosystem Improvement Projects and Actions

There are numerous ecosystem improvement projects and actions that could be potentially affected by changes in the coordinated long-term operation of the CVP and SWP, or could affect the CVP and SWP operations. Major future water supply and water quality projects and actions are discussed below.

3.5.2.1 Mill Creek Riparian Assessment

The need to restore and maintain riparian habitat in Mill Creek is identified in the Anadromous Fish Restoration Program and CALFED Bay-Delta Ecosystem Restoration Program goals, objectives, and targets. The AFRP is one of five CVPIA programs that have been integrated with the Ecosystem Restoration Plan. Both of these programs prioritize establishment, restoration, and maintenance of anadromous fish habitat on this stream, particularly in the arena of riparian habitat and flow enhancement. In response to this identified need, Reclamation and USFWS is implementing the Mill Creek Riparian Assessment. The project includes: 1) riparian habitat and condition mapping and vegetation classification of the Mill Creek watershed, 2) identifying and prioritizing areas that should be restored, enhanced, and/or preserved in addition to existing conservation easements, and 3) identifying the types of restoration actions that should occur at the prioritized sites (USFWS 2010).

3.5.2.2 Yolo County Habitat/Natural Community Conservation Plan

The Yolo County Habitat Joint Powers Authority, consisting of five local public agencies, launched the Yolo Natural Heritage Program in March 2007. This effort includes the continuing preparation of a joint Habitat Conservation Plan/ Natural Community Conservation Plan (HCP/NCCP). Member agencies include Yolo County and the cities of Davis, Woodland, West Sacramento, and Winters.

The HCP/NCCP describes the measures that local agencies will implement to conserve biological resources, obtain permits for urban growth and public infrastructure projects, and continue to maintain the agricultural heritage and productivity of Yolo County. The nearly 653,820-acre planning area provides habitat for covered species occurring within five dominant habitats/natural communities. The plan proposes to address 63 covered species, including seven state-listed species: palmate-bracted bird's-beak, Colusa grass, Crampton's tuctoria, giant garter snake, Swainson's hawk, western yellow-billed cuckoo, and bank swallow. Interim conservation activities include acquiring permanent conservation easements for sensitive species habitat in the plan area (YNHP 2015).

3.5.2.3 California EcoRestore

California EcoRestore is an initiative by the California Natural Resources Agency to coordinate and advance habitat restoration for at least 30,000 acres by 2019 (CNRA 2015a, 2015b). This acreage includes 25,000 acres of habitat restoration identified in the 2008 USFWS BO and 2009 NMFS BO, and 5,000 acres of habitat enhancements. Some of these programs would be funded by federal and state water agencies that are required to mitigate impacts of the CVP and SWP. Other programs would be sponsored by a combination of funds from state bonds (Proposition 1 and 1E), Assembly Bill 32 Greenhouse Gas Reduction Fund, federal agencies, local agencies, and private investments. The California Delta Conservancy will lead implementation of identified restoration projects in collaboration with local governments and with a priority on using public lands in the Delta.

Many of the programs to be implemented under California EcoRestore in Suisun Marsh, Yolo Bypass, and Cache Slough are discussed separately under the No Action Alternative and cumulative effects in this EIS.

3.5.2.4 North Delta Flood Control and Ecosystem Restoration Project

The North Delta Flood Control and Ecosystem Restoration Project is proposed near the confluence of the Cosumnes and Mokelumne rivers by the DWR and encompasses approximately 197 square miles. Consistent with objectives contained in the CALFED Record of Decision, the project is intended to improve flood management and provide ecosystem benefits in the North Delta area through actions such as construction of setback levees and configuration of flood bypass areas to create quality habitat for species of concern. These actions are focused on McCormack-Williamson Tract and Staten Island. The project would implement flood control improvements 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 resulting from overflows caused by insufficient channel capacities and catastrophic levee failures in the 197 square-mile project study area. The proposed project as described in the Final EIR (DWR 2010b) included: portions of the levee system degraded to allow controlled flow across McCormack-Williamson Tract; levee modification to mitigate hydraulic impacts; channel dredging to increase flood conveyance capacity; an off-channel detention basin on Staten Island; ecosystem restoration where floodplain forests and marshes would be developed at McCormack-Williamson Tract and the Grizzly Slough property; setback levee on Staten Island to expand the floodway conveyance; and opening up the southern portion of McCormack-Williamson Tract to boating; improving Delta Meadows property; providing access and interpretive kiosks for wildlife viewing; and providing restroom, circulation, parking, and signage infrastructure to support such uses.

3.5.2.5 Franks Tract Project

Reclamation has conducted studies to evaluate the feasibility of modifying the hydrodynamic conditions near Franks Tract to improve Delta water quality and enhance the aquatic ecosystem. The results of these studies have indicated that modifying the hydrodynamic conditions near Franks Tract may substantially reduce salinity in the Delta and protect fishery resources, including populations of Delta Smelt. Reclamation evaluated installing operable gates to control the flow of water at key locations (Threemile Slough and/or West False River) to reduce sea water intrusion, and to positively influence movement of fish species of concern to areas that provide favorable habitat conditions. The project gates would be operated seasonally and during certain hours of the day, depending on fisheries and tidal conditions. Boat passage facilities would be included to allow for passing of watercraft when the gates are in operation. The Franks Tract Project is consistent with ongoing planning efforts for the Delta to help balance competing uses and create a more sustainable system for the future. By protecting fish resources, this project also could improve operational reliability of the CVP and SWP because curtailments in water exports (pumping restrictions) are likely to be less frequent. Franks Tract was previously evaluated as part of DWR's Flooded Island Pre-Feasibility Study Report (DWR 2007).

3.6 Summary of Environmental Consequences

Conditions in 2030 related to environmental and human resources that would occur with implementation of the No Action Alternative were compared to conditions under the Second Basis of Comparison; and conditions under

Alternatives 1 through 5 were compared to the conditions under the No Action Alternative and the Second Basis of Comparison, as described in Chapter 4, Approach to Environmental Analysis. The results of these analyses by alternative are described in Chapters 5 through 21 of this EIS and summarized in Tables 3.6 and 3.7.

The tables present summarize the results of both quantitative and qualitative impact analyses. The tables include relative quantitative differences for adverse impacts to provide a basis for consideration of mitigation measures. Potential mitigation measures were considered related to the comparison of Alternatives 1 through 5 to the No Action Alternative. Mitigation measures were not included to address adverse impacts of implementation of Alternatives 1 through 5 and the No Action Alternative as compared to the Second Basis of Comparison because this analysis was included in this EIS for information purposes only.

Changes in surface water conditions are provided as a basis for identifying the impacts as described in Aquatic, Terrestrial, and Recreation resources. Therefore, no mitigation measures are presented for Surface Water Resources.

Differences in the quantitative analyses of 5 percent or less are considered to be “similar” because the modeling analyses are based on CalSim II model output which operates with monthly time steps. Therefore, it was determined that changes in the model of 5 percent or less were related to the uncertainties in the model processing.

Table 3.6 Comparison of Alternatives 1 through 5 to No Action Alternative

	Alternative 1 Compared to the No Action Alternative	Alternative 2 Compared to the No Action Alternative	Alternative 3 Compared to the No Action Alternative	Alternative 4 Compared to the No Action Alternative	Alternative 5 Compared to the No Action Alternative
SURFACE WATER					
Trinity Lake	Water surface elevations similar. Storage similar or increased.	No change.	Water surface elevations similar. Storage similar or increased.	Water surface elevations similar. Storage similar or increased.	Water surface elevations similar. Storage similar or increased.
Trinity River at Lewiston Dam	Flows similar or increased.	No change.	Flows similar or increased.	Flows similar or increased.	Water surface elevations similar. Storage similar.
Shasta Lake	Water surface elevations similar. Storage similar or increased.	No change.	Water surface elevations similar. Storage similar or increased.	Water surface elevations similar. Storage similar or increased.	Water surface elevations similar. Storage similar.
Sacramento River at Keswick Dam	Flows similar or increased except reduced in September and November (up to 44%).	No change.	Flows similar or increased except reduced in September and November (up to 42%).	Flows similar or increased except reduced in September and November (up to 44%).	Flows similar.
Sacramento River at Freeport	Flows similar or increased except reduced in September and November (up to 47%).	No change.	Flows similar or increased except reduced in September and November (up to 48%).	Flows similar or increased except reduced in September and November (up to 47%).	Flows similar.
Clear Creek near Igo	Flows same except reduced in May (41%).	No change.	Flows same except reduced in May (29%).	Flows same except reduced in May (41%).	No change.
Lake Oroville	Water surface elevations similar. Storage reduced except in June (up to 22%).	No change.	Water surface elevations similar. Storage similar or increased.	Water surface elevations similar. Storage reduced except in June (up to 22%).	Water surface elevations similar. Storage similar.

	Alternative 1 Compared to the No Action Alternative	Alternative 2 Compared to the No Action Alternative	Alternative 3 Compared to the No Action Alternative	Alternative 4 Compared to the No Action Alternative	Alternative 5 Compared to the No Action Alternative
Feather River downstream of Thermalito Complex	Flows similar or increased except reduced in July-September and November-December (up to 65%).	No change.	Flows similar or increased except reduced in July-September and October-January (up to 70%).	Flows similar or increased except reduced in July-September and November-December (up to 65%).	Flows similar or increased except reduced in April-May (up to 27%).
Folsom Lake	Water surface elevations similar Storage similar or increased except reduced in June-August in above normal and below normal years (up to 15%).	No change.	Water surface elevations similar Storage similar or increased except reduced in July-August in above normal and August-September in below normal years (up to 10%).	Water surface elevations similar Storage similar or increased except in reduced June-August in above normal and below normal years (up to 15%).	Water surface elevations similar. Storage similar.
American River at Nimbus Dam	Flows similar or increased except reduced in September-November and June-July (up to 48%).	No change.	Flows similar or increased except reduced in August-November and June (up to 46%).	Flows similar or increased except reduced in September-November and June-July (up to 48%).	Flows similar or increased except reduced in September and April-May (up to 14%).
New Melones Reservoir	Water surface elevations similar Storage similar or increased.	No change.	Water surface elevations similar Storage similar or increased.	Water surface elevations similar Storage similar or increased.	Water surface elevations similar. Storage reduced in July-September in above normal years (up to 6%); and all months in below normal, dry, and critical dry years (up to 19 percent).
Stanislaus River at Goodwin Dam	Flows similar or increased except reduced in July-August, December, and March (up to 18%).	No change.	Flows similar or increased except reduced in October and February-July (up to 73%).	Flows similar or increased except reduced in July-August, December, and March (up to 18%).	Flows similar or increased except reduced in June-August (up to 18%).

	Alternative 1 Compared to the No Action Alternative	**Alternative 2 Compared to the No Action Alternative**	**Alternative 3 Compared to the No Action Alternative**	**Alternative 4 Compared to the No Action Alternative**	**Alternative 5 Compared to the No Action Alternative**
San Joaquin River at Vernalis	Flows similar or increased except reduced in October and April (up to 19%).	No change.	Flows similar or increased except reduced in October and May-June (up to 21%).	Flows similar or increased except reduced in October and April (up to 19%).	Flows similar or increased.
San Luis Reservoir	Water surface elevations similar Storage similar or increased.	No change.	Water surface elevations similar Storage similar or increased.	Water surface elevations similar Storage similar or increased.	Water surface elevations similar Storage similar or increased except in below normal years in June-July (up to 9%); in dry years in April-September (up to 17%); and in critical dry years in April-January (up to 18%).
Flows into Yolo Bypass	Flows similar or increased except in October in wet years (20%).	No change.	Flows similar or increased except in October in wet years (25%).	Flows similar or increased except in October in wet years (20%).	Flows similar.
Delta Outflow	Reduced flows in many months. Increased flows in some months, including in December, February-March, and June in wet years (up to 1,492 cfs); and similar or increased flows in June and September in dry years (up to 385 cfs).	No change.	Reduced flows in many months. Increased flows in some months, including in December-March, in wet years (up to 3.307cfs); and increased flows in January-February and June-July in dry years (up to 277 cfs).	Reduced flows in many months. Increased flows in some months, including in December, February-March, and June in wet years (up to 1,492 cfs); and similar or increased flows in June and September in dry years (up to 385 cfs).	Flows would be similar or increased.
Reverse Flows in Old and Middle Rivers	Increased negative flows except in July-September.	No change.	Increased negative flows except in July-September.	Increased negative flows except in July-September.	Increased positive flows except in July-August.

	Alternative 1 Compared to the No Action Alternative	Alternative 2 Compared to the No Action Alternative	Alternative 3 Compared to the No Action Alternative	Alternative 4 Compared to the No Action Alternative	Alternative 5 Compared to the No Action Alternative
Water Supplies					
Non-CVP and Non-SWP Deliveries	Deliveries similar. No mitigation needed.	No change. No mitigation needed.	Deliveries similar. No mitigation needed.	Deliveries similar. No mitigation needed.	Deliveries similar. No mitigation needed.
CVP Water Deliveries (including CVP agricultural and municipal and industrial water service contracts; Sacramento River Settlement Contracts, San Joaquin River Exchange Contracts, and Eastside Division Contracts)	Deliveries similar or increased. No mitigation needed.	No change. No mitigation needed.	Deliveries similar or increased. No mitigation needed.	Deliveries similar or increased. No mitigation needed.	Deliveries similar or increased in wet to dry years. Reduced deliveries in the Eastside Division Contractors in critical dry years (8%). Potential Mitigation measure: Reclamation would support water transfers from other basin water rights holders.
SWP Water Deliveries (In accordance with Table A contracts without Article 21 water)	Deliveries similar or increased. No mitigation needed.	No change. No mitigation needed.	Deliveries similar or increased. No mitigation needed.	Deliveries similar or increased. No mitigation needed.	Deliveries similar or increased. No mitigation needed.

	Alternative 1 Compared to the No Action Alternative	Alternative 2 Compared to the No Action Alternative	Alternative 3 Compared to the No Action Alternative	Alternative 4 Compared to the No Action Alternative	Alternative 5 Compared to the No Action Alternative
Surface Water Quality					
Salinity in Northern Delta (near Emmaton)	Salinity increased in fall and winter months (up to 377%). Reduced in June in wet to dry years (up to 30%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	No change. No mitigation needed.	Salinity increased in fall and winter months in wet and above normal years (up to 378%). Reduced in June of above normal years and September of below normal years (up to 8%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in the western Delta in fall and winter months (up to 377%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in January-February in all years (up to 8%). Reduced in April-June in critical dry years (up to 15%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.
Salinity in Western Delta (near Port Chicago)	Salinity increased in Oct-March in below normal, dry, and critical dry years, and September wet and above normal years (up to 96%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	No change. No mitigation needed.	Salinity increased in October-January, April-May, June, and September in wet and above normal years (up to 95%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in Oct-March in below normal, dry, and critical dry years, and September wet and above normal years (up to 96%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity similar in most months except reduced in April-May in dry and critical dry years (up to 8%). No mitigation needed.

	Alternative 1 Compared to the No Action Alternative	**Alternative 2 Compared to the No Action Alternative**	**Alternative 3 Compared to the No Action Alternative**	**Alternative 4 Compared to the No Action Alternative**	**Alternative 5 Compared to the No Action Alternative**
Salinity in Western Central Delta (near Antioch)	Salinity increased in fall and winter months (up to 265%). Reduced in June in wet to below normal years (up to 14%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	No change. No mitigation needed.	Salinity increased in fall and winter months (up to 262%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in fall and winter months (up to 265%). Reduced in June in wet to below normal years (up to 14%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in February in critical dry years (7%). Reduced in April-May in below normal to critical dry years, and in June in critical dry years (up to 20%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.
Salinity in Western Central Delta (near Contra Costa Water District Intakes)	Salinity increased in October-January and September in wet and above normal years (up to 65%). Reduced in March-June in wet to below normal years (up to 32%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	No change. No mitigation needed.	Salinity increased in October-December in all year types, and January in above normal to dry years, and in September in wet and above normal years (up to 76%). Reduced in April-June (up to 34%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in October-January and September in wet and above normal years (up to 65%). Reduced in March-June in wet to below normal years (up to 32%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in April-June in below normal to critical dry years (up to 40%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.

	Alternative 1 Compared to the No Action Alternative	Alternative 2 Compared to the No Action Alternative	Alternative 3 Compared to the No Action Alternative	Alternative 4 Compared to the No Action Alternative	Alternative 5 Compared to the No Action Alternative
Salinity in Southern Delta (near CVP and SWP intakes)	Salinity increased in fall and early winter months (up to 65%). Reduced in February-June (up to 22%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	No change. No mitigation needed.	Salinity increased in October-December (up to 29% at Jones Pumping Plant intake and up to 41% at Clifton Court intake). Reduced in June (up to 13% at Jones Pumping Plant intake and up to 19% at Clifton Court intake). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in fall and early winter months (up to 65%). Reduced in February-June (up to 22%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in June in dry and critical dry years (up to 12%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.
Mercury in Delta Fish	Mercury concentrations similar or reduced concentrations. No mitigation needed.	No change. No mitigation needed.	Mercury concentrations similar or reduced concentrations. No mitigation needed.	Mercury concentrations similar or reduced concentrations. No mitigation needed.	Mercury concentrations similar concentrations. No mitigation needed.
Selenium in Delta and Delta Fish	Selenium concentrations similar concentrations. No mitigation needed.	No change. No mitigation needed.	Selenium concentrations similar concentrations. No mitigation needed.	Selenium concentrations similar concentrations. No mitigation needed.	Selenium concentrations similar concentrations. No mitigation needed.
Groundwater Resources					
Trinity River Region	Similar groundwater conditions. No mitigation needed.	No change. No mitigation needed.	Similar groundwater conditions. No mitigation needed.	Similar groundwater conditions. No mitigation needed.	Similar groundwater conditions. No mitigation needed.
Central Valley Region: Sacramento Valley	Similar groundwater conditions. No mitigation needed.	No change. No mitigation needed.	Similar groundwater conditions. No mitigation needed.	Similar groundwater conditions. No mitigation needed.	Similar groundwater conditions. No mitigation needed.

	Alternative 1 Compared to the No Action Alternative	Alternative 2 Compared to the No Action Alternative	Alternative 3 Compared to the No Action Alternative	Alternative 4 Compared to the No Action Alternative	Alternative 5 Compared to the No Action Alternative
Central Valley Region: San Joaquin Valley	Reduced groundwater pumping (8%); and higher groundwater elevations (2-200 feet). Potentially improved groundwater quality. Reduced subsidence potential. No mitigation needed.	No change. No mitigation needed.	Reduced groundwater pumping (6%); and higher groundwater elevations (2-200 feet). Potentially improved groundwater quality. Reduced subsidence potential. No mitigation needed.	Reduced groundwater pumping (8%); and higher groundwater elevations (2-200 feet). Potentially improved groundwater quality. Reduced subsidence potential. No mitigation needed.	Similar groundwater pumping; and similar to higher groundwater elevations (2-25 feet). Similar groundwater quality. Similar subsidence potential. No mitigation needed.
San Francisco Bay Area, Central Coast, and Southern California Region	Potentially reduced groundwater pumping; and potentially higher groundwater elevations. Potentially improved groundwater quality. Less subsidence potential. No mitigation needed.	No change. No mitigation needed.	Potentially reduced groundwater pumping; and potentially higher groundwater elevations. Potentially improved groundwater quality. Less subsidence potential. No mitigation needed.	Potentially reduced groundwater pumping; and potentially higher groundwater elevations. Potentially improved groundwater quality. Less subsidence potential. No mitigation needed.	Similar groundwater pumping; and groundwater elevations. Potentially similar groundwater quality. Similar subsidence potential. No mitigation needed.
CVP and SWP Energy Resources					
Energy Generated and Used by CVP and SWP Water Users	Similar CVP net generation. Decreased SWP net generation over the long-term (41%). Potentially reduced energy use by CVP and SWP water users. No mitigation needed.	No change. No mitigation needed.	Similar CVP net generation. Decreased SWP net generation over the long-term (27%). Potentially reduced energy use by CVP and SWP water users. No mitigation needed.	Similar CVP net generation. Decreased SWP net generation over the long-term (41%). Potentially reduced energy use by CVP and SWP water users. No mitigation needed.	Similar CVP and SWP net generation. Similar reduced energy use. No mitigation needed.

	Alternative 1 Compared to the No Action Alternative	Alternative 2 Compared to the No Action Alternative	Alternative 3 Compared to the No Action Alternative	Alternative 4 Compared to the No Action Alternative	Alternative 5 Compared to the No Action Alternative
Aquatic Resources					
Trinity River: Coho Salmon	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Trinity River: Spring-run Chinook Salmon	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Trinity River: Fall-run Chinook Salmon	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Trinity River: Steelhead	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Trinity River: Green Sturgeon	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Trinity Lake and Lewiston Reservoir: Reservoir Fish	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Trinity River: Pacific Lamprey	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Trinity River: Eulachon	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.

	Alternative 1 Compared to the No Action Alternative	Alternative 2 Compared to the No Action Alternative	Alternative 3 Compared to the No Action Alternative	Alternative 4 Compared to the No Action Alternative	Alternative 5 Compared to the No Action Alternative
Sacramento River System: Winter-run Chinook Salmon	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Potential mitigation measure: Implement fish passage around dams.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030; reduced pulse flows along lower Clear Creek; and lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants. Potential mitigation measure: Implement fish passage around dams to reduce temperature impacts. No mitigation measures have been identified for remaining impacts.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Improved conditions due to predator controls. Potential mitigation measure: Implement fish passage around dams.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Improved conditions due to predator controls. Potential mitigation measure: Implement fish passage around dams.	Similar conditions. No mitigation needed.

	Alternative 1 Compared to the No Action Alternative	**Alternative 2 Compared to the No Action Alternative**	**Alternative 3 Compared to the No Action Alternative**	**Alternative 4 Compared to the No Action Alternative**	**Alternative 5 Compared to the No Action Alternative**
Sacramento River System: Spring-run Chinook Salmon	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Potential mitigation measure: Implement fish passage around dams.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030; reduced pulse flows along lower Clear Creek; and lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants. Potential mitigation measure: Implement fish passage around dams to reduce temperature impacts. No mitigation measures have been identified for remaining impacts.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Improved conditions due to predator controls. Potential mitigation measure: Implement fish passage around dams.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Improved conditions due to predator controls. Potential mitigation measure: Implement fish passage around dams.	Similar conditions. No mitigation needed.
Sacramento River System: Fall-run Chinook Salmon	Similar conditions. No mitigation needed.	Reduced habitat conditions due to reduced pulse flows along lower Clear Creek; and lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants. No mitigation measures have been identified for remaining impacts.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.

	Alternative 1 Compared to the No Action Alternative	Alternative 2 Compared to the No Action Alternative	Alternative 3 Compared to the No Action Alternative	Alternative 4 Compared to the No Action Alternative	Alternative 5 Compared to the No Action Alternative
Sacramento River System: Late Fall-run Chinook Salmon	Similar conditions. No mitigation needed.	Reduced habitat conditions due to lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants. Potential mitigation measure: Implement fish passage around dams to reduce temperature impacts. No mitigation measures have been identified for remaining impacts.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Sacramento River System: Steelhead	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Potential mitigation measure: Implement fish passage around dams.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Potential mitigation measure: Implement fish passage around dams.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Potential mitigation measure: Implement fish passage around dams.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Potential mitigation measure: Implement fish passage around dams.	Similar conditions. No mitigation needed.
Sacramento River System: Green Sturgeon and White Sturgeon	Likely to result in improved conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Likely to result in improved conditions. No mitigation needed.	Likely to result in improved conditions. No mitigation needed.	Similar conditions. No mitigation needed.

	Alternative 1 Compared to the No Action Alternative	**Alternative 2 Compared to the No Action Alternative**	**Alternative 3 Compared to the No Action Alternative**	**Alternative 4 Compared to the No Action Alternative**	**Alternative 5 Compared to the No Action Alternative**
Delta: Delta Smelt	Reduced habitat conditions due to increased potential for entrainment during larval and juvenile stages, and increased salinity in the fall in the western Delta. No mitigation measures have been identified at this time.	Similar conditions. No mitigation needed.	Reduced habitat conditions due to increased potential for entrainment during larval and juvenile stages, and increased salinity in the fall in the western Delta. No mitigation measures have been identified at this time.	Reduced habitat conditions due to increased potential for entrainment during larval and juvenile stages, and increased salinity in the fall in the western Delta. No mitigation measures have been identified at this time.	Similar conditions. No mitigation needed.
Delta: Longfin Smelt	Reduced habitat conditions due to more negative Old and Middle River flows and other factors (as indicated by lower Longfin Smelt abundance indices). No mitigation measures have been identified at this time.	Similar conditions. No mitigation needed.	Reduced habitat conditions due to more negative Old and Middle River flows and other factors (as indicated by lower Longfin Smelt abundance indices). No mitigation measures have been identified at this time.	Reduced habitat conditions due to more negative Old and Middle River flows and other factors (as indicated by lower Longfin Smelt abundance indices). No mitigation measures have been identified at this time.	Similar conditions. No mitigation needed.
Delta: Sacramento Splittail	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Sacramento River System: Reservoir Fish	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Sacramento River System: Pacific Lamprey	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.

	Alternative 1 Compared to the No Action Alternative	Alternative 2 Compared to the No Action Alternative	Alternative 3 Compared to the No Action Alternative	Alternative 4 Compared to the No Action Alternative	Alternative 5 Compared to the No Action Alternative
Sacramento River System: Striped Bass, American Shad, and Hardhead	Similar conditions for Hardhead. Reduced habitat conditions for Striped Bass and American Shad due to reduced survival in larval and juvenile stages and increased salinity in the spring in the western Delta. No mitigation measures have been identified at this time.	Similar conditions. No mitigation needed.	Similar conditions for Hardhead. Reduced habitat conditions for Striped Bass and American Shad due to reduced survival in larval and juvenile stages and increased salinity in the spring in the western Delta. Adverse conditions for Striped Bass due to changes in harvest limitations. No mitigation measures have been identified at this time.	Similar conditions for Hardhead. Reduced habitat conditions for Striped Bass and American Shad due to reduced survival in larval and juvenile stages and increased salinity in the spring in the western Delta. Adverse conditions for Striped Bass due to changes in harvest limitations. No mitigation measures have been identified at this time.	Similar conditions. No mitigation needed.
Stanislaus River: Fall-run Chinook Salmon	Similar conditions. No mitigation needed.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030; and lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants. Potential mitigation measure: Implement fish passage around dams to reduce temperature impacts. No mitigation measures have been identified for remaining impacts.	Potential improved habitat conditions due to predator controls, trap and haul operations, and harvest restrictions; however, the effectiveness of these measures is uncertain. No mitigation needed.	Potential improved habitat conditions due to predator controls, trap and haul operations, and harvest restrictions; however, the effectiveness of these measures is uncertain. No mitigation needed.	Similar conditions. No mitigation needed.

	Alternative 1 Compared to the No Action Alternative	Alternative 2 Compared to the No Action Alternative	Alternative 3 Compared to the No Action Alternative	Alternative 4 Compared to the No Action Alternative	Alternative 5 Compared to the No Action Alternative
Stanislaus River: Steelhead	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030; and lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants. Potential mitigation measure: Implement fish passage around dams to reduce temperature impacts. No mitigation measures have been identified for remaining impacts.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030; and lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants. Potential mitigation measure: Implement fish passage around dams to reduce temperature impacts. No mitigation measures have been identified for remaining impacts.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030; and lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants. Potential improved habitat conditions due to predator controls and trap and haul operations; however, the effectiveness of these measures is uncertain. Potential mitigation measure: Implement fish passage around dams to reduce temperature impacts. No mitigation measures have been identified for remaining impacts.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030; and lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants. Potential improved habitat conditions due to predator controls and trap and haul operations; however, the effectiveness of these measures is uncertain. Potential mitigation measure: Implement fish passage around dams to reduce temperature impacts. No mitigation measures have been identified for remaining impacts.	Similar conditions. No mitigation needed.
Stanislaus River: White Sturgeon	Conditions may be similar; however, adverse impacts could occur due to higher water temperatures. No mitigation measures have been identified at this time.	Similar conditions. No mitigation needed.	Conditions may be similar; however, adverse impacts could occur due to higher water temperatures. No mitigation measures have been identified at this time.	Conditions may be similar; however, adverse impacts could occur due to higher water temperatures. No mitigation measures have been identified at this time.	Similar conditions. No mitigation needed.

	Alternative 1 Compared to the No Action Alternative	Alternative 2 Compared to the No Action Alternative	Alternative 3 Compared to the No Action Alternative	Alternative 4 Compared to the No Action Alternative	Alternative 5 Compared to the No Action Alternative
New Melones Reservoir; Reservoir Fish	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Stanislaus River: Other Fish	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions for lampreys and Hardheads. Adverse conditions for Striped Bass due to changes in harvest limitations. No mitigation needed for lamprey and Hardhead. No mitigation measures have been identified at this time for Striped Bass.	Similar conditions for lampreys and Hardheads. Adverse conditions for Striped Bass due to changes in harvest limitations. No mitigation needed for lamprey and Hardhead. No mitigation measures have been identified at this time for Striped Bass.	Similar conditions. No mitigation needed.
Pacific Ocean: Killer Whale	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Terrestrial Resources					
Terrestrial Resources along Shoreline of CVP and SWP Reservoirs	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Terrestrial Resources along Rivers Downstream of CVP and SWP Reservoirs	Similar or improved conditions along Trinity, Sacramento, American, and Feather rivers. Reduced conditions along Stanislaus River. No mitigation measures identified at this time for changes along the Stanislaus River.	No change. No mitigation needed.	Similar or improved conditions along Trinity, Sacramento, American, and Feather rivers. Reduced conditions along Stanislaus River. No mitigation measures identified at this time for changes along the Stanislaus River.	Similar or improved conditions along Trinity, Sacramento, American, and Feather rivers. Reduced conditions along Stanislaus River. No mitigation measures identified at this time for changes along the Stanislaus River.	Similar or improved conditions along Trinity, Sacramento, American, and Feather rivers. Improved conditions along Stanislaus River. No mitigation needed.

	Alternative 1 Compared to the No Action Alternative	Alternative 2 Compared to the No Action Alternative	Alternative 3 Compared to the No Action Alternative	Alternative 4 Compared to the No Action Alternative	Alternative 5 Compared to the No Action Alternative
Terrestrial Resources in Yolo Bypass	Similar conditions in Yolo Bypass. No mitigation needed.	No change. No mitigation needed.	Similar or improved conditions in Yolo Bypass. No mitigation needed.	Similar conditions in Yolo Bypass. No mitigation needed.	Similar conditions in Yolo Bypass. No mitigation needed.
Terrestrial Resources in Western Delta	Increased extent of salt water in the fall months of wet and above normal years in western Delta which could adversely affect terrestrial resources that use freshwater habitat. No mitigation measures identified at this time.	No change. No mitigation needed.	Increased extent of salt water in the fall months of wet and above normal years in western Delta which could adversely affect terrestrial resources that use freshwater habitat. No mitigation measures identified at this time.	Increased extent of salt water in the fall months of wet and above normal years in western Delta which could adversely affect terrestrial resources that use freshwater habitat. No mitigation measures identified at this time.	Similar habitat in western Delta. No mitigation needed.
Geology and Soils Resources					
Geology and Soils Resources	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Agricultural Resources					
Agricultural Production and Employment	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Land Use					
Municipal and Industrial Land Use	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Visual Resources					
Visual Resources of Land Irrigated with CVP and SWP Water	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Visual Resources at Reservoirs that Store CVP and SWP Water	Similar or improved conditions. No mitigation needed.	No change. No mitigation needed.	Similar or improved conditions. No mitigation needed.	Similar or improved conditions. No mitigation needed.	Similar conditions. No mitigation needed.

	Alternative 1 Compared to the No Action Alternative	Alternative 2 Compared to the No Action Alternative	Alternative 3 Compared to the No Action Alternative	Alternative 4 Compared to the No Action Alternative	Alternative 5 Compared to the No Action Alternative
Recreation Resources					
Recreation Resources at Reservoirs that Store CVP and SWP Water	Similar or improved conditions. No mitigation needed.	No change. No mitigation needed.	Similar or improved conditions. No mitigation needed.	Similar or improved conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Recreation Resources in Rivers downstream of CVP and SWP Reservoirs	Similar or improved conditions. No mitigation needed.	No change. No mitigation needed.	Similar or improved conditions. Reduced opportunities for Striped Bass and sport ocean salmon fishing. No mitigation measures identified at this time.	Similar or improved conditions. Reduced opportunities for Striped Bass and sport ocean salmon fishing. No mitigation measures identified at this time.	Similar conditions. No mitigation needed.
Air Quality and Greenhouse Gas Emissions					
Emissions of Criteria Air Pollutants and Precursors and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants from Diesel Engines at Groundwater Wells	Similar air quality conditions in the Trinity River Region and Sacramento Valley. Improved air quality conditions in the San Joaquin Valley and the San Francisco Bay Area, Central Coast, and Southern California regions. No mitigation needed.	No change. No mitigation needed.	Similar air quality conditions in the Trinity River Region and Sacramento Valley. Reduced air quality conditions in the San Joaquin Valley and the San Francisco Bay Area, Central Coast, and Southern California regions. No mitigation needed.	Similar air quality conditions in the Trinity River Region and Sacramento Valley. Improved air quality conditions in the San Joaquin Valley and the San Francisco Bay Area, Central Coast, and Southern California regions. No mitigation needed.	Similar air quality conditions in the Trinity River Region and Sacramento Valley. Similar air quality conditions in the San Joaquin Valley and the San Francisco Bay Area, Central Coast, and Southern California regions. No mitigation needed.

	Alternative 1 Compared to the No Action Alternative	Alternative 2 Compared to the No Action Alternative	Alternative 3 Compared to the No Action Alternative	Alternative 4 Compared to the No Action Alternative	Alternative 5 Compared to the No Action Alternative
Increased Greenhouse Gas Emissions (GHG) due to Changes in Energy Resources Related to CVP and SWP Water Use	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could increase in the San Francisco Bay Area, Central Coast, and Southern California regions.	No change.	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could increase in the San Francisco Bay Area, Central Coast, and Southern California regions.	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could increase in the San Francisco Bay Area, Central Coast, and Southern California regions.	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could increase in the San Francisco Bay Area, Central Coast, and Southern California regions.
Cultural Resources					
Potential for Disturbance of Cultural Resources	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Public Health					
Water Supply Availability for Wildland Firefighting	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Potential Exposure to Mercury in Fish in Delta	Similar or reduced concentrations. No mitigation needed.	No change. No mitigation needed.	Similar or reduced concentrations. No mitigation needed.	Similar or reduced concentrations. No mitigation needed.	Similar concentrations. No mitigation needed.
Socioeconomics					
Agricultural and Municipal and Industrial Employment	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Municipal and Industrial Water Supply Operating Expenses	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Recreational Economics CVP and SWP Reservoirs	Similar or improved conditions. No mitigation needed.	No change. No mitigation needed.	Similar or improved conditions. No mitigation needed.	Similar or improved conditions. No mitigation needed.	Similar or improved conditions. No mitigation needed.

	Alternative 1 Compared to the No Action Alternative	Alternative 2 Compared to the No Action Alternative	Alternative 3 Compared to the No Action Alternative	Alternative 4 Compared to the No Action Alternative	Alternative 5 Compared to the No Action Alternative
Recreational Economics Related to Striped Bass Fishing in Delta	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Reduced recreational opportunities and associated economics. No mitigation identified at this time.	Reduced recreational opportunities and associated economics. No mitigation identified at this time.	Similar conditions. No mitigation needed.
Commercial and Sport Ocean Salmon Fishing	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Reduced commercial and sport ocean salmon fishing and associated economics. No mitigation identified at this time.	Reduced commercial and sport ocean salmon fishing and associated economics. No mitigation identified at this time.	Similar conditions. No mitigation needed.
Indian Trust Assets					
Potential for Disturbance of Indian Trust Assets	No change. No mitigation needed.	No change. No mitigation needed.	No change. No mitigation needed.	No change. No mitigation needed.	No change. No mitigation needed.
Environmental Justice					
Emissions of Criteria Air Pollutants and Precursors and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants from Diesel Engines at Groundwater Wells	Improved air quality conditions. No mitigation needed.	No change. No mitigation needed.	Reduced air quality conditions. No mitigation needed.	Improved air quality conditions. No mitigation needed.	Similar air quality conditions. No mitigation needed.
Potential Exposure to Mercury in Fish in Delta	Similar or reduced concentrations. No mitigation needed.	No change. No mitigation needed.	Similar or reduced concentrations. No mitigation needed.	Similar or reduced concentrations. No mitigation needed.	Similar concentrations. No mitigation needed.

1 **Table 3.7 Comparison of No Action Alternative and Alternatives 1 through 5 to Second Basis of Comparison**

	No Action Alternative Compared to Second Basis of Comparison	Alternative 1 Compared to the Second Basis of Comparison	Alternative 2 Compared to the Second Basis of Comparison	Alternative 3 Compared to the Second Basis of Comparison	Alternative 4 Compared to the Second Basis of Comparison	Alternative 5 Compared to the Second Basis of Comparison
SURFACE WATER CONDITIONS						
Trinity Lake	Water surface elevations similar Storage would be similar in most months, except reduced in November-December in above normal years (up to 6%) and all months in critical dry years (up to 10%).	No change.	Water surface elevations similar Storage would be similar in most months, except reduced in November-December in above normal years (up to 6%) and all months in critical dry years (up to 10%).	Water surface elevations similar Storage similar or increased.	No change.	Water surface elevations similar Storage would be similar in most months, except reduced in all months in critical dry years (up to 10%).
Trinity River at Lewiston Dam	Flows similar or increased except reduced in December-February in wet to below normal years (up to 30%).	No change.	Flows similar or increased except reduced in December-February in wet to below normal years (up to 30%).	Flows similar or increased.	No change.	Flows similar or increased except reduced in December-February in wet to below normal years (up to 21%).
Shasta Lake	Water surface elevations similar Storage reduced in September-February in wet to dry years (up to 11%) and in all months in critical dry years (up to 14%).	No change.	Water surface elevations similar Storage reduced in September-February in wet to dry years (up to 11%) and in all months in critical dry years (up to 14%).	Water surface elevations similar Storage similar or increased.	No change.	Water surface elevations similar Storage reduced in September-February in most months of wet to dry years (up to 10%), and in all months in critical dry years (up to 17%).

	No Action Alternative Compared to Second Basis of Comparison	Alternative 1 Compared to the Second Basis of Comparison	Alternative 2 Compared to the Second Basis of Comparison	Alternative 3 Compared to the Second Basis of Comparison	Alternative 4 Compared to the Second Basis of Comparison	Alternative 5 Compared to the Second Basis of Comparison
Sacramento River at Keswick Dam	Flows reduced (up to 21%) except September and November.	No change.	Flows reduced (up to 21%) except September and November.	Flows similar or increased except reduced in August in below normal years (up to 6%).	No change.	Flows reduced (up to 16%) except September and November.
Sacramento River at Freeport	Flows similar or increased except reduced in May and June (up to 27%).	No change.	Flows similar or increased except reduced in May and June (up to 27%).	Flows similar or increased except reduced in June in below normal years (up to 13%).	No change.	Flows similar or increased except reduced in May and June (up to 28%).
Clear Creek near Igo	Flows similar or increased.	No change.	Flows similar or increased.	No change.	No change.	Flows similar or increased.
Lake Oroville	Water surface elevations similar. Similar in most months May-July in wet to dry years and in all months in critical dry years. Reduced in many months from September-February in all year types (up to 18%).	No change.	Water surface elevations similar. Similar in most months May-July in wet to dry years and in all months in critical dry years. Reduced in many months from September-February in all year types (up to 18%).	Water surface elevations similar Storage similar.	No change.	Water surface elevations similar. Similar in most months May-July in wet to dry years and in all months in critical dry years. Reduced in many months from September-February in all year types (up to 18%).
Feather River downstream of Thermalito Complex	Flows similar or increased except reduced in August-June (up to 52%).	No change.	Flows similar or increased except reduced in August-June (up to 52%).	Flows similar or increased except reduced in August-June (up to 28%).	No change.	Flows similar or increased except reduced in August-June (up to 58%).

	No Action Alternative Compared to Second Basis of Comparison	**Alternative 1 Compared to the Second Basis of Comparison**	**Alternative 2 Compared to the Second Basis of Comparison**	**Alternative 3 Compared to the Second Basis of Comparison**	**Alternative 4 Compared to the Second Basis of Comparison**	**Alternative 5 Compared to the Second Basis of Comparison**
Folsom Lake	Water surface elevations similar Storage similar in many months except reduced flows in September-January (up to 12%) in wet to below normal years and July-September in critical dry years (up to 11%).	No change.	Water surface elevations similar Storage similar in many months except reduced flows in September-January (up to 12%) in wet to below normal years and July-September in critical dry years (up to 11%).	Water surface elevations similar Storage similar.	No change.	Water surface elevations similar Storage similar in many months except reduced flows in August-January (up to 13%) in wet to below normal years and July in critical dry years (8%).
American River at Nimbus Dam	Flows similar or increased except reduced in June-August, December, February, and April (up to 25%).	No change.	Flows similar or increased except reduced in June-August, December, February, and April (up to 25%).	Flows similar or increased except reduced flows in June-August and April (up to 17%).	No change.	Flows similar or increased except reduced in December-February, April, June, and August (up to 25%).
New Melones Reservoir	Water surface elevations similar Storage similar in wet, below normal, and dry years, and in most months in above normal and critical dry years. Storage reduced in October in above normal water years (6%) and in October-January and April-June in critical dry years (up to 7%).	No change.	Water surface elevations similar Storage similar in wet, below normal, and dry years, and in most months in above normal and critical dry years. Storage reduced in October in above normal water years (6%) and in October-January and April-June in critical dry years (up to 7%).	Water surface elevations similar Storage similar or increased.	No change.	Water surface elevations similar Storage reduced in all months in all water year types (up to 23%).

	No Action Alternative Compared to Second Basis of Comparison	**Alternative 1 Compared to the Second Basis of Comparison**	**Alternative 2 Compared to the Second Basis of Comparison**	**Alternative 3 Compared to the Second Basis of Comparison**	**Alternative 4 Compared to the Second Basis of Comparison**	**Alternative 5 Compared to the Second Basis of Comparison**
Stanislaus River at Goodwin Dam	Flows similar or increased except reduced in November-March and May-June (up to 25%).	No change.	Flows similar or increased except reduced in November-March and May-June (up to 25%).	Flows reduced in all months (up to 79%) except April and August.	No change.	Flows reduced in all months (up to 25%) except October, April, and May.
San Joaquin River at Vernalis	Flows similar or increased except reduced in November and May-June (up to 9%).	No change.	Flows similar or increased except reduced in November and May-June (up to 9%).	Flows similar or increased except reduced in May-June (up to 27%).	No change.	Flows similar or increased except reduced in November and June (up to 10%).
San Luis Reservoir	Water surface elevations reduced in all months in wet to below normal water years and in February-September in dry and critical dry years (up to 16%). Storage reduced in October-June in most water years (up to 71%).	No change.	Water surface elevations reduced in all months in wet to below normal water years and in February-September in dry and critical dry years (up to 16%). Storage reduced in October-June in most water years (up to 71%).	Water surface elevations similar except reduced in January-February in above normal years (up to 6%) and February-August in critical dry years (up to 7%). Storage similar or increased in some months except in December-February and June in wet years (up to 16%), October-July in above normal and below normal years (up to 40%), January-September in dry years (up to 19%), and October-August in critical dry years (up to 29%).	No change.	Water surface elevations reduced in all months in all year types (up to 70%). Storage would be reduced in October-August in wet to below normal years (up to 17%), in January-September in dry years (up to 14%), and in all months in critical dry years (up to 14%).

	No Action Alternative Compared to Second Basis of Comparison	**Alternative 1 Compared to the Second Basis of Comparison**	**Alternative 2 Compared to the Second Basis of Comparison**	**Alternative 3 Compared to the Second Basis of Comparison**	**Alternative 4 Compared to the Second Basis of Comparison**	**Alternative 5 Compared to the Second Basis of Comparison**
Flows into Yolo Bypass	Flows similar or increased except reduced in November-December in wet years (up to 15%), January-March in above normal years (14%), December-March in below normal years (up to 25%), and December in dry years (6%).	No change.	Flows similar or increased except reduced in November-December in wet years (up to 15%), January-March in above normal years (14%), December-March in below normal years (up to 25%), and December in dry years (6%).	Flows similar except reduced in October of wet years (6%).	No change.	Flows similar or increased except reduced in November-January in wet years (up to 15%), January-March in above normal years (15%), December-March in below normal years (up to 24%), and December in dry years (7%).
Delta Outflow	Flows similar or increased in many months. Reduced flows in some months, including in December, February-March, and June in wet years (up to 1,590 cfs).	No change.	Flows similar or increased in many months. Reduced flows in some months, including in December, February-March, and June in wet years (up to 1,590 cfs).	Flows would increase in many months. Reduced flows in some months, including October and March-June in wet years (up to 1,127 cfs), and October and May-June in dry years (up to 373 cfs).	No change.	Flows similar or increased in many months. Reduced flows in some months, including in December, February-March, and June in wet years (up to 1,713 cfs), and June in dry years (526 cfs).
Reverse Flows in Old and Middle Rivers	Increased positive flows except in June-August in most years and March in wet years.	No change.	Increased positive flows except in June-August in most years and March in wet years.	Increased negative flows in June-August in most years and March in wet years.	No change.	Increased negative flows in July-August in most years and March and June in wet years.

	No Action Alternative Compared to Second Basis of Comparison	**Alternative 1 Compared to the Second Basis of Comparison**	**Alternative 2 Compared to the Second Basis of Comparison**	**Alternative 3 Compared to the Second Basis of Comparison**	**Alternative 4 Compared to the Second Basis of Comparison**	**Alternative 5 Compared to the Second Basis of Comparison**
Water Supplies						
Non-CVP and Non-SWP Deliveries	Deliveries similar.	Deliveries similar.	Deliveries similar.	Deliveries similar.	Deliveries similar.	Deliveries similar.
North of Delta CVP Water Deliveries: Agricultural Water Contractors	Deliveries reduced up to 16% over the long-term to 34% in critical dry years.	No change.	Deliveries reduced up to 16% over the long-term to 34% in critical dry years.	Deliveries similar over the long-term. Reduced up to 9% in dry years to 11% in critical dry years.	No change.	Deliveries reduced up to 16% over the long-term to 31% in critical dry years.
North of Delta CVP Water Deliveries: Municipal and Industrial Water Contractors	Deliveries similar.	No change.	Deliveries similar.	Deliveries similar.	No change.	Deliveries similar.
South of Delta CVP Water Deliveries: Agricultural Water Contractors	Deliveries reduced up to 23% over the long-term to 33% in critical dry years.	No change.	Deliveries reduced up to 23% over the long-term to 33% in critical dry years.	Deliveries similar over the long-term. Reduced up to 8% in dry years to 14% in critical dry years.	No change.	Deliveries reduced up to 24% over the long-term to 33% in critical dry years.
South of Delta CVP Water Deliveries: Municipal and Industrial Water Contractors	Deliveries reduced up to 10% over the long-term to 5% in critical dry years.	No change.	Deliveries reduced up to 10% over the long-term to 5% in critical dry years.	Deliveries similar.	No change.	Deliveries reduced up to 10% over the long-term to 8% in critical dry years.
CVP Water Deliveries: Eastside Division Contractors	Deliveries reduced up to 19% in critical dry years.	No change.	Deliveries reduced up to 19% in critical dry years.	Deliveries similar.	No change.	Deliveries reduced up to 19% in critical dry years.
North of Delta: SWP Water Deliveries under Table A without Article 21 water	Deliveries reduced up to 13% over the long-term to 20% in critical dry years.	No change.	Deliveries reduced up to 13% over the long-term to 20% in critical dry years.	Deliveries similar over the long-term and in dry years. Reduced by 10% in critical dry years.	No change.	Deliveries reduced up to 19% over the long-term to 21% in critical dry years.

	No Action Alternative Compared to Second Basis of Comparison	Alternative 1 Compared to the Second Basis of Comparison	Alternative 2 Compared to the Second Basis of Comparison	Alternative 3 Compared to the Second Basis of Comparison	Alternative 4 Compared to the Second Basis of Comparison	Alternative 5 Compared to the Second Basis of Comparison
North of Delta: SWP Water Deliveries under Table A without Article 21 water	Deliveries reduced up to 18% over the long-term to 22% in critical dry years.	No change.	Deliveries reduced up to 18% over the long-term to 22% in critical dry years.	Deliveries similar over the long-term and in dry years. Reduced by 11% in critical dry years.	No change.	Deliveries reduced up to 19% over the long-term to 23% in critical dry years.
Surface Water Quality						
Salinity in Northern Delta (near Emmaton)	Salinity increased in June in wet to dry years (up to 21%). Reduced in fall and winter months in wet and above normal years (up to 79%).	No change.	Salinity increased in June in wet to dry years (up to 21%). Reduced in fall and winter months in wet and above normal years (up to 79%).	Salinity increased in June in wet to dry years (up to 35%). Reduced in fall and winter months in wet and above normal years (up to 24%).	No change.	Salinity increased in June in wet to dry years (up to 21%). Reduced in fall and winter months in wet and above normal years (up to 79%).
Salinity in Western Delta (near Port Chicago)	Salinity reduced in September-May (up to 49%).	No change.	Salinity reduced in September-May (up to 49%).	Salinity increased in June in wet to below normal years (up to 9%). Reduced in January-March (up to 25%).	No change.	Salinity reduced in September-May (up to 49%).
Salinity in Western Central Delta (near Antioch)	Salinity increased in June in wet to below normal years (up to 16%). Reduced in fall and winter months (up to 73%).	No change.	Salinity increased in June in wet to below normal years (up to 16%). Reduced in fall and winter months (up to 73%).	Salinity increased in May in wet years and June in wet to dry years (up to 20%). Reduced in January-April (up to 40%).	No change.	Salinity increased in June in wet to below normal years (up to 14%). Reduced in fall and winter months (up to 73%).

	No Action Alternative Compared to Second Basis of Comparison	Alternative 1 Compared to the Second Basis of Comparison	Alternative 2 Compared to the Second Basis of Comparison	Alternative 3 Compared to the Second Basis of Comparison	Alternative 4 Compared to the Second Basis of Comparison	Alternative 5 Compared to the Second Basis of Comparison
Salinity in Western Central Delta (near Contra Costa Water District Intakes)	Salinity increased in March-June (up to 47%). Reduced in October-January and September (up to 42%).	No change.	Salinity increased in March-June (up to 47%). Reduced in October-January and September (up to 42%).	Salinity increased in March-April in dry and critical dry years (up to 16%). Reduced in December-February in dry and critical dry years (up to 23%).	No change.	Salinity increased in March-June (up to 63%). Reduced in October-January and September (up to 41%).
Salinity in Southern Delta (near CVP and SWP intakes)	Salinity increased in February-June (up to 23%). Reduced in October-January (up to 28%).	No change.	Salinity increased in February-June (up to 23%). Reduced in October-January (up to 28%).	Salinity increased in February-May in dry and critical dry years (up to 23%).	No change.	Salinity increased in February-June (up to 26%). Reduced in October-January (up to 28%).
Mercury in Delta Fish	Mercury concentrations increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).	No change.	Mercury concentrations increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).	Similar conditions.	No change.	Mercury concentrations increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).
Selenium in Delta and Delta Fish	Selenium concentrations similar concentrations.	No change.	Selenium concentrations similar concentrations.	Selenium concentrations similar concentrations.	No change.	Selenium concentrations similar concentrations.
Groundwater Resources						
Trinity River Region	Similar groundwater conditions.	No change.	Similar groundwater conditions.	Similar groundwater conditions.	No change.	Similar groundwater conditions.

	No Action Alternative Compared to Second Basis of Comparison	Alternative 1 Compared to the Second Basis of Comparison	Alternative 2 Compared to the Second Basis of Comparison	Alternative 3 Compared to the Second Basis of Comparison	Alternative 4 Compared to the Second Basis of Comparison	Alternative 5 Compared to the Second Basis of Comparison
Central Valley Region: Sacramento Valley	Similar groundwater conditions.	No change.	Similar groundwater conditions.	Similar groundwater conditions.	No change.	Similar groundwater conditions.
Central Valley Region: San Joaquin Valley	Increased groundwater pumping (8%); and lower groundwater elevations (2-200 feet). Potentially reduced groundwater quality. Increased subsidence potential.	No change.	Increased groundwater pumping (8%); and lower groundwater elevations (2-200 feet). Potentially reduced groundwater quality. Increased subsidence potential.	Similar groundwater pumping; and similar to lower groundwater elevations (2-25 feet). Similar groundwater quality. Similar subsidence potential.	No change.	Increased groundwater pumping (8%); and lower groundwater elevations (2-200 feet). Potentially reduced groundwater quality. Increased subsidence potential.
San Francisco Bay Area, Central Coast, and Southern California Region	Potentially increased groundwater pumping; and potentially lower groundwater elevations. Potentially reduced groundwater quality. Increased subsidence potential.	No change.	Potentially increased groundwater pumping; and potentially lower groundwater elevations. Potentially reduced groundwater quality. Increased subsidence potential.	Potentially increased groundwater pumping; and potentially lower groundwater elevations. Potentially reduced groundwater quality. Increased subsidence potential.	No change.	Potentially increased groundwater pumping; and potentially lower groundwater elevations. Potentially reduced groundwater quality. Increased subsidence potential.

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CVP and SWP Energy Resources						
Energy Generated and Used by CVP and SWP Water Users	Similar CVP net generation. Increased net generation over the long-term (29%). Potentially increased energy use by CVP and SWP water users.	No change.	Similar CVP net generation. Increased net generation over the long-term (29%). Potentially increased energy use by CVP and SWP water users.	Similar CVP net generation. Increased net generation over the long-term (10%). Potentially increased energy use by CVP and SWP water users.	No change.	Similar CVP net generation. Increased net generation over the long-term (30%). Potentially increased energy use by CVP and SWP water users.
Aquatic Resources						
Trinity River: Coho Salmon	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Trinity River: Spring-run Chinook Salmon	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Trinity River: Fall-run Chinook Salmon	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Trinity River: Steelhead	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Trinity River: Green Sturgeon	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Trinity Lake and Lewiston Reservoir: Reservoir Fish	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Trinity River: Pacific Lamprey	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Trinity River: Eulachon	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.

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Sacramento River System: Winter-run Chinook Salmon	Improved habitat conditions due to fish passage at dams and other actions to address high water temperatures caused by climate change by 2030.	No change.	Similar conditions.	Improved habitat conditions due to improved escapement potential and predator controls.	Similar conditions.	Improved habitat conditions due to fish passage at dams and other actions to address high water temperatures caused by climate change by 2030.
Sacramento River System: Spring-run Chinook Salmon	Improved habitat conditions due to fish passage at dams and other actions to address high water temperatures caused by climate change by 2030.	No change.	Similar conditions.	Improved habitat conditions due to harvest limitations and predator controls.	Similar conditions.	Improved habitat conditions due to fish passage at dams and other actions to address high water temperatures caused by climate change by 2030.
Sacramento River System: Fall-run Chinook Salmon	Similar conditions.	No change.	Similar conditions.	Similar conditions.	Similar conditions.	Similar conditions.
Sacramento River System: Late Fall-run Chinook Salmon	Improved habitat conditions due to measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants.	No change.	Similar conditions.	Similar conditions.	Similar conditions.	Improved habitat conditions due to measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants.

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Sacramento River System: Steelhead	Improved habitat conditions due to fish passage programs to address high water temperatures caused by climate change by 2030; and measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants.	No change.	Similar conditions.	Similar conditions.	Similar conditions.	Improved habitat conditions due to fish passage programs to address high water temperatures caused by climate change by 2030; and measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants.
Sacramento River System: Green Sturgeon and White Sturgeon	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030 that are not improved by other actions.	No change.	Similar conditions.	Improved habitat conditions due to lower water temperatures.	No change.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030 that are not improved by other actions.
Delta: Delta Smelt	Improved habitat conditions due to reduced potential for entrainment during larval and juvenile stages, and reduced salinity in the fall in the western Delta.	No change.	Similar conditions.	Similar conditions.	No change.	Improved habitat conditions due to reduced potential for entrainment during larval and juvenile stages, and reduced salinity in the fall in the western Delta.

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Delta: Longfin Smelt	Improved habitat conditions due to more positive Old and Middle River flows and other factors (as indicated by higher Longfin Smelt abundance indices).	No change.	Similar conditions.	Similar conditions.	No change.	Improved habitat conditions due to more positive Old and Middle River flows and other factors (as indicated by higher Longfin Smelt abundance indices).
Delta: Sacramento Splittail	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Sacramento River System: Reservoir Fish	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Sacramento River System: Pacific Lamprey	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Sacramento River System: Striped Bass, American Shad, and Hardhead	Similar conditions for Hardhead. Improved habitat conditions for Striped Bass and American Shad due to improved survival in larval and juvenile stages and reduced salinity in the spring in the western Delta.	No change.	Similar conditions.	Similar habitat conditions for Hardhead, Striped Bass, and American Shad. Adverse conditions for Striped Bass due to changes in harvest limitations.	No change in habitat conditions for Hardhead, Striped Bass, and American Shad. Adverse conditions for Striped Bass due to changes in harvest limitations.	Similar conditions for Hardhead. Improved habitat conditions for Striped Bass and American Shad due to improved survival in larval and juvenile stages and reduced salinity in the spring in the western Delta.

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Stanislaus River: Fall-run Chinook Salmon	Similar or improved conditions.	No change.	Similar conditions.	Potential improved habitat conditions due to predator controls, trap and haul operations, and harvest restrictions; however, the effectiveness of these measures is uncertain.	Potential improved habitat conditions due to predator controls, trap and haul operations, and harvest restrictions; however, the effectiveness of these measures is uncertain.	Similar or improved conditions.
Stanislaus River: Steelhead	Improved habitat conditions due to measures to address high water temperatures caused by climate change by 2030; and measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants.	No change.	Similar conditions.	Potential improved habitat conditions due to predator controls and trap and haul operations; however, the effectiveness of these measures is uncertain.	Potential improved habitat conditions due to predator controls and trap and haul operations; however, the effectiveness of these measures is uncertain.	Improved habitat conditions due to measures to address high water temperatures caused by climate change by 2030; and measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants.
Stanislaus River: White Sturgeon	Conditions may be similar; however, improved conditions could occur due to lower water temperatures.	No change.	Similar conditions.	Similar conditions.	No change.	Conditions may be similar; however, improved conditions could occur due to lower water temperatures.
New Melones Reservoir; Reservoir Fish	Similar conditions.	No change.	Similar conditions.	Improved conditions for black bass nest survival.	No change.	Similar conditions.

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Stanislaus River: Other Fish	Similar conditions.	No change.	Similar conditions.	Similar conditions for lamprey and Hardhead. Adverse conditions for Striped Bass due to changes in harvest limitations.	Similar conditions for lamprey and Hardhead. Adverse conditions for Striped Bass due to changes in harvest limitations.	Similar conditions.
Pacific Ocean: Killer Whale	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Terrestrial Resources						
Terrestrial Resources along Shoreline of CVP and SWP Reservoirs	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Terrestrial Resources along Rivers Downstream of CVP and SWP Reservoirs	Similar or improved conditions along Trinity, Sacramento, American, and Stanislaus rivers. Reduced conditions along Feather River. No mitigation measures identified at this time for changes along Feather River.	No change.	Similar or improved conditions along Trinity, Sacramento, American, and Stanislaus rivers. Reduced conditions along Feather River. No mitigation measures identified at this time for changes along Feather River.	Similar or improved conditions along Trinity, Sacramento, Feather, and American rivers. Reduced conditions along Stanislaus River. No mitigation measures identified at this time for changes along Stanislaus River.	No change.	Similar or improved conditions along Trinity, American, and Stanislaus rivers. Reduced conditions along Feather and Sacramento rivers. No mitigation measures identified at this time for changes along Feather and Sacramento rivers.
Terrestrial Resources in Yolo Bypass	Similar conditions in Yolo Bypass.	No change.	Similar conditions in Yolo Bypass.	Similar conditions in Yolo Bypass.	No change.	Similar or reduced conditions in Yolo Bypass.
Terrestrial Resources in Western Delta	Increased extent of freshwater habitat in western Delta.	No change.	Increased extent of freshwater habitat in western Delta.	Similar conditions.	No change.	Increased extent of freshwater habitat in western Delta.

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Geology and Soils Resources						
Geology and Soils Resources	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Agricultural Resources						
Agricultural Production and Employment	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Land Use						
Municipal and Industrial Land Use	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Visual Resources						
Visual Resources of Land Irrigated with CVP and SWP Water	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.

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Visual Resources at Reservoirs that Store CVP and SWP Water	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, and New Melones Reservoir. Similar conditions at San Luis Reservoir in above normal to dry years. Reduced conditions at San Luis Reservoir in wet and critical dry years (up to 6%). Potentially reduced conditions in the San Francisco Bay Area, Central Coast, and Southern California regions (up to 18%).	No change.	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, and New Melones Reservoir. Similar conditions at San Luis Reservoir in above normal to dry years. Reduced conditions at San Luis Reservoir in wet and critical dry years (up to 6%). Potentially reduced conditions in the San Francisco Bay Area, Central Coast, and Southern California regions (up to 18%).	Similar conditions.	No change.	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, and New Melones Reservoir. Similar conditions at San Luis Reservoir in above normal to dry years. Reduced conditions at San Luis Reservoir in wet and critical dry years (up to 9%). Potentially reduced conditions in the San Francisco Bay Area, Central Coast, and Southern California regions (up to 18%).

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Recreation Resources						
Recreation Resources at Reservoirs that Store CVP and SWP Water	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, and New Melones Reservoir. Similar conditions at San Luis Reservoir in above normal to dry years. Reduced conditions at San Luis Reservoir in wet and critical dry years (up to 6%). Potentially reduced conditions in the San Francisco Bay Area, Central Coast, and Southern California regions (up to 18%).	No change.	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, and New Melones Reservoir. Similar conditions at San Luis Reservoir in above normal to dry years. Reduced conditions at San Luis Reservoir in wet and critical dry years (up to 6%). Potentially reduced conditions in the San Francisco Bay Area, Central Coast, and Southern California regions (up to 18%).	Similar conditions.	No change.	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, and New Melones Reservoir. Similar conditions at San Luis Reservoir in above normal to dry years. Reduced conditions at San Luis Reservoir in wet and critical dry years (up to 9%). Potentially reduced conditions in the San Francisco Bay Area, Central Coast, and Southern California regions (up to 18%).
Recreation Resources in Rivers downstream of CVP and SWP Reservoirs	Similar or improved conditions; except reduced conditions in June and August along the Feather and American rivers, and in May along the Feather River and Sacramento River near Freeport.	No change.	Similar or improved conditions; except reduced conditions in June and August along the Feather and American rivers, and in May along the Feather River and Sacramento River near Freeport.	Similar or improved conditions along rivers. Reduced opportunities for Striped Bass and sport ocean salmon fishing.	No change along rivers. Reduced opportunities for Striped Bass and sport ocean salmon fishing.	Similar or improved conditions; except reduced conditions in May and June and August along the Sacramento and Feather rivers, in August along the American River; and in June-August along Stanislaus River.

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Air Quality and Greenhouse Gas Emissions						
Emissions of Criteria Air Pollutants and Precursors and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants from Diesel Engines at Groundwater Wells	Similar air quality conditions in the Trinity River Region and Sacramento Valley. Potential increase in emissions (up to 18%) in the San Joaquin Valley and the San Francisco Bay Area, Central Coast, and Southern California regions.	No change.	Similar air quality conditions in the Trinity River Region and Sacramento Valley. Potential increase in emissions (up to 18%) in the San Joaquin Valley and the San Francisco Bay Area, Central Coast, and Southern California regions.	Similar conditions.	No change.	Similar air quality conditions in the Trinity River Region and Sacramento Valley. Potential increase in emissions (up to 18%) in the San Joaquin Valley and the San Francisco Bay Area, Central Coast, and Southern California regions.
Increased Greenhouse Gas Emissions due to Changes in Energy Resources Related to CVP and SWP Water Use	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could be reduced in the San Francisco Bay Area, Central Coast, and Southern California regions.	No change.	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could be reduced in the San Francisco Bay Area, Central Coast, and Southern California regions.	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could be reduced in the San Francisco Bay Area, Central Coast, and Southern California regions.	No change.	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could be reduced in the San Francisco Bay Area, Central Coast, and Southern California regions.

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Cultural Resources						
Potential for Disturbance of Cultural Resources	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Public Health						
Water Supply Availability for Wildland Firefighting	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir. Reduced potential at San Luis Reservoir (6%).	No change.	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir. Reduced potential at San Luis Reservoir (6%).	Similar conditions.	No change.	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir. Reduced potential at San Luis Reservoir (9%).
Potential Exposure to Mercury in Fish in Delta	Increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).	No change.	Increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).	Similar conditions.	No change.	Increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).
Socioeconomics						
Agricultural and Municipal and Industrial Employment	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Municipal and Industrial Water Supply Operating Expenses	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.

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Recreational Economics CVP and SWP Reservoirs	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir. Reduced potential at San Luis Reservoir and reservoirs that store CVP and SWP water in San Francisco Bay Area, Central Coast, and Southern California regions.	No change.	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir. Reduced potential at San Luis Reservoir and reservoirs that store CVP and SWP water in San Francisco Bay Area, Central Coast, and Southern California regions.	Similar conditions.	No change.	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir. Reduced potential at San Luis Reservoir and reservoirs that store CVP and SWP water in San Francisco Bay Area, Central Coast, and Southern California regions.
Recreational Economics Related to Striped Bass Fishing in Delta	Similar conditions.	No change.	Similar conditions.	Reduced recreational opportunities and associated economics.	Reduced recreational opportunities and associated economics.	Similar conditions.
Commercial and Sport Ocean Salmon Fishing	Similar conditions.	No change.	Similar conditions.	Reduced commercial and sport ocean salmon fishing and associated economics.	Reduced commercial and sport ocean salmon fishing and associated economics.	Similar conditions.
Indian Trust Assets						
Potential for Disturbance of Indian Trust Assets	No change.	No change.	No change.	No change.	No change.	No change.

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Environmental Justice						
Emissions of Criteria Air Pollutants and Precursors and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants from Diesel Engines at Groundwater Wells	Potential increase in emissions (up to 18%).	No change.	Potential increase in emissions (up to 18%).	Similar conditions.	No change.	Potential increase in emissions (up to 18%).
Potential Exposure to Mercury in Fish in Delta	Increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).	No change.	Increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).	Similar conditions.	No change.	Increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).

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Chapter 4

Approach to Environmental Analysis

This chapter describes the organization of the remaining chapters in the Environmental Impact Statement (EIS). It also defines the scope, extent, and framework of the environmental analysis, including a description of resources areas evaluated and not evaluated.

The resource chapters in this EIS (Chapters 5 through 21) describe the affected environment and the impact analysis for each resource associated with implementation of the No Action Alternative, Second Basis of Comparison, and Alternatives 1 through 5. Potential mitigation measures (if necessary and available) to avoid, reduce, or otherwise minimize potential adverse impacts to the environment due to implementation of Alternatives 1 through 5 as compared to conditions under the No Action Alternative are discussed within each resource section. Potential cumulative effects that would occur with implementation of the alternatives are described in each resource chapter.

4.1 Basis of the Environmental Analysis

The impact analysis is focused on the coordinated long-term operation of the Central Valley Project (CVP) and the State Water Project (SWP). This EIS addresses conditions that would result from the long-term operation of Alternatives 1 through 5 as compared to the long-term conditions that would occur under the No Action Alternative and the Second Basis of Comparison in the Year 2030. This EIS does not address interim changes that would occur between now and 2030.

This EIS does not address the impacts that could occur between now and 2030 due to the construction of projects that are assumed to be implemented under the No Action Alternative, Second Basis of Comparison, and Alternatives 1 through 5. As described in Chapter 3, Description of Alternatives, there are several ongoing projects that are assumed to be implemented in 2030, including facilities that require construction. The 2030 conditions assume the projected long-term conditions for each ongoing project as described in their respective environmental documents. This EIS does not address the construction activities of each ongoing project because those impacts are addressed in separate environmental documents for each project.

Implementation of the No Action Alternative and Alternatives 1, 3, 4, and 5 also could result in construction of facilities (e.g., fish passage facilities around dams or across the Delta under these alternatives). Because, at this time, it is not known if construction will be required to implement these provisions or the nature of future facilities, this EIS does not address the construction activities of the future facilities. Impacts of future facilities will be addressed in separate environmental documents for each project. It is assumed that the provisions in the alternatives, including construction activities, would be implemented in 2030.

4.2 Resources Considered for Environmental Analysis

The resources and issues included in Chapters 5 through 22 were identified through a review of scoping comments and subsequent comments received from agencies and the public during preparation of this EIS, as described in Chapter 3, Description of Alternatives. The resources and issues are described and analyzed in the following chapters of this EIS.

- Chapter 5 – Surface Water Resources and Water Supplies
- Chapter 6 – Surface Water Quality
- Chapter 7 – Groundwater Resources and Groundwater Quality
- Chapter 8 – Energy
- Chapter 9 – Fish and Aquatic Resources
- Chapter 10 – Terrestrial Biological Resources
- Chapter 11 – Geology and Soils Resources
- Chapter 12 – Agricultural Resources
- Chapter 13 – Land Use
- Chapter 14 – Visual Resources
- Chapter 15 – Recreation Resources
- Chapter 16 – Air Quality and Greenhouse Gas Emissions
- Chapter 17 – Cultural Resources
- Chapter 18 – Public Health
- Chapter 19 – Socioeconomics
- Chapter 20 – Indian Trust Assets
- Chapter 21 – Environmental Justice
- Chapter 22 – Other National Environmental Policy Act (NEPA) Considerations
- Chapter 23 – Consultation and Coordination
- Chapter 24 – Distribution of Draft EIS
- Chapter 25 – List of Preparers
- Chapter 26 – Index

As described above, this EIS only addresses long-term operational impacts. It is assumed that the coordinated long-term operation of the CVP and SWP would not result in substantial impacts to transportation, noise, hazards and hazardous materials, infrastructure related to public services and utilities, and paleontological resources because there would not be ongoing construction activities and the operation and maintenance activities would be similar to conditions under the No Action Alternative or the Second Basis of Comparison.

Scoping comments were received related to potential impacts to transportation on highways and airports due to dust generated from noncultivated agricultural lands. The potential for changes in dust generation is addressed in Chapter 16, Air Quality and Greenhouse Gas Emissions; based upon the impact assessment, it does not appear that the amount of noncultivated land would change substantially between the alternatives and result in substantial change in dust generation.

It is recognized that the ability to fund some public services and utilities could be affected through implementation of the alternatives evaluated in this EIS. These potential changes related to water supply costs are addressed in Chapter 19, Socioeconomics.

Chapter 23 includes a discussion of comments received during scoping and meetings that were held throughout preparation of the EIS with stakeholders. Chapter 24 includes a list of recipients of this Draft EIS. Chapter 25 includes a list of preparers of this Draft EIS.

4.3 Methodology for the Environmental Analysis

This EIS assesses the potential impacts of changes that could result on the resources identified above from implementation of each of the alternatives as compared to the No Action Alternative and the Second Basis of Comparison. The impact analysis includes an evaluation of potential direct, indirect, and cumulative effects by resource.

4.3.1 Geographic Range of Analysis

The project area that could be affected varies by resource. As described in Chapter 1, Introduction, the project area includes most of the CVP facilities and CVP service areas, and all of the SWP facilities and the SWP service areas. For the analysis purposes, the project area was divided into five regions, as shown in Figure 4.1 at the end of this chapter. The geographic extent for each resource is described by applicable regions in Chapters 5 through 21. The geographic range of the project area encompasses 35 counties. The locations of CVP and SWP water supply facilities, locations of CVP and SWP water users, and areas potentially affected by the long-term coordinated operation of the CVP and SWP, are summarized in Table 4.1.

Table 4.1 Geographic Range of the EIS Analysis

Region	County	Reasons for Inclusion of County in Project Area
Trinity River	Trinity	CVP Facilities: Trinity Lake, and Lewiston and Whiskeytown reservoirs Trinity River downstream of Lewiston Dam
	Humboldt	Trinity River to confluence of lower Klamath River Lower Klamath River from Trinity County border to Del Norte County border
	Del Norte	Lower Klamath River from Humboldt County border to Pacific Ocean
Central Valley	Shasta	CVP Facilities: Shasta Lake and Keswick Reservoir Sacramento River downstream of Keswick Dam to Tehama County border
		CVP Water Users: Anderson-Cottonwood Irrigation District Bella Vista Water District Centerville Community Services District City of Redding City of Shasta Lake Clear Creek Community Services District Mountain Gate Community Services District Redding Rancheria Tribe Shasta Community Services District Shasta County Service Area No. 25 Shasta County Water Agency U.S. Forest Service Multiple Contracts with Individuals and Businesses
	Plumas	SWP Facilities: Antelope Lake, Lake Davis, and Frenchman Lake
		SWP Water Users: Plumas County Flood Control and Water Conservation District
	Tehama	CVP Facilities: Portion of the Tehama Colusa Canal and Corning Canal Sacramento River within Tehama County
		CVP Water Users: Corning Water District Kirkwood Water District Thomes Creek Water District Proberta Water District Lake California Property Owners Association Multiple Contracts with Individuals and Businesses

Region	County	Reasons for Inclusion of County in Project Area
Central Valley (continued)	Glenn	CVP Facilities: Portion of the Tehama Colusa Canal Sacramento River within Glenn County
		CVP Water Users: 4-E Water District Elk Creek Community Services District Glenn-Colusa Irrigation District Glide Water District Kanawha Water District Orland-Artois Water District Provident Irrigation District Stony Creek Water District U.S. Forest Service Portion of Sacramento National Wildlife Refuge
	Colusa	CVP Facilities: Portion of the Tehama Colusa Canal Sacramento River within Colusa County
		CVP Water Users: 4-M Water District Cachil Dehe Band of Wintu Indians of the Colusa Indian Community Carter Mutual Water Company Colusa County Water District Colusa Drain Mutual Water Company Cortina Water District County of Colusa County of Colusa (Stonyford) Davis Water District Glenn Valley Water District Holthouse Water District La Grande Water District Maxwell Irrigation District Myers-Marsh Mutual Water Company Princeton-Codora-Glenn Irrigation District Reclamation District No. 1004 Reclamation District No. 108 Roberts Ditch Irrigation Company Sartain Mutual Water Company Westside Water District Colusa National Wildlife Refuge Delevan National Wildlife Refuge Portion of Sacramento National Wildlife Refuge Multiple Contracts with Individuals and Businesses
	Butte	SWP Facilities: Lake Oroville and Thermalito Reservoir Sacramento River within Butte County
		CVP Water User: Gray Lodge Wildlife Area
		SWP Water User: Butte County Water and Resources Conservation District

Region	County	Reasons for Inclusion of County in Project Area
Central Valley (continued)	Sutter	Sacramento River within Sutter County
		CVP Water Users: Feather Water District Meridian Farms Water Company Natomas Basin Conservancy Pleasant Grove Verona Mutual Water Company Sutter Mutual Water Company Tisdale Irrigation and Drainage Company Sutter National Wildlife Refuge
		SWP Water Users: City of Yuba City
	Yuba	Sacramento River within Yuba County
		Water Supplies from Yuba County Water Agency are available to CVP and SWP
	Nevada	Water Supplies from Nevada County flow in the Bear River into CVP facilities on the American River
	Placer	CVP Water Facilities: Portion of Folsom Lake
		CVP Water Users: Placer County Water Agency City of Roseville San Juan Water District
	El Dorado	CVP Water Facilities: Portion of Folsom Lake
		CVP Water Users: El Dorado Irrigation District El Dorado County Water Agency
	Sacramento	CVP Water Facilities: Portion of Folsom Lake, Lake Natoma, and Folsom South Canal American River downstream of Nimbus Dam to confluence with Sacramento River Sacramento River and Delta within Sacramento County
		CVP Water Users: City of Folsom City of Sacramento Natomas Central Mutual Water Company Reclamation District No. 1000 Regional Water Authority Sacramento County Sacramento County Water Agency Sacramento Municipal Utility District Sacramento Suburban Water District San Juan Water District Natomas Basin Conservancy

Region	County	Reasons for Inclusion of County in Project Area
Central Valley (continued)	Yolo	CVP Facilities: Portion of the Tehama Colusa Canal Sacramento River and Delta within Yolo County Yolo Bypass
		CVP Water Users: City of West Sacramento Conaway Preservation Group Dunnigan Water District Eastside Mutual Water Company Pelger Mutual Water Company Reclamation District No. 900 Multiple Contracts with Individuals and Businesses
	Solano (included in San Francisco Bay Area Region in some chapters)	SWP Facilities: Portion of the North Bay Aqueduct Sacramento River and Delta within Solano County Yolo Bypass
		SWP Water Users: Solano County Water Agency
	Stanislaus	CVP Facilities: New Melones Reservoir and portion of the Delta Mendota Canal Stanislaus River downstream of New Melones Dam to confluence with San Joaquin River San Joaquin River within Stanislaus County
		SWP Facilities: Portion of the California Aqueduct
		CVP Water Users: Del Puerto Water District Oakdale Irrigation District Patterson Irrigation District West Stanislaus Irrigation District Portion of San Luis National Wildlife Refuge
		SWP Water Users: Oak Flat Water District
	Merced	CVP Facilities: San Luis and O'Neill reservoirs, portions of Delta-Mendota Canal and San Luis Canal San Joaquin River within Merced County
		SWP Facilities: San Luis and O'Neill reservoirs and portion of California Aqueduct

Region	County	Reasons for Inclusion of County in Project Area
Central Valley (continued)	Merced (continued)	CVP Water Users: Centinella Water District Central California Irrigation District City of Dos Palos Del Puerto Water District Eagle Field Water District Grasslands Water District Laguna Water District Oro Loma Water District San Luis Canal Company San Luis Water District Turner Island Water District U.S. Department of Veterans Affairs, San Joaquin Valley National Cemetery Widren Water District Merced National Wildlife Refuge Portion of San Luis National Wildlife Refuge Kesterson National Wildlife Refuge Los Banos and Volta Wildlife Areas, Grasslands Resources Conservation District
	Madera	CVP Facilities: Madera Canal
	San Joaquin	San Joaquin River and Delta within San Joaquin County
		CVP Water Users: Banta-Carbona Irrigation District Byron-Bethany Irrigation District Central San Joaquin Water Conservation District City of Tracy Del Puerto Water District South San Joaquin Irrigation District Stockton-East Water District The West Side Irrigation District West Stanislaus Irrigation District
	Fresno	CVP Facilities: Portions of Delta-Mendota Canal and San Luis Canal, Friant Dam and Millerton Lake San Joaquin River within Fresno County

Region	County	Reasons for Inclusion of County in Project Area
Central Valley (continued)	Fresno (continued)	CVP Water Users: Broadview Water District California Department of Fish and Wildlife Central California Irrigation District City of Avenal City of Coalinga City of Huron Coelho Family Trust Columbia Canal Company County of Fresno Eagle Field Water District Firebaugh Canal Company Fresno Slough Water District Hills Valley Irrigation District James Irrigation District Laguna Irrigation District Mercy Springs Water District Meyers Farm Pacheco Water District Panoche Water District Pleasant Valley Water District Reclamation District No. 1606 San Luis Water District Tranquility Irrigation District Tranquility Public Utility District Tri-Valley Water District Westlands Water District Widren Water District
		SWP Water Users: Dudley Ridge Water District
	Kings	SWP Facilities: Portion of the California Aqueduct
		CVP Water Users: Angiola Water District Atwell Island City of Avenal
		SWP Water Users: County of Kings Empire West Side Irrigation District Tulare Lake Basin Water Storage District
	Tulare	CVP Water Users: County of Tulare Tranquility Public Utility District Pixley National Wildlife Refuge
	Kern	CVP Facilities: Cross Valley Canal and portion of the California Aqueduct
		SWP Facilities: Portion of the California Aqueduct

Region	County	Reasons for Inclusion of County in Project Area
Central Valley (continued)	Kern (continued)	CVP Water Users: Kern National Wildlife Refuge Kern Tulare Water District Pixley Irrigation District
		SWP Water Users: Kern County Water Agency
San Francisco Bay Area	Alameda	CVP Facilities: Jones Pumping Plant and northern reaches of Delta-Mendota Canal
		SWP Facilities: Banks Pumping Plant, Bethany Reservoir, Lake Del Valle, and portions of the South Bay Aqueduct and California Aqueduct
		CVP Water Users: East Bay Municipal Utility District
		SWP Water Users: Alameda County Water District Zone 7 Water Agency
	Contra Costa	CVP Facilities: Contra Costa Pumping Plant, Contra Loma Reservoir, and Contra Costa Canal Delta within Contra Costa County
		SWP Facilities: Clifton Court Forebay
		CVP Water Users: Byron-Bethany Irrigation District Contra Costa Water District
	Santa Clara	CVP Facilities: Santa Clara Conduit
		SWP Facilities: Portion of the South Bay Aqueduct
		CVP and SWP Water Users: Santa Clara Valley Water District
	San Benito	CVP Water Facilities: Pacheco Conduit, San Justo Reservoir, and Hollister Conduit
		CVP Water Users: San Benito County Water District
	Napa	SWP Facilities: Portion of the North Bay Aqueduct
		SWP Water Users: County of Napa
Central Coast	San Luis Obispo	SWP Facilities: Portion of Coastal Branch Aqueduct
		SWP Water Users: Central Coast Water Authority San Luis Obispo County Flood Control and Water Conservation District

Region	County	Reasons for Inclusion of County in Project Area
Central Coast (continued)	Santa Barbara	SWP Facilities: Portion of Coastal Branch Aqueduct
		SWP Water Users: Central Coast Water Authority Santa Barbara County Flood Control and Water Conservation District
Southern California	Ventura	SWP Water Users: Ventura County Watershed Protection District
	Los Angeles	SWP Facilities: Portion of California Aqueduct
		SWP Water Users: Antelope Valley-East Kern Water Agency Castaic Lake Water Agency Littlerock Creek Irrigation District Metropolitan Water District of Southern California Palmdale Water District San Gabriel Valley Municipal Water District
	Orange	SWP Water Users: Metropolitan Water District of Southern California
	San Diego	SWP Water Users: Metropolitan Water District of Southern California
	Riverside	SWP Facilities: Portion of California Aqueduct
		SWP Water Users: Desert Water Agency Coachella Valley Water District Metropolitan Water District of Southern California San Gorgonio Pass Water Agency
	San Bernardino	SWP Facilities: Portion of California Aqueduct
		SWP Water Users: Crestline Lake Arrowhead Water Agency Metropolitan Water District of Southern California Mojave Water Agency San Bernardino Valley Municipal Water District

4.3.2 Regulatory Environment and Compliance Requirements

Potential actions that could be implemented under the alternatives evaluated in this EIS that are located on Federal or state lands, or actions that are implemented, funded, or approved by Federal and state agencies, need to be compliant with appropriate Federal and state agency policies and regulations. Federal and state policies and regulations that could be relevant to implementation of the alternatives evaluated in this EIS are summarized in Appendix 4A.

4.3.3 Affected Environment

The Affected Environment portions of Chapters 5 through 21 provide an adequate level of detail for the quantitative and qualitative impact analyses presented in this EIS. Changes in CVP and SWP operations could result in changes to:

- Water elevations in reservoirs that store CVP and SWP water supplies, including reservoirs owned by regional and local water agencies that use CVP and/or SWP water, and associated use of the reservoir or surrounding areas to support biological resources, visual resources, recreation, and cultural resources
- Flow rates and water quality in rivers downstream of CVP and SWP reservoirs, and associated use of the rivers to support biological resources, protection of soils from erosion along the rivers, and recreation
- Flows and water quality in the Delta, including Delta outflow and reverse flows, and associated use of the rivers to support beneficial uses including biological resources and food and water supplies for human consumption
- CVP and SWP deliveries, and associated changes in groundwater use, CVP and SWP energy use and generation, and land use which could affect air quality, human health, soil erosion, and cultural resources.

References are provided for each chapter and not compiled for the entire EIS.

4.3.4 Impact Analysis

In accordance with the Council on Environmental Quality regulations, an EIS must evaluate the effects of implementation of the alternatives on the environment, any adverse environmental effects which cannot be avoided, the relationship between short-term uses of the human environment and long-term productivity, and any irreversible or irretrievable commitments of resources if the alternatives are implemented. The impact analyses sections address direct, indirect, and cumulative effects of the alternatives in each resource chapter (Chapters 5 through 21), and are organized in the following manner to describe the approach and present the results of the impact assessment.

- Potential Mechanisms for Change and Analytical Tools
- Conditions in Year 2030 without Implementation of Alternatives 1 through 5
- Evaluation of Alternatives
    - Comparison of the No Action Alternative to the Second Basis of Comparison
    - Comparison of Alternatives 1 through 5 to the No Action Alternative
    - Comparison of Alternatives 1 through 5 to the Second Basis of Comparison
    - Summary of Impact Analysis
    - Potential Mitigation Measures
    - Cumulative Effects Analysis

The impact analysis includes quantitative and qualitative analyses depending upon the availability of acceptable numerical analytical tools and available information. The quantitative analyses include numerous analytical tools, as summarized in Figure 4.2.

An EIS must identify relevant, reasonable mitigation measures that are not already included in the proposed action or alternatives to the proposed action that could avoid, minimize, rectify, reduce, eliminate, or compensate for the project's adverse environmental effects (40 Code of Federal Regulations [CFR] 1502.14, 1502.16, 1508.8). Mitigation measures are presented for each resource to avoid, minimize, rectify, reduce, eliminate, or compensate for adverse environmental effects of Alternatives 1 through 5 as compared to the No Action Alternative. Mitigation measures were not included to address adverse impacts under the alternatives as compared to the Second Basis of Comparison because this analysis was included in this EIS for information purposes only.

The cumulative effects of implementation of reasonably foreseeable projects and the alternatives as compared to conditions under the No Action Alternative and Second Basis of Comparison are discussed for each resource in Chapters 5 through 21. Cumulative effects are impacts on the environment that result from the incremental impacts of an alternative when added to other past, present, and reasonably foreseeable future actions of Federal, state, or local agencies or individual entities or persons (40 CFR 1508.7). Such impacts can result from individually minor, but collectively significant, actions taking place over time (40 CFR 1508.8).

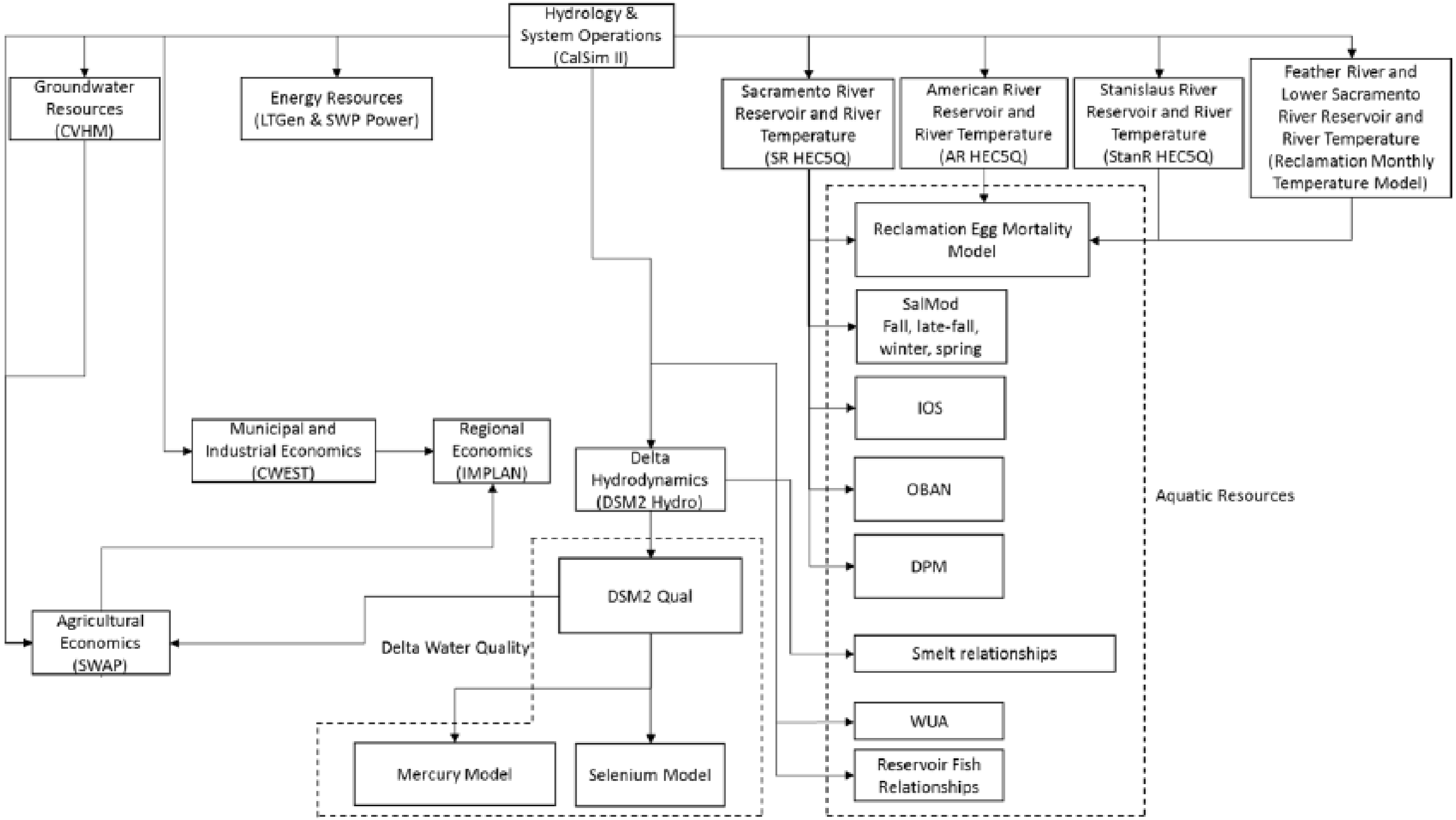
4.3.5 Other NEPA Considerations

The irreversible and irretrievable commitments of resources, and the relationship between short-term uses of the environment and long-term productivity are discussed in Chapter 22, Other NEPA Considerations.

4.3.6 Consultation and Coordination

Public outreach and agency involvement efforts related to preparation of the Draft EIS and Final EIS are presented in Chapter 23, Consultation and Coordination. A listing of the agencies, other entities, and interest groups that received a copy of the Draft EIS and Final EIS is presented in Chapter 24, Distribution of Draft EIS. A list of preparers of the EIS is presented in Chapter 25.

Figure 4.1 Study Area



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2 **Figure 4.2 Analytical Framework Used to Evaluate Impacts of the Alternatives**

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Chapter 5

Surface Water Resources and Water Supplies

5.1 Introduction

This chapter describes the surface water resources and water supplies in the study area and potential changes that could occur as a result of implementing the alternatives evaluated in this Environmental Impact Statement (EIS). Implementation of the alternatives could affect these resources through potential changes in operation of the Central Valley Project (CVP) and State Water Project (SWP) and ecosystem restoration components of the long-term operation of the CVP and SWP.

5.2 Regulatory Environment and Compliance Requirements

Potential actions that could be implemented under the alternatives evaluated in this EIS could affect surface water resources, including rivers and reservoirs directly or indirectly impacted by changes in the operations of the CVP or SWP water facilities and users of CVP and SWP water supplies. Actions located on public agency lands or implemented, funded, or approved by Federal and state agencies would need to be compliant with appropriate Federal and state agency policies and regulations, as summarized in Chapter 4, Approach to Environmental Analysis.

5.3 Affected Environment

This section describes the surface water resources and water supplies that could be potentially affected by the implementation of the alternatives considered in this EIS, including:

- **Surface Water Hydrology:** Changes in surface water hydrology may occur in the rivers within the Trinity River and Central Valley regions due to changes in CVP and SWP operations as some rivers in these regions are used to convey CVP and/or SWP water supplies. Changes in reservoir elevations may occur within the Trinity River, Central Valley, San Francisco Bay Area, Central Coast, and Southern California regions due to changes in CVP and SWP operations. The ongoing CVP and SWP facilities and operations are described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations.

- **Summaries of the Water Supplies used by CVP and SWP Water Users:** The water users which may be affected by changes in CVP and SWP operations are located in the Trinity River, Central Valley, San Francisco Bay Area, Central Coast, and Southern California regions.

5.3.1 Overview of California Water Supply and Water Management Facilities

5.3.1.1 Sources of Water in California

Variability and uncertainty are the dominant characteristics of California's water resources. Precipitation is the source of 97 percent of California's water supply (DWR 2009a). It varies greatly from year to year, as well as by season and location within the state. The unpredictability and geographic variation in precipitation that California receives make it challenging to manage the available runoff to meet urban, agricultural, and environmental water needs. With climate change, precipitation patterns are expected to become even more unpredictable, as described in Appendix 5A, CalSim II and DSM2 Modeling.

In an average water year, precipitation provides California with approximately 200 million acre-feet (MAF) of water falling as either rain or snow (DWR 2009a), including up to 10 MAF from surface water flows entering California due to precipitation falling in the Klamath River and Lost River watersheds in Oregon; and the Colorado River watershed in Wyoming, Colorado, Utah, Nevada, New Mexico, and Arizona, and northwestern Mexico. The total volume of water the state receives can vary dramatically between dry and wet years. California may receive less than 100 MAF of water during a dry year and more than 300 MAF in a wet year (Western Regional Climate Center 2011).

The majority of California's precipitation occurs between November and April, while most of the state's demand for water is in the summer months (Western Regional Climate Center 2011). In addition, most of the precipitation falls in the northern portion of the state and much of the state water demand comes from the central and southern portions of the state where the major agricultural and population centers are located on the Central Valley floor and in Southern California. In some years, the northern regions of the state can receive 100 inches or more of precipitation, while the southern regions receive only a few inches.

Over time, annual precipitation trends have been changing and continue to change, as shown on Figure 5.1. From 1906 to 1960, 33 percent of the water years in California were classified by the California Department of Water Resources (DWR) as "dry" or "critically dry" and that percentage increased to 36 percent from 1961 to 2013 (DWR 2014a). From 1906 to 1960, 45 percent of the water years in California were classified by DWR as "above normal" or "wet" and that percentage increased to 49 percent from 1961 to 2013. Additionally, the 1906 to 1960 period had 42 percent of water years classified as extreme ("critically dry" or "wet") and that percentage increased to 51 percent after 1960.

Although there were more extreme water year classifications in the later period, the overall precipitation averages in pre-1960 years and post-1960 years have little differences.

Despite having similar precipitation averages, the year to year variation and patterns of extreme condition occurrences are significantly different between the time periods. The year to year statewide precipitation variation is larger and more frequent from 1961 to 2013 than 1906 to 1960. Also, the occurrence of a year to year change of more than 10 inches of precipitation is 3 times higher in the post-1960 time period as compared to the pre-1960 time period. There are also more occurrences of sequential "critically dry" years and sequential "wet" years after 1960.

Approximately 50 percent of the precipitation that California receives evaporates, is used consumptively by native vegetation and crops (not including irrigation water supplies), is used by managed wetlands, flows into streams within Oregon or Nevada, flows into saline water bodies (such as Salton Sea), or percolates into saline groundwater aquifers (DWR 2013a). Therefore, less than 50 percent of the water that enters California, or less than 100 MAF per year, is available for use by urban, agricultural, and other environmental uses, collectively.

5.3.1.2 Development of Major California Water Management Facilities

Due to the hydrologic variability that ranges from dry summers and fall months to floods in winter and spring, water from precipitation in the winter and spring must be stored for use in the summer and fall. During an average hydrological year, approximately 15 MAF of water is stored in the Sierra Nevada snowpack (DWR 2013a). However, not all of the snowpack becomes available in a timely manner for uses throughout the state. Therefore, Federal, state, and local agencies and private entities have constructed reservoirs, aqueducts, pipelines, and water diversion facilities to capture and use the rainfall and the subsequent snowmelt.

5.3.1.2.1 Water Facilities Development through the Early 1900s

Spanish settlements were initially established in the late 1700s in southern California, including conveyance systems to bring water to the pueblos. The first water storage and diversion project in California was constructed in 1772, including a 12-foot high dam on the San Diego River and 6 miles of canals to deliver water to the San Diego Mission (Reclamation 1997). Over the next 80 years, other irrigation systems were constructed to provide water for communities and irrigated lands. The major levee was constructed in the Delta in 1840 along Grand Island to protect agricultural lands from floods.

After California became a state in 1850, the state legislature adopted English Common Law, which included the doctrine of riparian rights to provide water supplies to lands adjacent to rivers and streams (Reclamation 1997). The California legislature at this time also recognized "pueblo water rights" that were granted under both Spanish and Mexican governments, including water rights on the Los Angeles and San Diego rivers. Water rights also were influenced by the practice of miners of "posting notice" at their points of diversion to substantiate water rights as an “appropriative right” for areas not adjacent to the rivers and streams. This set of appropriative rights was catalogued with respect to “first in time, first in right.” Appropriative water rights were given statutory recognition in 1872.

Between the 1850s and early 1900s, numerous dams and canals were constructed by miners, agricultural water users, and communities (Reclamation 1997). In the 1870s, the first wells were constructed with wood-burning engines. By the late 1890s, natural gas engines and electricity became available to power pumps. Between 1906 and 1910, over 4,000 natural gas or electric groundwater pumps were installed in the San Joaquin Valley. Substantial use of groundwater caused extensive groundwater aquifer depletions and land subsidence in some areas of the Central Valley. The availability of electricity to communities also resulted in more hydroelectric generation facilities and associated dams being constructed throughout the Sierra Nevada.

5.3.1.2.2 Conceptual Development of the Central Valley Project and State Water Project

The need for coordinated water development was evaluated in the 1870s when Congress authorized the Alexander Commission to evaluate water supply concepts in the Sacramento and San Joaquin rivers watersheds, including reservoirs and large-scale irrigation water supply projects (Reclamation 1997).

1919 Marshall Plan

In 1919, Colonel Robert Marshall, chief geographer for the U.S. Geological Survey, proposed a major water storage and conveyance plan to irrigate lands in the Central Valley and San Francisco Bay Area and provide water to communities in the San Francisco Bay Area and southern California (Marshall 1919). The Marshall Plan recommended two major dams on the San Joaquin River near Friant and Stanislaus River between the present locations of Tulloch and Goodwin dams to serve the eastern San Joaquin Valley and reduce groundwater overdraft in Tulare and Kern counties; four dams on Kern River to serve the Los Angeles area; and dams on the Sacramento River near Red Bluff, Klamath River downstream of Klamath Falls, and dams along the Sacramento River tributaries to provide stored water into two canals along the western and eastern sides of the Central Valley to provide exchange water to San Joaquin River water rights holders affected by the San Joaquin River dam, water to other San Joaquin Valley users, and water to communities in Contra Costa, Alameda, Santa Clara, and San Francisco counties.

1930s State Water Plan

During the 1920s, the California state legislature commissioned a series of investigations to further evaluate the Marshall Plan (DPW 1930; Reclamation 1997). The 1930 Division of Water Resources Bulletin No. 25 outlined a statewide water plan, including the concept that became the CVP and SWP. The plan included 37 water supply and flood management reservoirs, including a dam on the San Joaquin River near Friant and canals to distribute the water along the eastern San Joaquin Valley to reduce groundwater overdraft in Tulare and Kern counties; 14 dams along the Trinity River, Sacramento River, and Sacramento River tributaries to provide water to the San Joaquin River water rights contractors affected by the dam on the San Joaquin River and water users on the west side of the San Joaquin Valley and in Contra Costa County; and eight dams on San Joaquin Valley rivers to provide water to the San Joaquin Valley. These dams included recommended facilities near the present CVP Trinity, Shasta, Folsom, New Melones, and Friant dams and the present SWP Oroville Dam. The recommendations also included a Delta Cross Channel canal to improve south Delta water quality; a canal from a south Delta pumping plant to a regulating reservoir and pumping plant near Mendota; canals from Mendota to the San Joaquin Valley; a canal from the Delta into Contra Costa County; and expansion of the San Joaquin River and associated channels with five operable barriers along the San Joaquin River.

The study also addressed use of aquifer storage, improved navigation along the Sacramento and San Joaquin rivers, flood management, salt water barrier along the western Delta, recycled wastewater and stormwater in Southern California, and importation of Colorado River water to Southern California.

In 1933, the state authorized the Central Valley Project Act. However, during the 1930s depression, the state could not raise the funds. The state appealed to the Federal Government for assistance. The overall SWP was approved by the State Legislature in 1941.

As described above, six of the 37 dams in the SWP were included in the CVP and SWP facilities (Reclamation 1997). However, most of the recommended dams were constructed by the U.S. Army Corps of Engineers (USACE), local or regional water supply and/or flood management agencies, and hydropower entities on the Yuba, Bear, Feather, American, Mokelumne, Calaveras, Chowchilla, Fresno, Merced, Tuolumne, Stanislaus, Kings, Kaweah, Tule, and Kern rivers. Dams on the Fresno and Chowchilla rivers were initially developed by the USACE; however, the Hidden and Buchanan dams, respectively, were integrated into the CVP to supply water to portions of the eastern side of the San Joaquin Valley (DPW 1930; Reclamation 1997).

5.3.1.2.3 Overview of the Central Valley Project

With the passage of the Rivers and Harbors Act of 1935, Congress appropriated funds and authorized construction of the CVP by the USACE (Reclamation 1997; Reclamation 2011a). When the Rivers and Harbors Act was reauthorized in 1937, the construction and operation of the CVP was assigned to Reclamation, and the CVP became subject to Reclamation Law (as defined in the Reclamation Act of 1902 and subsequent legislation).

The CVP facilities were initiated in the late 1930s (Reclamation 1997, 2011a). The CVP facilities, as shown on Figure 5.2, include:

- Trinity and Lewiston dams on the Trinity River.
- Shasta and Keswick dams on the Sacramento River.

- Red Bluff Pumping Plant on the Sacramento River to deliver water into the Tehama-Colusa Canal and the Corning Canal.
- Folsom and Nimbus dams on the American River and the Folsom-South Canal.
- Delta Cross Channel in the Delta.
- Rock Slough Intake to deliver water into the Contra Costa Canal, Contra Costa Pumping Plant, and Contra Loma Reservoir.
- Friant Dam along the San Joaquin River to deliver water into the Friant-Kern and Madera.
- C.W. Jones Pumping Plant (Jones Pumping Plant) (previously known as the Tracy Pumping Plant) in the south Delta to deliver water into the Delta-Mendota Canal and Mendota Pool.
- Delta-Mendota Canal/California Aqueduct Intertie downstream of the CVP Jones Pumping Plant and the SWP Banks Pumping Plant.
- San Luis Reservoir-related facilities, including the CVP facilities consisting of the O'Neill Forebay, Pumping Plant, and Canal; Coalinga Canal, Pleasant Valley Pumping Plant, and San Luis Drain. The O'Neill Forebay is operated in coordination with the SWP. The SWP facilities operated in coordination with the CVP include the B.F. Sisk San Luis Dam (the major dam that forms San Luis Reservoir), San Luis Canal, Los Banos and Little Panoche dams, and associated pumping plants.
- Pacheco Tunnel and Conduit to deliver water from the San Luis Reservoir into the San Justo Dam and Reservoir, Hollister Conduit, and Santa Clara Tunnel and Conduit.
- New Melones Dam along the Stanislaus River.

The CVP reservoirs are listed in Table 5.1 and shown on Figures 5.3 through 5.5. Table 5.1 also includes reservoirs of the Bureau of Reclamation Orland Project (which are not part of CVP) because these reservoirs also affect hydrology of Stony Creek, a tributary to the Sacramento River.

Table 5.1 Major Central Valley Project and Orland Project Reservoirs

Project	Reservoir	Dam	Stream	Year Initiated	Capacity (acre-feet)
CVP	Millerton Lake	Friant	San Joaquin River	1942	524,000
CVP	Shasta Lake	Shasta	Sacramento River	1945	4,552,000
CVP	Keswick Reservoir	Keswick	Sacramento River	1950	23,772
CVP	Trinity Lake	Trinity	Trinity River	1962	2,447,650
CVP	Lewiston Reservoir	Lewiston	Trinity River	1963	14,660
CVP	Spring Creek Reservoir	Spring Creek Debris Dam	Spring Creek (tributary of Sacramento River)	1963	5,874
CVP	Whiskeytown Lake	Whiskeytown	Clear Creek (tributary of Sacramento River)	1963	241,100
CVP	Folsom Lake	Folsom	American River	1956	967,000
CVP	Lake Natoma	Nimbus	American River	1955	9,000
CVP	Contra Loma Reservoir	Contra Loma	Off-Stream	1967	2,627
CVP	Martinez Reservoir	Martinez	Wildcat Creek	1938	268
CVP	San Luis Reservoir	B.F. Sisk	San Luis Creek	1967	2,041,000
CVP	O'Neill Forebay	O'Neill	San Luis Creek	1967	56,400
CVP	Los Banos Creek Reservoir	Los Banos Detention	Los Banos Creek	1965	34,600
CVP	Little Panoche Creek Reservoir	Little Panoche Detention	Little Panoche Creek	1966	5,580
CVP	San Justo Reservoir	San Justo	Offstream	1985	10,300
CVP	Funks Reservoir	Funks	Funks Creek	1976	2,460
CVP	New Melones Reservoir	New Melones	Stanislaus River	1979	2,400,000
CVP	Hensley Lake	Hidden	Fresno River	1975	90,000
CVP	H.V. Eastman Lake	Buchanan	Chowchilla River	1975	150,000
Orland	East Park Reservoir	East Park	Little Stony Creek (tributary of Sacramento River)	1910	51,000
Orland	Stony Gorge Reservoir	Stony Gorge	Stony Creek (tributary of Sacramento River)	1928	50,350

Sources: DWR 2014b; Reclamation 1994, 2014a, 2014b.

Note: CVP is Central Valley Project; Orland is Orland Project

Detailed information describing the CVP facilities and operations is presented in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations.

5.3.1.2.4 Overview of the State Water Project

As the CVP facilities were being constructed after World War II, the state began investigations to meet additional water needs through development of the California Water Plan. In 1957, DWR published Bulletin Number 3 that identified new facilities to provide flood control in northern California and water supplies to the San Francisco Bay Area, San Joaquin Valley, San Luis Obispo and Santa Barbara counties in the Central Coast Region, and southern California (DWR 1957, 2012; Reclamation 2011a). The study identified a seasonal deficiency of 2.675 MAF/year in 1950 that resulted in groundwater overdraft throughout many portions of California. The report described facilities to meet the water demands and reduce groundwater overdraft, including facilities that would become part of the SWP.

In 1960, California voters authorized the Burns-Porter Act to construct the initial SWP facilities. The SWP facilities, as shown on Figure 5.2, include:

- Antelope Lake, Lake Davis, and Frenchman Lake on the upper Feather River upstream of Oroville Dam.
- Oroville Dam and Thermalito Diversion Dam on the Feather River.
- Barker Slough Pumping Plant in the north Delta which delivers water to the North Bay Aqueduct.
- Clifton Court Forebay and Harvey O. Banks Pumping Plant (Banks Pumping Plant) in the south Delta, which delivers water into the Bethany Forebay and California Aqueduct.
- South Bay Pumping Plant to deliver water from Bethany Forebay to the South Bay Aqueduct and Lake Del Valle.
- San Luis Reservoir-related facilities, including the SWP facilities B.F. Sisk San Luis Dam (the major dam that forms San Luis Reservoir), San Luis Canal, Los Banos and Little Panoche dams, and associated pumping plants, and the CVP O’Neill Forebay. These facilities are operated in coordination between the SWP and CVP.
- California Aqueduct to deliver water to the San Joaquin Valley, Central Coast, and southern California. The California Aqueduct extends from the Banks Pumping Plant to San Luis Reservoir and continues to Lake Perris in Riverside County. The California Aqueduct reach in southern California also includes Quail Lake, Pyramid Lake, Castaic Lake, Silverwood Lake, Crafton Hills Reservoir, and Lake Perris.
- The Coastal Branch of the California Aqueduct to deliver water from the California Aqueduct to San Luis Obispo and Santa Barbara counties.

Major SWP reservoirs are listed in Table 5.2 and shown on Figures 5.3 through 5.6.

Table 5.2 State Water Project Reservoirs

Reservoir	Dam	Stream	Year Initiated	Capacity (acre-feet)
Frenchman Lake	Frenchman	Little Last Chance Creek (tributary of Feather River)	1961	55,477
Antelope Lake	Antelope	Indian Creek (tributary of Feather River)	1964	22,566
Lake Davis	Grizzly Valley	Big Grizzly Creek (tributary of Feather River)	1966	83,000
Oroville Reservoir	Oroville	Feather River	1968	3,537,577
Thermalito Pool	Thermalito Diversion	Feather River	1967	13,328
Thermalito Forebay	Thermalito Forebay	Cottonwood Creek (tributary of Feather River)	1967	11,768
Thermalito Afterbay	Thermalito Afterbay	Feather River	1967	57,041
Clifton Court Forebay	Clifton Court Forebay	Old River	1970	29,000
Bethany Forebay	Bethany Forebay	Italian Slough	1961	5,250
Patterson Reservoir	Patterson	Offstream	1962	98
Lake Del Valley	Del Valle	Arroyo Valle	1968	77,100
Quail Lake	No dam	Offstream	Historic	5,654
Pyramid Lake	Pyramid	Piru Creek	1973	180,000
Castaic Lake	Castaic	Castaic Creek	1973	323,700
Silverwood Lake	Cedar Springs	Mojave River (West Fork)	1971	78,000
Crafton Hills Reservoir	Crafton Hills	Yucaipa Creek	2001	130
Lake Perris	Perris	Bernasconi Pass	1973	131,452

Sources: DWR 2014b, 2014c.

Detailed information describing the SWP is presented in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations.

5.3.1.2.5 Other Major Water Supply and Flood Management Reservoirs

During the past 100 years, numerous water supply, flood management, and hydroelectric generation reservoirs were constructed throughout California. Many of these projects were constructed on tributaries to the Sacramento and San Joaquin rivers and tributaries to the Tulare Lake Basin. Operations of these non-CVP and non-SWP reservoirs affect flow patterns into the Sacramento and San Joaquin rivers and the Delta. However, implementation of the alternatives evaluated in this EIS would not result in changes in operations in most of these reservoirs, except on the lower Stanislaus River.

Major non-CVP and non-SWP reservoirs in the Sacramento Valley and San Joaquin Valley watersheds, generally with storage capacities greater than 100,000 acre-feet, which could affect operations of CVP or SWP reservoirs or Delta facilities or could be affected by implementation of the alternatives evaluated in this EIS, are listed in Tables 5.3 and 5.4.

Table 5.3 Major Non-Central Valley Project and Non-State Water Project Reservoirs in the Sacramento Valley Watershed Considered in this EIS

Owner	Reservoir	Dam	Stream	Year Initiated	Capacity (acre-feet)
U.S. Army Corps of Engineers	Black Butte Reservoir	Black Butte	Stony Creek (tributary of Sacramento River)	1963	143,700
Yuba County Water Agency	Bullards Bar Reservoir	New Bullards Bar	Yuba River (North Fork)	1970	969,600
U.S. Army Corps of Engineers	Englebright Reservoir	Englebright	Yuba River	1941	70,000
South Sutter Water District	Camp Far West Reservoir	Camp Far West	Bear River	1963	104,500
Pacific Gas & Electric Company	Bucks Lake	Bucks Storage	Bucks Creek (tributary of Feather River)	1928	103,000
Pacific Gas & Electric Company	Lake Almanor	Lake Almanor	Feather River (North Fork)	1927	1,308,000
South Feather Water And Power Agency	Little Grass Valley Reservoir	Little Grass Valley	Feather River (South Fork)	1961	93,010
Pacific Gas & Electric Company	Salt Springs Reservoir	Salt Springs	Mokelumne River (North Fork)	1931	141,900
East Bay Municipal Utility District	Pardee Lake	Pardee	Mokelumne River	1929	209,950
East Bay Municipal Utility District	Camanche Lake	Camanche	Mokelumne River	1963	417,120
Sacramento Municipal Utility District	Union Valley Reservoir	Union Valley	Silver Creek (tributary of American River)	1963	230,000
Placer County Water Agency	French Meadows Reservoir	L. L. Anderson	American River (Middle Fork)	1965	136,400
Placer County Water Agency	Hell Hole Reservoir	Lower Hell Hole	Rubicon River (tributary of American River)	1966	208,400

Sources: DWR 2014b, 2014c.

Table 5.4 Major Non-Central Valley Project and Non-State Water Project Reservoirs in the San Joaquin Valley Watersheds Considered in this EIS

Owner	Reservoir	Dam	Stream	Year Initiated	Capacity (acre-feet)
Southern California Edison Company	Lake Thomas A. Edison	Vermilion Valley	Mono Creek (tributary of San Joaquin River)	1954	125,000
Southern California Edison Company	Shaver Lake	Shaver Lake	Stevenson Creek (tributary of San Joaquin River)	1927	135,283
Merced Irrigation Dist	Lake McClure	New Exchequer	Merced River	1967	1,032,000
San Francisco Public Utilities Commission	Cherry Lake	Cherry Valley	Cherry Creek (tributary of Tuolumne River)	1956	273,500
San Francisco Public Utilities Commission	Hetch Hetchy Reservoir	O' Shaughnessy	Tuolumne River	1923	360,000
Turlock Irrigation District	New Don Pedro Reservoir	New Don Pedro	Tuolumne River	1971	2,030,000
Calaveras County Water District	New Spicer Meadow Reservoir	New Spicer Meadow	Highland Creek (tributary of Stanislaus River)	1989	190,000
Tri-Dam Project	Donnells Reservoir	Donnells	Stanislaus River (Middle Fork)	1958	56,893
Tri-Dam Project	Beardsley Reservoir	Beardsley	Stanislaus River (Middle Fork)	1957	77,600
Tri-Dam Project	Tulloch Reservoir	Tulloch	Stanislaus River	1958	68,400
Oakdale Irrigation District and South San Joaquin Irrigation District	Goodwin Diversion	Goodwin	Stanislaus River	1912	500
South San Joaquin Irrigation District	Woodward Reservoir	Woodward	Simmons Creek (tributary of Stanislaus River)	1918	35,000
U.S. Army Corps of Engineers	New Hogan Lake	New Hogan	Calaveras River	1963	317,000

Sources: DWR 2014b, 2014c.

Major reservoirs used to store CVP and SWP water supplies in the San Francisco Bay Area, Central Coast, and Southern California regions are shown on Figures 5.5 and 5.6 and listed in Tables 5.5, 5.6, and 5.7.

Table 5.5 Major Non-Central Valley Project and Non-State Water Project Reservoirs in the San Francisco Bay Area Region Used to Store Central Valley Project and/or State Water Project Water

Owner	Reservoir	Dam	Stream	Year Initiated	Capacity (acre-feet)
Contra Costa Water District	Los Vaqueros Reservoir	Los Vaqueros	Kellogg Creek	1997	160,000
East Bay Municipal Utility District	Briones Reservoir	Briones	Bear Creek	1964	67,520
East Bay Municipal Utility District	San Pablo Reservoir	San Pablo	Bear Creek	1964	38,600
East Bay Municipal Utility District	Lafayette Reservoir	Lafayette	Marsh Creek	1963	4,250
East Bay Municipal Utility District	Upper San Leandro Reservoir	Upper San Leandro	San Leandro Creek	1977	37,960
East Bay Municipal Utility District	Chabot Reservoir	Chabot	San Leandro Creek	1892	10,281

Sources: DWR 2014b, 2014c; East Bay Municipal Utility District (EBMUD) 2011; City and County of San Francisco (CCSF) 2009; Santa Clara Valley Water District (SCVWD) 2011.

Note:

a. Anderson Reservoir capacity is restricted due to California Department of Safety and Dams (SCVWD 2011).

Table 5.6 Major Non-Central Valley Project and Non-State Water Project Reservoirs in the Central Coast Region Used to Store State Water Project Water

Owner	Reservoir	Dam	Stream	Year Initiated	Capacity (acre-feet)
Bureau of Reclamation	Cachuma Lake	Bradbury	Santa Ynez River	1953	205,000

Sources: DWR 2014b; Reclamation 2014c.

Table 5.7 Major Non-Central Valley Project and Non-State Water Project Reservoirs in the Southern California Region Used to Store State Water Project Water

Owner	Reservoir	Dam	Stream	Year Initiated	Capacity (acre-feet)
United Water Conservation District	Lake Piru	Santa Felicia	Piru Creek	1955	100,000
Metropolitan Water District Of Southern California	Diamond Valley Lake	Diamond Valley Lake	Domenigoni Valley Creek	2000	800,000
Metropolitan Water District Of Southern California	Lake Skinner	Robert A Skinner	Tucalota Creek	1973	43,800
Rancho California Water District	Vail Lake	Vail	Temecula Creek	1949	51,000
City of Escondido	Dixon Lake	Dixon	Escondido Creek	1970	2,500
San Diego County Water Authority	Olivenhain Reservoir	Olivenhain	Escondido Creek	2003	24,900
City of San Diego	Lake Hodges	Lake Hodges	San Dieguito River	1918	37,700
City of San Diego	San Vincente Reservoir	San Vicente	San Vicente Creek	1943	146,994
City of San Diego	El Capitan Reservoir	El Capitan	San Diego River	1934	112,800
Helix Water District	Lake Jennings	Chet Harritt	Quail Canyon Creek	1962	9,790
Sweetwater Authority	Sweetwater Reservoir	Sweetwater	Sweetwater River	1888	27,700
City of San Diego	Murray Reservoir	Murray	Off-stream	1918	4,818
City of San Diego	Morena Reservoir	Morena	Cottonwood Creek	1912	50,694
City of San Diego	Lower Otay Reservoir	Savage	Otay River	1919	49,849

Sources: DWR 2014b, 2014c; City of San Diego 2014a, 2014b, 2014c, 2014d; SDCWA and USACE 2008.

5.3.2 Hydrologic Conditions and Major Surface Water Facilities

This section of Chapter 5 provides an overview of hydrologic conditions in the Trinity River and Central Valley watersheds. As described below, not all of the tributaries and sub-watersheds would be affected by changes in the CVP and SWP operations considered under the alternatives in this EIS.

Changes in surface water hydrology may occur in the rivers within the Trinity River and Central Valley regions due to changes in CVP and SWP operations because some rivers in these regions are used to convey CVP and/or SWP water supplies. Tributaries to the Sacramento and San Joaquin rivers that are not affected by CVP and SWP operations are also discussed briefly in this section to provide an overview of the major streams in the Central Valley watersheds. Available information related to flow conditions between Water Years 2001 and 2012 (October 2000 through September 2012) are provided for reservoirs and rivers that are affected by CVP and/or SWP operations.

In the San Francisco Bay Area, Central Coast, and Southern California regions, the surface water streams generally are not used to convey CVP and SWP water supplies. The streams downstream of reservoirs that store CVP and SWP water supplies generally receive either reservoir overflows in storm conditions or minimum instream flows related to water rights and/or aquatic resources beneficial uses. After the minimum instream flow requirements are fulfilled, the remaining volumes of water are provided to municipal, agricultural, and/or environmental water users. Changes in CVP and SWP water operations will not affect the need to meet minimum instream flows or high flows during storm conditions.

5.3.2.1 Trinity River Region

The Trinity River Region includes the area along the Trinity River from Trinity Lake to the confluence with the Klamath River; and along the lower Klamath River from the confluence with the Trinity River to the Pacific Ocean. The Trinity River Region includes Trinity Lake, Lewiston Reservoir, the Trinity River between Lewiston Reservoir and the confluence with the Klamath River, and along the lower Klamath River.

5.3.2.1.1 Trinity River Watershed

The Trinity River watershed extends over approximately 1,897,600 acres and ranges in elevation from over 9,000 feet above sea level in the headwaters area to less than 300 feet at the confluence of the Trinity River with the Klamath River (California North Coast Regional Water Quality Control Board [NCRWQCB] et al. 2009; U.S. Fish and Wildlife Service [USFWS] et al. 1999). Average precipitation in the Trinity River watershed range from 30 to 70 inches per year, with a long-term average of approximately 62 inches per year. Over 90 percent of the precipitation has historically occurred between October and April. Precipitation ranges from mostly snow at higher elevations to mostly rain near the confluence with the Klamath River.

The Trinity River includes the mainstem, North Fork Trinity River, South Fork Trinity River, New River, and numerous smaller streams (NCRWQCB et al. 2009; USFWS et al. 1999). The mainstem of the Trinity River flows 170 miles to the west from the headwaters to the confluence with the Klamath River. The CVP Trinity and Lewiston dams are located at approximately River Miles 105 and 112, respectively; and upstream of the confluences of the Trinity River and the North Fork, South Fork, and New River. Flows on the North Fork, South Fork, and New River are not affected by CVP facilities. The Trinity River flows approximately 112 miles from Lewiston Dam to the Klamath River through

Trinity and Humboldt counties and the Hoopa Indian Reservation within Trinity and Humboldt counties.

Trinity Lake, a CVP facility on the Trinity River formed by the Trinity Dam, was constructed by 1962. The 2.4-MAF reservoir is located approximately 50 miles northwest of Redding (USFWS et al. 1999). Lewiston Reservoir, a CVP facility on the Trinity River formed by Lewiston Dam, was constructed by 1963 and is located 7 miles downstream of the Trinity Dam. Lewiston Reservoir is used as a regulating reservoir for downstream releases to the Trinity River and to Whiskeytown Lake, located in the adjacent Clear Creek watershed. Water is diverted from the lower outlets in Trinity Lake to Lewiston Reservoir to provide cold water to Trinity River. There are no other major dams in the Trinity River watershed.

Prior to completion of Trinity and Lewiston dams, flows in the Trinity River were highly variable and could range from over 100,000 cubic feet per second (cfs) in the winter and spring to 25 cfs in the summer and fall (USFWS et al. 1999). Total annual flow volume at Lewiston (immediately downstream of the current location of Lewiston Dam) ranged from 0.27 to 2.7 MAF with a long-term average of 1.2 MAF.

A large portion of the Trinity River flows upstream of Trinity Lake and Lewiston Dam is exported to the Sacramento River watershed through CVP facilities. The reduction in flows in the Trinity River initially caused substantial reductions in the Trinity River fish populations (Department of the Interior [DOI] 2000). In response to the reductions in fish populations, Congress enacted legislation and directed that restoration actions be evaluated for the Trinity River. In December 2000, the U.S. Department of the Interior (DOI) adopted the Trinity River Mainstem Fishery Restoration Record of Decision (Trinity River ROD) which restored Trinity River flow and habitat to produce a healthy, functioning alluvial river system. The Trinity River ROD included physical channel rehabilitation; sediment management; watershed restoration; and variable annual instream flow releases from Lewiston Dam based on forecasted hydrology for the Trinity River Basin as of April 1st each year that range from 368,600 acre-feet/year in critically dry years to 815,000 acre-feet/year in extremely wet years. The Trinity River ROD was challenged in United States District Court for the Eastern District of California (District Court); and the changes in operations related to flow were not allowed to proceed while supplemental environmental documentation was prepared and reviewed (NCRWQCB et al. 2009). In 2004, the United States Court of Appeals for the Ninth Circuit entered an opinion that reversed the District Court order; and all actions in the Trinity River ROD were mandated. The flow actions were not completely implemented until several infrastructure projects in the Trinity River channel were completed to protect areas from flood damage.

Additional water releases periodically occur into the Trinity River as part of flood control operations and to provide other flow releases (NCRWQCB et al. 2009; Reclamation 2011a). Although flood control is not an authorized purpose of the Trinity River Division, flood control benefits are provided through normal operations. The Reclamation Safety of Dams release criteria generally provide for maximum storage in Trinity Lake of 2.1 between November and March. Initial flood releases are discharged from Trinity Lake into Lewiston Reservoir, and then, through the powerplant and into Whiskeytown Lake in the Clear Creek watershed. To reduce the potential for flooding on the Trinity River, releases into Trinity River generally are less than 11,000 cfs from Lewiston Dam (under Safety of Dams criteria) due to local high water concerns in the floodplain and local bridge flow capacities. Reclamation has periodically released water from Lewiston Dam into the Trinity River to improve late summer flow conditions to avoid fish die-offs in the lower Klamath River or for tribal requirements along the Trinity River (DOI 2014; Trinity River Restoration Program [TRPP] 2014).

Temperature objectives for the Trinity River are set forth in State Water Resources Control Board (SWRCB) Water Rights Order 90-5, as summarized in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. These objectives vary by reach and by season. Between Lewiston Dam and Douglas City Bridge, the daily average temperature should not exceed 60 degrees Fahrenheit (°F) from July 1 to September 14, and 56°F from September 15 to September 30. From October 1 to December 31, the daily average temperature should not exceed 56°F between Lewiston Dam and the confluence of the North Fork Trinity River.

Historical water storage volumes and water storage elevations for Trinity Lake for Water Years 2001 through 2012 are presented on Figures 5.7 and 5.8 (DWR 2013d, 2013e). Trinity Lake storage varies in accordance with upstream hydrology and downstream water demands and instream flow requirements. Reclamation maintains at least 600 TAF in Trinity Reservoir, except during the 10 to 15 percent of the years when Shasta Lake is also drawn down.

Historical water storage volumes and water storage elevations in Lewiston Reservoir for Water Years 2001 through 2012 are presented on Figures 5.9 and 5.10 (DWR 2013g, 2013h). The Lewiston Reservoir water storage volume is more consistent throughout the year because this reservoir is used to regulate flow releases to the powerplant and other downstream uses; and not to provide long-term water storage.

Trinity River flows downstream of Lewiston Reservoir at Douglas City are presented on Figure 5.11 (DWR 2013i). The flow record is limited at the Douglas City gauge to 2003 through 2012. The mean monthly flows reflect the wet year pattern in 2006 and the drier year patterns in 2008 and 2009.

5.3.2.1.2 Lower Klamath River from Trinity River Confluence to the Pacific Ocean

The Klamath River watershed extends over 15,600 square miles from southern Oregon to northern California, and ranges in elevation from over 9,500 feet above sea level near the headwaters to sea level at the Pacific Ocean (USFWS et al. 1999). The Klamath River watershed is generally divided into two or three subbasins. For the purpose of this study, the upper Klamath River basin extends over 60 miles from the headwaters to Iron Gate Dam (DOI and DFG 2012).

The lower Klamath River basin extends 190 miles from Iron Gate Dam to the Pacific Ocean. Four major tributaries flow into the lower Klamath River, including Shasta, Scott, Salmon, and Trinity rivers. The lower Klamath River flows 43.5 miles from the confluence with the Trinity River to the Pacific Ocean (USFWS et al. 1999). Downstream of the Trinity River confluence, the Klamath River flows through Humboldt and Del Norte counties and through the Hoopa Indian Reservation, Yurok Indian Reservation, and Resighini Indian Reservation within Humboldt and Del Norte counties (DOI and Department of Fish and Game [now known as Department of Fish and Wildlife] DFG 2012).

The Trinity River is the largest tributary to the Klamath River (DOI and DFG 2012). There are no dams located in the Klamath River watershed downstream of the confluence with the Trinity River. The western portion of the Klamath River watershed receives substantial rainfall during the winter months. Average precipitation in the western portion of the watershed ranges from 60 to 125 inches per year (DWR 2013a). Due to the heavy precipitation and the upstream water supply projects in the Klamath River, approximately 85 percent of the flows in the lower Klamath River occur due to runoff in the lower watershed during the winter months (DOI and DFG 2012).

The Klamath River estuary extends from approximately 5 miles upstream of the Pacific Ocean (DOI and DFG 2012). This area is generally under tidal effects and salt water can occur up to 4 miles from the coastline during high tides in summer and fall when Klamath River flows are low. Klamath River flows at Klamath within the Klamath River estuary are affected by tidal influence within the estuary, as presented on Figure 5.12 (DWR 2014d).

5.3.2.2 Central Valley Region

The Central Valley Region extends from above Shasta Lake to the Tehachapi Mountains, and includes the Sacramento Valley, San Joaquin Valley, Delta, and Suisun Marsh.

5.3.2.2.1 Sacramento Valley

Rivers in the Sacramento Valley that could be affected by changes in CVP and SWP operations include the following:

- Clear Creek from Whiskeytown Reservoirs to the confluence with the Sacramento River
- Sacramento River from Shasta Lake to the confluence with the San Joaquin River in the Delta
- Feather River from upstream of Oroville Reservoir to the confluence with the Sacramento River
- Yuba River from New Bullards Bar Reservoir to the confluence with the Feather River
- Bear River from Camp Far West Reservoir to the confluence with the Feather River

- American River from Folsom Lake to the confluence with the Sacramento River

Flows from smaller tributaries to the Sacramento River and the Cosumnes and Mokelumne rivers in the Sacramento Valley contribute substantial flows into the Sacramento River and affect CVP and SWP operations; however, flows in these rivers would not be affected by changes in CVP and SWP operations. Therefore, hydrologic conditions on these waterbodies are not described in this EIS.

The Sacramento River watershed encompasses an area over 15,360,000 acres in the northern portion of the Central Valley; extends from the foothills of the Coast Ranges and Klamath Mountains on the west; extends from the foothills of the Sierra Nevada and Cascade Range on the east; and extends through the Delta on the south (Reclamation 2013a).

Ground surface elevations in the northern portion of the Sacramento River watershed range from approximately 14,000 feet above mean sea level in the headwaters of the Sacramento River to approximately 1,070 feet at Shasta Lake (Reclamation 2013a). In the mountains surrounding the valley, annual average precipitation generally ranges between 60 and 70 inches up to 90 inches, with snow prevalent at higher elevations. The floor of the Sacramento Valley is relatively flat, with elevations ranging from approximately 60 to 300 feet above mean sea level. This area is characterized by hot dry summers and mild winters. Average precipitation ranges from 15 to 20 inches per year, falling mostly as rain.

The Sacramento River flows approximately 351 miles from the north near Mount Shasta to the confluence with the San Joaquin River at Collinsville in the western Delta (Reclamation 2013a). The Sacramento River receives contributing flows from numerous major and minor streams and rivers that drain the east and west sides of the basin. The Sacramento River also receives imported flows from the Trinity River watershed, as discussed above. The volume of flow increases as the river progresses southward, and is increased considerably by the contribution of flows from the Feather River and the American River.

Upper Sacramento River Watershed Hydrology

The portion of the watershed upstream of Keswick Dam includes the McCloud River, Pit River, Squaw Creek, headwaters of the Sacramento River, and Goose Lake basins. The Goose Lake basin is located within the Pit River watershed; however, water rarely spills from Goose Lake into the Pit River. The last recorded spill occurred in 1880 (Reclamation 2013a). Long-term average annual inflows into Shasta Lake are approximately 4.875 MAF between the mid-1940s and 2010.

The McCloud River watershed extends over approximately 402,000 acres (Reclamation 2013a). The McCloud River flows approximately 59 miles from the headwaters in Moosehead Creek located southeast of Mount Shasta, through McCloud Reservoir, and into Shasta Lake. McCloud Reservoir is operated primarily to generate hydroelectric power.

The Pit River watershed extends over approximately 3,008,000 acres along the north and south forks of the Pit River basins, and includes 21 named tributaries and numerous smaller tributaries (Reclamation 2013a). Pacific Gas and Electric Company operate several hydropower diversions and reservoirs within the Pit River watershed.

The Squaw Creek watershed extends over approximately 66,000 acres located to the east of Shasta Lake (Reclamation 2013a).

The Sacramento River extends approximately 40 miles from the headwaters to Shasta Lake downstream of the town of Delta (Reclamation 2013a). The basin extends into portions of Mount Shasta and the Trinity and Klamath mountains.

Hydrological conditions in these upper watersheds would not be affected by implementation of the alternatives considered in this EIS.

Whiskeytown Lake

Whiskeytown Lake is located within the Clear Creek watershed. The Clear Creek watershed is 238 square miles that extends from the Trinity Mountains to the confluence with the Sacramento River downstream of the City of Redding (DWR 1986 and Western Shasta Resource Conservation District [WSRCD] 2004). Hydrology in the watershed is divided into the upper 238-square mile watershed upstream of Whiskeytown Dam at River Mile 18.1, and the lower 49 square miles watershed downstream of the dam. Clear Creek flows approximately 17 miles from the Trinity Mountains into Whiskeytown Lake. Clear Creek continues for 18.1 miles downstream of Whiskeytown Lake into the Sacramento River downstream of the CVP Keswick Dam and south of the City of Redding.

Whiskeytown Dam, a CVP facility constructed by 1963, is the only dam on Clear Creek and is located approximately 16.5 miles downstream of the headwaters (Reclamation 1997). Whiskeytown Lake, which is formed by the dam, has a storage capacity of 0.241 MAF; and regulates runoff from Clear Creek and diversions from the Trinity River watershed, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. Flows from Lewiston Reservoir in the Trinity River watershed are diverted to Whiskeytown Lake through the Clear Creek Tunnel. Currently, the Clear Creek Tunnel between Lewiston Reservoir and Whiskeytown Lake has a capacity of 3,200 cfs (Reclamation 2011b).

Water from Whiskeytown Lake is released to the Sacramento River through the Spring Creek Tunnel which conveys water to the Spring Creek Conduit, and then to Keswick Reservoir. Water from Whiskeytown Lake also is released into Clear Creek directly from Whiskeytown Lake; or during high flow conditions (e.g., flood flows), from a Glory Hole within Whiskeytown Lake through a conduit into Clear Creek. Most of the flows are released through the Spring Creek Tunnel and Powerplant to Keswick Reservoir. These flows into Keswick Reservoir provide cold water flows that reduce temperatures in the upper Sacramento River, especially during the fall months. Water also is discharged from Whiskeytown Lake to Clear Creek to provide for instream flows and water for users located in the CVP Clear Creek South Unit within, or adjacent to, the Clear Creek watershed.

The capacity of the outlet from Whiskeytown Dam that conveys water to Clear Creek is 1,240 cfs when the water elevation in Whiskeytown Lake is at 1,220.5 feet. To provide flows into Clear Creek in excess of 1,240 cfs, the Whiskeytown Reservoir water elevations need to be raised higher than 1,220 feet to allow water to flow through the Glory Hole spillway, as described below (CALFED 2004; Reclamation 2009a).

Historical water storage volume and water storage elevations related to Whiskeytown Lake for Water Years 2001 through 2012 are presented on Figures 5.13 and 5.14 (DWR 2013j, 2013k, 2013l). Whiskeytown Lake storage is relatively constant due to agreements between Reclamation and the National Park Service to maintain certain winter and summer lake elevations for recreation. Whiskeytown Lake outflow variations were greater prior to 2006 when Trinity River restoration flows were implemented which reduced the amount of water available for conveyance to CVP water users. In addition, hydrologic conditions in the years following 2006 were drier than the water years between 2001 and 2006.

Implementation of 2009 National Marine Fisheries Service Biological Opinion

In accordance with the 2009 National Marine Fisheries Service (NMFS) Biological Opinion (BO) Reasonable and Prudent Alternative (RPA), Reclamation is required to manage Whiskeytown Lake releases to meet daily water temperatures in Clear Creek at Igo, as discussed in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations.

Clear Creek

Substantial modifications of the Clear Creek stream channel occurred due to placer mining activities from the mid-1800s through the early 1900s. In addition, several irrigation diversions were constructed along the lower Clear Creek reach during the late 1800s and early 1900s. One of the largest diversions was the 15-foot-high, 200-foot-wide McCormick-Saeltzer Dam constructed in 1903 at River Mile 6.5 (approximately 12 miles downstream of Whiskeytown Dam). The downstream of Whiskeytown Dam was constructed upstream of a steep gorge along Clear Creek and removed in 2001. More recent channel modifications occurred in the lower Clear Creek due to gravel extraction activities from the 1950s to 1970s.

Construction of Whiskeytown Dam modified the hydraulics, gravel loading, and sediment transport in the lower Clear Creek. The overall average annual flow in the lower Clear Creek was reduced by 87 percent following construction of the dam (DWR 1984, 1986). The dam also reduced gravel loading into the lower Clear Creek and the frequency of high flow events that move the gravel and remove fine sediments from riffles. This change in hydrology and loss of gravel loading adversely affected the salmonid habitat downstream of Whiskeytown Dam, including compaction of riffles with sand. Recently, minimum flow releases from Whiskeytown Lake into Clear Creek occur in accordance with Federal and state requirements (DWR 1984), as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. Historical flow data has been collected since 1941 at the Igo Gage at River Mile 10.9 (approximately 7.2 miles downstream of Whiskeytown Dam) (DWR 1986 and WSRCD 2004).

Since the early 1980s, numerous studies were conducted to evaluate methods to rehabilitate and/or restore habitat along lower Clear Creek. In the 1990s, additional studies were conducted following the adoption of the 1992 Central Valley Project Improvement Act (CVPIA). In 1998, a watershed management plan prepared by the WSRCD evaluated methods to achieve healthy fish populations, diverse biological habitats, recreational opportunities, clean and safe conditions for visitors, and protection of property rights developed by the Lower Clear Creek Coordinated Resource Management and Planning Group of local landowners, stakeholders, and agencies (WSRCD 1998). The recommendations included the following:

- Removal of the McCormick-Saeltzer Dam.
- Inject gravel downstream of Whiskeytown Dam and reconstruct gravel channels below McCormick-Saeltzer Dam to reduce stranding.
- Modify water release patterns from Whiskeytown Dam.
- Reduce exotic vegetation along Clear Creek.
- Reduce sands in Clear Creek through erosion control programs in the lower watershed.

This and other studies led to the formation of the Lower Clear Creek Floodway Rehabilitation Project that was implemented under CVPIA (CALFED 2004, WSRCD 2002). Initial actions under this program included gravel augmentation initiated in 1996, increase in Whiskeytown Dam releases initiated in 2001, removal of the McCormick-Saeltzer Dam in 2001, reconstruction and revegetation of the floodway, and reduction of watershed erosion.

Following the removal of the McCormick-Saeltzer Dam, extensive geomorphological studies have been conducted to recommend approaches for restoration of the channel and adjacent floodplain downstream of the McCormick-Saeltzer Dam site. Based upon hydrological data collected at the Igo gage, one of the studies discussed that peak flow events in lower Clear Creek following completion of Whiskeytown Dam occur about once every 3 years; although, the pre-dam frequency was approximately once every 2 years. Clear Creek flows at Igo between 2000 and 2012 are presented on Figure 5.15. During this period, high flow events occurred in April and May of 2003 and December 2005 (DWR 2013s). The high flow events: 1) naturally moved gravel placed downstream of Whiskeytown Dam and along Clear Creek; 2) developed and maintained Clear Creek channel and adjacent floodplain habitat for spring-run and fall-run Chinook Salmon and steelhead; 3) created and maintained deep pools in the channel to support spawning of spring-run Chinook Salmon and steelhead, and create appropriate salmonid habitat within and along Clear Creek; and 4) established and maintained nesting and foraging habitat for neotropical migrant birds, native resident birds, and amphibians.

Following removal of McCormick-Saeltzer Dam, the Clear Creek channel and adjacent floodplain geomorphology changed. The Clear Creek channel capacity is generally about 3,000 cfs. The 2004 studies indicated that flows in excess of 3,000 cfs are required to overflow from the Clear Creek channel onto the adjacent floodplains. The study discussed that during pre- and post-Whiskeytown periods, the 5-year flood event at Igo decreased from 9,000 to 3,400 cfs and the 2.5-year flood event decreased from 6,200 to 1,800 cfs. Therefore, the study discussed that flows in excess of 5,000 cfs did not occur more frequently than 3 times in 10 years (CALFED 2004).

Implementation of 2009 National Marine Fisheries Service Biological Opinion

The 2009 NMFS BO RPA requires Reclamation to release spring attraction flows for adult spring-run Chinook Salmon and channel maintenance flows in Clear Creek and to continue gravel augmentation programs initiated under CVPIA. The spring attraction flows are to be released from Whiskeytown Lake into Clear Creek in at least two pulse flows of at least 600 cfs in May and June.

The channel maintenance flows are to be released at a minimum flow of 3,250 cfs, which is excess of the 1,240 cfs capacity of the Whiskeytown Dam outlet to Clear Creek. Therefore, to provide channel maintenance flows, the Whiskeytown Lake water elevation must be increased to provide flow of water over the Glory Hole inlet. The Glory Hole is designed to operate with the higher water elevations during flood events. However, during non-flood periods, raising the water elevations and operating the Glory Hole inlet can cause safety concerns for recreationists along the Whiskeytown Lake shoreline.

Shasta Lake and Keswick Reservoir

The CVP Shasta and Keswick dams are located at approximately River Miles 308 and 299, respectively, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. Shasta Lake, a CVP facility on the Sacramento River formed by Shasta Dam, is located near Redding. Construction on the 4.552-MAF reservoir was initiated in 1945. Water flows from Shasta Lake along the Sacramento River into the 0.0238 MAF Keswick Reservoir, a CVP facility, which operates as an afterbay, or regulating reservoir, for Shasta Lake hydropower operations. Construction on Keswick Reservoir was initiated in 1950. A temperature control device at Shasta Dam was constructed between 1996 and 1998 to provide cold water without power bypass to the Sacramento River downstream of Keswick Reservoir.

Historical water storage volumes and water storage elevations for Shasta Lake for Water Years 2001 through 2012 are presented on Figures 5.16 and 5.17 (DWR 2013m, 2013n, 2013o). Shasta Lake storage varies in accordance with upstream hydrology and downstream water demands and instream flow requirements. For example, storage declined during the drier years in 2008 and 2009.

Keswick Reservoir receives water from Shasta Lake and Whiskeytown Lake, as described above; and from Spring Creek. Flows on Spring Creek are partially regulated by the CVP Spring Creek Debris Dam (Reclamation 2014d, 2014e). The debris dam minimizes the potential for debris entering the Spring Creek Powerplant, which is located at the discharge end of the Spring Creek Conduit immediately upstream of Keswick Reservoir. The debris dam also controls contaminated runoff from old mine tailings on upper Spring Creek, which reduces water quality effects on aquatic resources.

The Keswick Reservoir water storage volume is more consistent throughout the year because this reservoir is used to regulate flow releases to the powerplant and other downstream uses and not to provide long-term water storage, as shown on Figures 5.18 and 5.19 (DWR 2013p, 2013q, 2013r).

Implementation of 2009 National Marine Fisheries Service Biological Opinion

The 2009 NMFS BO RPA requires Reclamation meet specific temperature requirements at Balls Ferry, Jelly's Ferry, and Bend Bridge based upon minimum end-of-September storage in Shasta Lake for a specified frequency over 10 years, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. Reclamation also is required to evaluate a monthly Keswick release schedule to address releases in fall and early winter within the range of 7,000 and 3,250 cfs; to be adjusted in consideration of the water year type, Shasta Lake storage, and the need to provide flow releases under the 2009 NMFS BO RPA and to meet other Federal and state water quality requirements in the Delta.

Sacramento River from Keswick Dam to the Delta

Water released from Shasta Dam travels approximately 245 miles over three to four days to the northern Delta boundary near Freeport (Reclamation 2013a). The upper reach of the Sacramento River flows for approximately 60 miles from Keswick Dam to Red Bluff; and the middle reach of the Sacramento River flows approximately 160 miles from Red Bluff to the confluence with the Feather River. The lower reach of the Sacramento River flows for approximately 20 river miles between the confluence with the Feather River and Freeport, immediately downstream of the confluence with the American River.

Moderately high releases (greater than 10,000 cfs) are typically sustained during the major irrigation season of June through September. Flows are released in the fall months from CVP and SWP reservoirs to meet water temperature criteria for winter-run Chinook Salmon spawning and incubation, to provide suitable habitat for spring-run and early returning fall-run Chinook Salmon, provide water supplies to rice farms for rice stubble decomposition, and to provide water for wildlife refuges.

Sacramento River from Keswick Dam to Red Bluff

Reclamation operates the Shasta, Sacramento River, and Trinity River divisions of the CVP to meet (to the extent possible) the provisions of SWRCB Order 90-05. An April 5, 1960 Memorandum of Agreement between Reclamation and

California Department of Fish and Wildlife (CDFW) 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 critically dry years, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. Since October 1981, Keswick Dam has 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 Reclamation and CDFW. This release schedule was included in SWRCB Order 90-05, which maintains a minimum release of 3,250 cfs at Keswick Dam and Red Bluff Pumping Plant from September through the end of February in all water years except critically dry years.

Generally, releases from Keswick Reservoir are implemented to comply with the minimum fishery requirement by October 15 each year and to minimize changes in Keswick releases between October 15 and December 31. Releases may be increased during this period to meet downstream needs such as higher outflows in the Delta to meet water quality requirements, or to meet flood control requirements. Releases from Keswick Dam may be reduced when downstream tributary inflows increase to a level that will meet flow needs. Reclamation attempts to establish a base flow that minimizes release fluctuations to reduce impacts to fisheries and bank erosion from October through December.

The Sacramento River between Keswick Dam and the City of Red Bluff flows through the northern foothills of the Sacramento Valley. Flows are influenced by outflow from Keswick Reservoir and inflows from Clear Creek (described above); and Cow Creek, Bear Creek, Cottonwood Creek, Battle Creek, and Paynes Creek which provide 15 to 20 percent of the flows in this reach as measured at Bend Bridge. There are several moderate major diversions along the Sacramento River upstream of Red Bluff, including the CVP Wintu Pumping Plant to provide water for the Bella Vista Water District, and the Anderson-Cottonwood Irrigation District Diversion. Both of these diversions near Redding provide water to agricultural, municipal, and industrial water users (Reclamation 1997). No major storage or diversion structures have been constructed in the tributary watersheds in this reach of the Sacramento River, although several small diversions for irrigation, domestic use, and hydroelectric power generation are present (Reclamation 1997). Flow patterns on one major tributary in this reach, Battle Creek, are undergoing changes as the Battle Creek Salmon and Steelhead Restoration Project is implemented to restore ecological processes along 42 miles of Battle Creek and 6 miles of tributaries while minimizing reductions to hydroelectric power generation through the decommissioning of five powerplants.

Sacramento River from Red Bluff to the Delta

Between Red Bluff and Colusa, the Sacramento River is a meandering stream, migrating through alluvial deposits between widely spaced levees. From Colusa to the northern boundary of the Delta near Freeport, flows increase due to the addition of the Feather and American rivers flows.

Recent mean daily flows in the Sacramento River at Bend Bridge (near Red Bluff), Vina Bridge (near Tehama), Hamilton City, Wilkins Slough (upstream of the Feather River confluence), Verona (downstream of the Feather River confluence), and Freeport (downstream of the American River Confluence and near the northern boundary of the Delta), are presented on Figures 5.20 through 5.25 (DWR 2013u, 2013v, 2013w, 2013x, 2103y, 2013z). Flows in the Sacramento River generally peak during winter and spring storm events. Upstream of Hamilton City, sharp increases in flow occur during rainfall events, such as events in February 2004, December 2005/January 2006, and January 2010. Downstream of Hamilton City, the high flow events occur over a longer period of time as water flows into the river from the tributaries.

Historically, Reclamation has maintained a minimum flow of 5,000 cfs at Chico Landing to support navigation in accordance with references to Sacramento River Division operations in the River and Harbors Act of 1935 and the Rivers and Harbors Act of 1937. Currently, there is no commercial traffic 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 at the Wilkins Slough gauging station when diversions are occurring downstream, under all but the most critical water supply conditions.

Major diversions in this reach of the Sacramento River include the CVP Red Bluff Pumping Plant, Glenn-Colusa Irrigation District (GCID) intake, and individual diversions for the CVP Sacramento River Settlement Contractors. The Red Bluff Pumping Plant was completed in August 2012 to improve fish passage conditions on the Sacramento River by removing the Red Bluff Diversion Dam, and to continue to divert water from the Sacramento River into the Tehama-Colusa and Corning canals. The GCID Main Pump Station is located near Hamilton City to divert water into the GCID Canal that conveys water to over 130,000 acres, including the USFWS Sacramento National Wildlife Refuge; and terminates at the Colusa Basin Drain near Williams. In 2001, the GCID Fish Screen was completed in addition to several canal improvements to allow year-round water deliveries.

Major streams entering the Sacramento River between Red Bluff and the Feather River include Antelope, Elder, Mill, Thomes, Deer, Stony, Big Chico, and Butte creeks. No major storage or diversion structures have been constructed on Antelope, Elder, Mill, and Thomes creeks, although several small seasonal diversions for irrigation, domestic use, and hydroelectric power generation are present (Reclamation 1997). Moderate non-CVP and non-SWP diversion dams are located on Deer, Big Chico, and Butte creeks.

Stony Creek flows are controlled by East Park Dam, Stony Gorge Dam, and Black Butte Dam (Reclamation 1997). East Park and Stony Gorge reservoirs store surplus water for irrigation deliveries and are operated by Reclamation as part of the Orland Project which is independent of the CVP. Black Butte Dam is operated by the USACE for flood control and irrigation supply. Black Butte Dam operations are coordinated with the CVP. The GCID canal, which crosses Stony Creek downstream of Black Butte Dam, includes a seasonal gravel dam constructed across the creek on the downstream side of the canal.

The Sacramento River between Red Bluff and Chico Landing, the Sacramento River Flood Control Project has provided bank protection and incidental channel modification since 1958 (DWR 2013t). Between Chico Landing and Colusa, the flood management facilities consist of levees and overflow areas. Black Butte Reservoir regulates Stony Creek flood flows, which enter the Sacramento River downstream of Hamilton City. Right bank levees from Ord Ferry through Colusa prevent Sacramento River flood water from entering the Colusa Basin, except when flows exceed 300,000 cfs near Ord Ferry (DWR 2013t). Three flood relief weirs along the right bank, downstream of Chico Landing, allow flood flows to spill into the Butte Basin Overflow Area. The left bank levee begins midway between Ord Ferry and Butte City and extends south through Verona, and includes the Moulton and Colusa weirs that allow flood flows to spill into the Butte Basin Overflow Area. The natural Sutter Basin overflow (Sutter Bypass) to the east of the Sacramento River and downstream of the Sutter Buttes was included in the Sacramento River Flood Control Project. The Sutter Bypass conveys floodwaters from the Butte Basin Overflow Area, Butte Creek, Wadsworth Canal, and Reclamation Districts 1660 and 1500 drainage plants, state drainage plants, and Tisdale Weir to the confluence of the Sacramento and Feather rivers. Downstream of Colusa, Reclamation Districts 70, 108, and 787 pump flood waters from adjacent closed basin lands into the river.

The Colusa Basin Drain provides drainage for a large portion of the irrigated lands on the western side of the Sacramento Valley in Glenn, Colusa, and Yolo counties; and supplies irrigation water to lands in this area. Water from the drain is discharged to the Sacramento River through the Knights Landing Outfall, a gravity flow structure and prevents the Sacramento River from flowing into the Colusa Basin.

Implementation of 2009 National Marine Fisheries Service Biological Opinion

The 2009 NMFS BO RPA requires Reclamation to evaluate approaches to provide minimum flows at Wilkins Slough of less than 5,000 cfs.

Yolo Bypass

Flows from the Sacramento River, Feather River, Sutter Bypass, and Natomas Cross Canal join upstream of Verona on the Sacramento River. When the Sacramento River flows exceed 62,000 cfs, flows spill over the Fremont Weir into the Yolo Bypass. The Yolo Basin was a natural overflow area located to the west of the Sacramento River. The Sacramento River Flood Control Project modified the basin by confining the extent of overflow through a leveed bypass and allowing flood flows to enter the Yolo Bypass from the Sacramento River over the Fremont and Sacramento weirs. The Yolo Bypass conveys floodwaters around the Sacramento metropolitan area and reconnects to the Sacramento River at Rio Vista (DWR 2013t). Tributaries within the Yolo Bypass include the Cache Creek Detention Basin, Willow Slough, and Putah Creek.

Flows also enter the Yolo Bypass from the Colusa Basin, including from the Colusa Basin Drain through the Knights Landing Ridge Cut. In 2011 and 2012, construction at the outfall gates required water from the Colusa Basin Drain to be diverted into the Yolo Bypass. These events temporarily resulted in a fall pulse flow in the Yolo Bypass that increased the volume of flow by more than 300 to 900 percent (Frantzich 2014).

Historical mean daily flows into the Yolo Bypass at Fremont Weir are presented on Figure 5.26 (DWR 2013aa). Between 2002 and 2012, flows have entered the Yolo Bypass at Fremont Weir during 13 periods, including:

- January 2002 – spill continued for 7 days with flows up to 30,000 cfs
- January 2003 – spill continued for 6 days with flows up to 22,000 cfs
- May 2003 – spill continued for 1 day with flows up to 100 cfs
- January 2004 – spill continued for 3 days with flows up to 3,000 cfs
- February 2004 – spill continued for 20 days with flows up to 79,000 cfs
- May 2005 – spill continued for 4 days with flows up to 35,000 cfs
- January/February 2006 (2 events) – spill continued for a total of 37 days with flows up to 205,000 cfs
- March/April/May 2006 – spill continued for 65 days with flows up to 96,000 cfs
- January 2010 – spill continued for 4 days with flows up to 5,000 cfs
- December 2010 – spill continued for 4 days with flows up to 9,000 cfs
- March/April 2011 – spill continued for 24 days with flows up to 85,000 cfs
- December 2012 – spill continued for 5 days with flows up to 26,000 cfs

Implementation of 2009 National Marine Fisheries Service Biological Opinion

The 2009 NMFS BO RPA requires Reclamation to evaluate approaches to increase acreage of seasonal floodplain rearing habitat with biologically appropriate durations and magnitudes, from December through April, in the lower Sacramento River basin, on a return rate of approximately one to three years. The initial performance measure was defined in the RPA as 17,000 to 20,000 acres of floodplain rearing habitat, such as in the Yolo Bypass, excluding tidally influenced areas. Reclamation also is required to develop enhancement plans for Lower Putah Creek, Liberty Island/Lower Cache Slough, and Lower Yolo Bypass. The plans also are required to develop improvements to Fremont Weir and Lisbon Weir to eliminate migration barriers and stranding potential.

Feather River Watershed

The Feather River, with a drainage area of 3,607 square miles on the east side of the Sacramento Valley, is the largest tributary to the Sacramento River below Shasta Dam (Reclamation 1997, DWR 2007a). The Feather River enters the Sacramento River from the east at Verona. The total flow is provided by the Feather River and tributaries, which include the Yuba and Bear rivers.

Upper Feather River, Lake Oroville, and the Thermalito Complex

The upper Feather River includes numerous reservoirs and powerplant diversions, including the 1,308-TAF Lake Almanor owned by Pacific Gas & Electric Company; and the SWP Upper Feather River Lakes, including Antelope Lake, Lake Davis, and Frenchman Lake. The major SWP facility on the Feather River is the 3,500-TAF Lake Oroville, which is formed by the Oroville Dam located at the confluence of the North, Middle, and South forks of the Feather River. Lake Oroville stores winter and spring runoff, which is released into the Feather River to meet SWP water demands; provide pumpback capability to allow for on-peak electrical generation; provide 750 TAF of flood control storage, recreation, and freshwater releases to control salinity intrusion in the Delta; and for fish and wildlife protection, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. Historical water storage volumes and water storage elevations for Lake Oroville for Water Years 2001 through 2012 are presented on Figures 5.27 and 5.28 (DWR 2013 ab, 2013ac).

A maximum of 17,400 cfs can be released from Lake Oroville through the Edward Hyatt Powerplant, and the Thermalito Power Canal into the Thermalito Diversion Pool. Water continues through the Thermalito Diversion Pool into the Feather River Fish Hatchery and the 11,768-acre-foot Thermalito Forebay formed by the Thermalito Diversion Dam. Water is released from the Thermalito Forebay through the Thermalito Powerplant into the Thermalito Afterbay and the low flow channel of the Feather River.

Historical water storage volumes and water storage elevations for Thermalito Afterbay for Water Years 2001 through 2012 are presented on Figures 5.29 and 5.30 (DWR 2013ab, 2013ac, 2013ad). Water from the afterbay flows into the Feather River. Historical mean daily flows in the Feather River are presented on Figure 5.31 (DWR 2013af). Local agricultural districts divert water directly from the afterbay.

Maximum allowable ramp-down release requirements in the low flow channel of the Feather River are required to prevent rapid reductions in water levels that could potentially cause redd dewatering and stranding of juvenile salmonids and other aquatic organisms. Water releases from Lake Oroville are also affected by temperature criteria, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations.

Major diversions on the Feather River downstream of the Thermalito Complex include diversions into the Western Canal, Richvale Canal, the Pacific Gas and Electric Company Lateral, and the Sutter-Butte Canal. Some of the water diverted into these canals is exported to the Butte Creek watershed. Riparian water users along the Feather River also divert water for agricultural and municipal uses within the Feather River and Butte Creek watersheds (Reclamation 1997; DWR 2007).

Lower Yuba River

The Yuba River watershed extends over 1,339 square miles in the Sierra Nevada. The Yuba River is a major tributary to the Feather River, and historically has contributed over 40 percent of the lower Feather River flows (Reclamation 1997). The major reservoir in the watershed is the 970-TAF New Bullards Bar Reservoir that is owned and operated by the Yuba County Water Agency to provide flood control, water storage, and hydroelectric generation (Yuba County Water Agency [YCWA] 2012). The Yuba River watershed also includes over 400 TAF additional storage in reservoirs located upstream of New Bullards Bar Reservoir.

Water is diverted from New Bullards Bar Reservoir through the Colgate Tunnel and Powerhouse and discharged into the Yuba River. The 70-TAF Englebright Lake is formed by the Harry L. Englebright Dam downstream of New Bullards Dam. Englebright Lake was constructed by the California Debris Commission to trap and store sediment from historical hydraulic mining sites in the upper watershed and provide recreation and hydroelectric generation opportunities (USACE 2013). Following decommissioning of the California Debris Commission in 1986, administration of Englebright Dam and Lake was assumed by the USACE (USACE 2012, 2013, 2014). Major water diversions from the Yuba River occur 12.5 miles downstream of Englebright Dam at Daguerre Point Dam. Water transfers have occurred between Yuba County Water Agency and other water agencies, including CVP and SWP water users, since 2008 under the Lower Yuba River Accord, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations (Lower Yuba River Accord, River Management Team [LYRARMT] 2013).

American River from Folsom Lake to Sacramento River

The American River watershed extends over 1,895 square miles and contributes approximately 15 percent of the flow in the lower Sacramento River.

Folsom Lake and Lake Natoma

Folsom Lake and Lake Natoma on the American River are located within portions of the American River watershed that could be affected by changes in CVP and/or SWP operations. Folsom Lake is a CVP facility formed by Folsom Dam 7 miles upstream of the CVP Nimbus Dam (Reclamation et al. 2006). Folsom, Lake is the largest reservoir in the American River watershed, and has a capacity of 967 TAF. Numerous smaller reservoirs in the upper basin provide hydroelectric generation and water supply and are not owned or operated by Reclamation or DWR. The total upstream reservoir storage above Folsom Lake is approximately 820 TAF. Ninety percent of this upstream storage is provided by five reservoirs: French Meadows (136 TAF); Hell Hole (208 TAF); Loon Lake (76 TAF); Union Valley (271 TAF); and Ice House (46 TAF).

Nimbus Dam creates Lake Natoma, a forebay built to re-regulate flows of the American River and to direct water into the CVP Folsom South Canal. Releases from Nimbus Dam to the American River pass through the Nimbus Powerplant when releases are less than 5,000 cfs or the spillway gates for higher flows. The American River flows 23 miles between Nimbus Dam and the confluence with the Sacramento River. Historical water storage volumes and water storage elevations for Folsom Lake and Lake Natoma for Water Years 2001 through 2012 are presented on Figures 5.32 through 5.35) (DWR 2013ag, 2013ah, 2013ai, 2013aj). Median daily flows in American River downstream of Nimbus Dam are presented in Figure 5.36 (DWR 2013ak).

Water is diverted to municipal and industrial water users, including water rights holders, upstream of Folsom Dam, from the Folsom South Canal, and from the American River downstream of Folsom Dam. During extreme critical dry years, water elevations in Folsom Lake can be too low for adequate operation of diversion facilities; and Reclamation has provided temporary barges with intake and conveyance facilities to divert water from the lake to the adjacent water users.

Lower American River Flows

Flow patterns in the lower American River (downstream of Lake Natoma) are influenced by operations of the CVP both within the American River watershed and within the entire Sacramento River watershed. Flows can be affected by local operations such as flood management requirements at Folsom Lake and Lake Natoma, federal and state flow requirements, temperature requirements and water uses in the American River watershed. Flows can also be affected by delta operations including outflow and salinity requirements as well as exports within and south of the delta. Recent mean daily flows in the American River are presented on Figure 5.36 (DWR 2013ak).

Lower American River Flood Management

Flood management requirements and regulating criteria for October 1 through May 31 each year were specified in 1987 by the USACE to manage flooding in the Sacramento area, as practicable; provide maximum amount of water conservation storage in Folsom without impairing the flood control; and provide maximum amount of power practicable and be consistent with required flood control operations and the conservation functions of the reservoir. Following significant flood events in February 1986 and January 1997, the lower American River flooding issues were analyzed; and revised flood operations criteria were developed by the Sacramento Area Flood Control Agency (SAFCA), as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. The SAFCA release criteria are generally equivalent to the USACE plan, except the SAFCA diagram may prescribe flood releases earlier than the USACE plan. The SAFCA diagram also relies on Folsom Dam outlet capacity to make the earlier flood releases. The outlet capacity at Folsom Dam is currently limited to 32,000 cfs based on lake elevation. Since 1996, Reclamation has operated according to modified flood control criteria, which reserve 400 to 670 TAF of flood control space in Folsom Reservoir in combination with empty reservoir space in Hell Hole, Union Valley, and French Meadows to be treated as if it were available in Folsom Reservoir.

Reclamation and USACE constructed an auxiliary spillway under the Joint Federal Project, at Folsom Dam in accordance with the recommendations of the Water Control Manual Update (Reoperation Study). The USACE is also implementing increased system capabilities provided by the authorized features of the Common Features Project to strengthen the American River levees to convey up to 160,000 cfs and completion of the authorized Folsom Dam Mini-Raise Project.

Lower American River Minimum Flow and Temperature Requirements

The minimum allowable flows in the lower American River are defined by SWRCB Water Right Decision 893 (D-893), which states that, in the interest of fish conservation, releases should not ordinarily fall below 250 cfs between January 1 and September 15 or below 500 cfs at other times. D-893 minimum flows are rarely the controlling objective of CVP operations at Nimbus Dam. Nimbus Dam releases are nearly always controlled during significant portions of a water year by either flood control requirements or are coordinated with other CVP and SWP releases to meet CVP water supply and Delta operations objectives. Power regulation and management needs occasionally control Nimbus Dam releases. Nimbus Dam releases generally exceed the D-893 minimum flows in all but the driest of conditions.

Dedication of water in accordance with Section 3406(b)(2) of CVPIA on the American River provides instream flows below Nimbus Dam greater than those that would have occurred under pre-CVPIA conditions, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. Instream flow objectives from October through May generally aim to provide suitable habitat for salmon and steelhead spawning, incubation, and rearing, while considering impacts to other CVP and SWP uses. Instream flow objectives for June to September endeavor to provide suitable flows and water temperatures for juvenile steelhead rearing, while balancing the effects on temperature operations into October and November to help support fall-run Chinook Salmon spawning.

In July 2006, Reclamation, the Sacramento Area Water Forum and other stakeholders agreed to a flow and temperature regime (known as the Lower American River Flow Management Standard [FMS]) to improve conditions for fish in the lower American River, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. Minimum flow requirements during October, November, and December are primarily intended to address fall-run Chinook Salmon spawning, and flow requirements during January and February address fall-run Chinook Salmon egg incubation and steelhead spawning. From March through May, minimum flow requirements are primarily intended to facilitate steelhead spawning and egg incubation, as well as juvenile rearing and downstream movement of fall-run Chinook Salmon and steelhead. The June through September flows are designed to address over-summer rearing by juvenile steelhead, although this period partially overlaps with adult fall-run Chinook Salmon immigration.

Water temperature control operations in the lower American River are affected by many factors and operational tradeoffs. These include available cold water resources, Nimbus release schedules, annual hydrology, Folsom power penstock shutter management flexibility, Folsom Dam Urban Water Supply Temperature Control Device (TCD) management, and Nimbus Hatchery considerations, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. Meeting both the summer steelhead and fall salmon temperature objectives without negatively impacting other CVP project purposes requires reserving water in Folsom Lake for use in the fall to provide suitable fall-run Chinook Salmon spawning temperatures. In most years, the volume of cold water is not sufficient to support strict compliance with the summer water temperature target of 65°F at the downstream end of the compliance reach at the Watt Avenue Bridge; while at the same time reserving adequate water for fall releases to protect fall-run Chinook Salmon, or in some cases, continuing to meet steelhead over-summer rearing objectives later in the summer. The Folsom Water Supply Intake TCD has provided additional flexibility to conserve cold water for later use.

American River Flows to Meet Delta Salinity Requirements

Folsom Reservoir also is operated by Reclamation to release water to meet Delta salinity and flow objectives established to improve fisheries conditions. Weather conditions combined with tidal action and local accretions from runoff and return flows can quickly affect Delta salinity conditions, and require increases in spring Delta inflow to maintain salinity standards, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. In accordance with Federal and state regulatory requirements, the CVP and SWP are frequently required to release water from upstream reservoirs to maintain Delta water quality. Folsom Lake is located closer to the Delta than Lake Oroville and Shasta Lake; therefore, the water generally is first released from Folsom Lake. Water released from Lake Oroville and Shasta Lake generally reaches the Delta in approximately three and four days, respectively. As water from the other reservoirs arrives in the Delta, Folsom Reservoir releases can be reduced.

Implementation of 2009 National Marine Fisheries Service Biological Opinion

The 2009 NMFS BO RPA requires Reclamation to implement the FMS; minimize flow fluctuation effects in the lower American River between January and May; and meet specific temperature requirements in the lower American River, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations, through operational modifications of temperature control shutters on Folsom Dam, and installation of structural improvements (TCDs or the functional equivalent) on several intakes in Folsom Lake and Lake Natoma.

5.3.2.2.2 San Joaquin Valley

The San Joaquin Valley is divided into two drainage major drainage basins. The northern drainage basin extends from the San Joaquin River along the southern boundary of the Delta and along the adjacent lands to the San Joaquin River from the northern drainage of the San Joaquin River in Madera County to the southern drainage in Fresno County (DWR 2013a). The northern drainage basin includes the San Joaquin River; five major tributaries that flow from westward from the Sierra Nevada, including Fresno, Chowchilla, Tuolumne, Merced, Stanislaus, and Calaveras rivers; and three major creeks that flow eastward from the Coast Range, including Del Puerto, Orestimba, and Panoche Creek. All flows in the San Joaquin River flow westward to the Delta.

The southern drainage basin (also known as the Tulare Lake Basin) extends into the southern San Joaquin Valley between the Sierra Nevada on the east, Tehachapi Mountains on the south, and the Coast Rage on the west (DWR 2013a). The southern basin includes four major tributaries, including Kings, Kaweah, Tule, and Kern rivers, which drain towards three ancient lakes on the valley floor, including the Tulare, Buena Vista, and Goose lakes. Flows into these lakes have declined as water supply projects and agricultural development has occurred. The northern and southern drainage basins are generally hydrologically separated by a low, broad ridge that extends across the San Joaquin Valley between the San Joaquin and Kings rivers. However, in flood years, water flows from the Kings River through the James Bypass and Fresno Slough into the San Joaquin River near Mendota; therefore, the basins become hydrologically connected.

Flows from Fresno, Chowchilla, Tuolumne, Merced, Calaveras, Kings, Kaweah, Tule, and Kern rivers contribute substantial flows into the San Joaquin Valley and affect operations of CVP and SWP water users and operations. However, the operations of reservoirs on these rivers are not modified within the alternatives evaluated in this EIS. Therefore, these rivers are not discussed in this chapter. This chapter will focus on the flows in the San Joaquin and Stanislaus rivers that are affected by changes in CVP and SWP operations considered in the alternatives evaluated in this EIS.

San Joaquin River

The San Joaquin River flows 100 miles from Friant Dam to the Delta. Flows in the upper San Joaquin River are regulated by the CVP Friant Dam which forms Millerton Lake. Flows downstream of Friant Dam are influenced by flows from tributary rivers and streams, as described below; including CVP operations of New Melones Reservoir on the Stanislaus River. Flows on the San Joaquin River have recently changed since the expiration of the Vernalis Adaptive Management Plan in 2012.

Millerton Lake

Operations of Millerton Lake and the CVP Friant Division will not be modified by changes in CVP and SWP operations under the alternatives considered in this EIS. Therefore, Millerton Lake and Friant Division are not analyzed in this EIS.

The following information is presented to provide a general understanding of Millerton Lake and Friant Division operations as part of the CVP.

Friant Dam is located on the San Joaquin River, 25 miles northeast of Fresno where the San Joaquin River exits the Sierra foothills and enters the valley. The drainage basin is 1,676 square miles. Millerton Lake, formed by Friant Dam, has a capacity of 520 TAF. Several reservoirs in the upper portion of the San Joaquin River watershed, including Mammoth Pool and Shaver Lake, affect the inflow to Millerton Lake (Reclamation and DWR 2011).

Millerton Lake provides flood control capacity on the San Joaquin River, provides downstream releases to meet senior water rights requirements above Mendota Pool, and provides conservation storage as well as diversion into Madera and Friant-Kern Canals. Flood control storage space in Millerton Lake is based on a complex formula, which considers storage in upstream reservoirs, forecasted snowmelt, and time of year. Flood management releases occur approximately once every 3 years and are managed based on downstream channel design capacity to the extent possible.

San Joaquin River from Friant Dam to Mendota Pool

Historically, in the 40-mile reach between Friant Dam and the Gravelly Ford, flow is influenced by releases from Friant Dam, with minor contributions from agricultural and urban return flows. Gravelly Ford, located downstream of Friant Dam, is a sandy and gravelly section of the San Joaquin River that is subject to high losses of river flow. The 17-mile reach of the San Joaquin River between Gravelly Ford and the Mendota Pool historically has been generally dry since construction of Friant Dam except when flood control flows are released from Millerton Lake. Reclamation releases water from Millerton Lake to comply with Holding Contracts between Reclamation and riparian water right holders downstream of Friant Dam that will provide for at least 5 cfs past each of the Holding Contract diversion locations that extend to Gravelly Ford (San Joaquin River Restoration Program [SJRRP] 2011a). The typical release from Millerton Lake to provide water to water rights holders is approximately 125 cfs (SWRCB 2012).

Two major flood control facilities, the Chowchilla and Eastside bypasses, intercept flows of the San Joaquin, Fresno, and Chowchilla rivers and smaller San Joaquin River tributaries to provide flood protection for downstream agricultural lands. During flood control operations, up to 6,500 cfs of excess flows in the San Joaquin River at Mendota Pool are diverted into the Chowchilla Bypass which conveys water to the Chowchilla River. The East Side Bypass conveys high flows from the Chowchilla River to the San Joaquin River upstream of Fremont Ford. These bypasses are located in highly permeable soils and are used to provide an area for groundwater recharge using flood flows.

The 50-TAF Mendota Pool serves as a forebay for diversions to the Main and Outside canals; and is the termination of the Delta-Mendota Canal, which conveys CVP water from the Delta, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. Water also enters

Mendota Pool via Fresno Slough (also known as James Bypass) which conveys flood flows to the San Joaquin River from the Kings River (located in the Tulare Lake Basin). Recent mean daily flows in the San Joaquin River at Mendota are presented on Figure 5.37 (DWR 2013al).

San Joaquin River Restoration Program: Friant Dam to Confluence of Merced River

In 2006, parties to *NRDC, et al., v. Rodgers, et al.*, executed a stipulation of settlement that called for a comprehensive long-term effort to restore flows to the San Joaquin River from Friant Dam to the confluence of the Merced River and a self-sustaining Chinook Salmon fishery while reducing or avoiding adverse water supply impacts. The SJRRP implements the settlement consistent with the San Joaquin River Restoration Settlement Act in Public Law 111-11. The USFWS issued a Programmatic BO for the implementation of the SJRRP on August 21, 2012 and NMFS issued a Programmatic BO on September 18, 2012 for SJRRP flow releases of up to 1,660 cfs from Millerton Lake into the San Joaquin River. The settlement-required flow targets for releases from Millerton Lake include six water year types for releases depending upon available water supply as measures of inflow to Millerton Lake, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. The Millerton Lake releases include the flexibility to reshape and retime releases forwards or backwards by 4 weeks during the spring and fall pulse periods. Flood flows may potentially occur and meet or exceed the Settlement flow targets. If flood flows meet the settlement flow targets, then Reclamation would not release additional water from Millerton Lake. The San Joaquin River channel downstream of Friant Dam currently lacks the capacity to convey flows to the Merced River and releases are limited accordingly. Reclamation has initiated planning and environmental compliance activities to improve river channel conveyance and allow for the full release of SJRRP flows. Diversions and infiltration losses reduce the amount of Settlement flows reaching the San Joaquin River and Merced River confluence. For the purposes of this analysis, flows that reach the Merced confluence are assumed to continue to the Delta.

San Joaquin River from Merced River to the Delta

Two major tributaries, the Tuolumne and Stanislaus rivers, join the San Joaquin River between the confluence with the Merced River and Vernalis (located at the southeastern boundary of the Delta). The flows in this reach are influenced by flow and water quality requirements at Vernalis as well as releases from the upstream reach and the two major tributaries. Recent mean daily flows in the San Joaquin River at Vernalis are presented on Figure 5.38 (DWR 2013am).

Stanislaus River

The Stanislaus River originates in the western slopes of the Sierra Nevada and drains a watershed of approximately 900 square miles. The median annual unimpaired runoff in the basin is approximately 1.08 MAF per year (SWRCB 2012). Snowmelt from March through early July contributes the largest portion of the flows in the Stanislaus River, with the highest runoff occurring in the months of April, May, and June.

The North, Middle, and South forks of the Stanislaus River converge upstream of the CVP New Melones Reservoir. The 2.4 MAF New Melones Reservoir is located approximately 60 miles upstream from the confluence of the Stanislaus River and the San Joaquin River. Water from New Melones Reservoir flows into Tulloch Reservoir (Reclamation 2010a). Tulloch Reservoir is owned and operated by the Tri-Dams Project for recreation, power, and flow re-regulation of New Melones Reservoir releases. Water released by Tulloch Reservoir and Powerplant flows downstream to Goodwin Reservoir where water is either diverted to canals to serve, Oakdale Irrigation District, South San Joaquin Irrigation District, and Stockton East Water District; or released from Goodwin Reservoir to the lower Stanislaus River (SWRCB 2012).

Below Goodwin Dam, the lower Stanislaus River flows approximately 40 miles to the confluence with the San Joaquin River. Agricultural return flows and operational spills from irrigation canals also enter the lower Stanislaus River.

New Melones Reservoir

The operating criteria for New Melones Reservoir are constrained by water rights requirements, flood control operations, contractual obligations, and federal requirements under the Federal Endangered Species Act (ESA) and CVPIA. Reclamation must operate New Melones Reservoir to meet senior water rights and in-basin demands. Senior water rights are defined for both current and future upstream water right holders in accordance with the SWRCB Decision 1422 (D-1422) and Decision 1616 (D-1616); through protest settlement agreements with Tuolumne and Calaveras Counties; and for current downstream water right holders and riparian rights whose priorities are either senior to Reclamation or senior to appropriative rights in general, respectively, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. Reclamation also is required to make full contract amounts available to Stockton East Water District and Central San Joaquin Water Conservation District except for when contractual shortage provisions apply.

Required releases include flows to meet flow and water quality requirements included in the SWRCB Revised Decision 1641 (D-1641). This includes dissolved oxygen requirements in the lower Stanislaus River in accordance with the Central Valley Regional Water Quality Control Board (CVRWQCB) Basin Plan; minimum flow requirements in the lower San Joaquin River at Vernalis per SWRCB D-1641; and total dissolved solids requirement in the lower San Joaquin River at Vernalis per SWRCB D-1641.

Reservoir storage varies in accordance with upstream hydrology and downstream water demands and instream flow requirements. Recent water storage volumes and elevations for Water Years 2001 through 2012 in New Melones and Goodwin reservoirs are presented on Figures 5.39 through 5.42 (DWR 2013an, 2013ao, 2013ap, 2013aq). Recent mean daily flows in the Stanislaus River downstream of Goodwin Dam are presented on Figure 5.43 (DWR 2013as).

Implementation of 2009 National Marine Fisheries Service Biological Opinion

The 2009 NMFS BO RPA requires Reclamation to adaptively manage available flows to meet minimum instream flow, ramping flow, pulse flow, floodplain inundation, and geomorphic and function flow patterns, through the following actions. The available flows to meet the 2009 NMFS BO RPA are defined following compliance with water rights needs.

- Minimum base flows to optimize available steelhead habitat for adult migration, spawning, and juvenile rearing by water year type, as measured downstream of Goodwin Dam, as specified in Appendix 2-E of the 2009 NMFS BO RPA.
- Fall pulse flows to improve instream conditions sufficiently to attract steelhead to the Stanislaus River.
- Winter instability flows to simulate natural variability in the winter hydrograph and to enhance access to varied rearing habitats.
- Channel forming and maintenance flows in the 3,000 to 5,000 cfs range in above normal and wet years to maintain spawning and rearing habitat quality after March 1 to protect incubating eggs and to provide outmigration flow cues and late spring flows.
- Outmigration flow cues to enhance likelihood of anadromy.
- Late spring flows for conveyance and maintenance of downstream migratory habitat quality in the lowest reaches and into the Delta.

The 2009 NMFS BO also required Reclamation to meet temperature requirements at Orange Blossom Bridge and Knights Ferry to protect steelhead, as discussed in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. Reclamation is also required to evaluate an approach to operate New Melones Reservoir flow releases to achieve floodplain inundation flows and improved freshwater migratory habitat for steelhead. Reclamation also participates in gravel augmentation to improve spawning habitat.

5.3.2.2.3 Delta and Suisun Marsh

The Delta and Suisun Marsh area constitutes a natural floodplain that covers 1,315 square miles and drains approximately 40 percent of the state (DWR 2013a). The Delta and Suisun Marsh have a complex web of channels and islands and is located at the confluence of the Sacramento and San Joaquin rivers.

Historically, the natural Delta system was formed by water inflows from upstream tributaries in the Delta watershed and outflow to Suisun Bay and San Francisco Bay. In the late 1800s, local land reclamation efforts in the Delta resulted in the construction of channels and levees that began altering the Delta’s surface water flows. Over time, the natural pattern of water flows continued to change as the result of upper watershed diversions and the construction of facilities to divert and export water through the Delta to areas where supplemental water supplies are needed, including densely populated areas such as San Francisco and Southern California and agricultural regions such as the San Joaquin Valley and Tulare Lake. The SWP and CVP use the Delta as the hub of their conveyance systems to deliver water to large pumps located in the southern Delta.

Inflows to the Delta occur primarily from the Sacramento River system and Yolo Bypass, the San Joaquin River, and other eastside tributaries such as the Mokelumne, Calaveras, and Cosumnes rivers. In general, in any given year, approximately 77 percent of water enters the Delta from the Sacramento River, approximately 15 percent enters from the San Joaquin River, and approximately 8 percent enters from the eastside tributaries (DWR 1994). The Delta is tidally influenced; rise and fall varies from less than 1 foot in the eastern Delta to more than 5 feet in the western Delta (DWR 2013a).

Water quality in the Delta is highly variable and strongly influenced by inflows from the rivers and by seawater intrusion into the western and central portions of the Delta during periods of low outflow that may be affected by high volumes of export pumping. The concentrations of salts and other materials in the Delta are affected by river inflows, tidal flows, agricultural diversions, drainage flows, wastewater discharges, water exports, cooling water intakes and discharges, and groundwater accretions. Seawater intrusion into the Delta is dependent on tidal conditions, inflows to the Delta, and Delta channel geometry. Delta channels are typically less than 30 feet deep, unless dredged, and vary in width from less than 100 feet to more than 1 mile. Although some channels are edged with riparian and aquatic vegetation, steep mud or rip-rap covered levees border most channels. To enhance flow and aid in levee maintenance, vegetation is often removed from the channel margins. The tidal currents carry large volumes of seawater back and forth through the San Francisco Bay-Delta Estuary with the tidal cycle. The mixing zone of salt and fresh water can shift 2 to 6 miles daily depending on the tides, and may reach far into the Delta during periods of low inflow.

Salinity objectives adopted by the SWRCB were established to protect beneficial uses, including agricultural and municipal water supplies, and fisheries. The CVP and SWP facilities are operated to comply with the requirements that would protect the Delta water quality, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. These operational requirements affect the hydrology in the Delta.

Hydrological conditions in the Delta and Suisun Marsh are substantially affected by structures that route water through the Delta towards the major Delta water diversions in the south Delta, including the CVP Jones Pumping Plant, the SWP Banks Pumping Plant, the Delta-Mendota/California Aqueduct Intertie, the CVP Contra Costa Canal Pumping Plant at Rock Slough, and the Contra Costa Water District (CCWD) intakes on Old and Middle rivers; while protecting Delta water quality for these intakes, the SWP Barker Slough Pumping Plant in the north Delta and over 1,800 municipal and agricultural in-Delta diversions (DWR 2010b). These structures include the Delta Cross Channel and temporary barriers in the south Delta. Diversion patterns for the major facilities also are regulated to maintain Delta water quality and to protect fish that are listed as threatened or endangered species under ESA in accordance with the SWRCB D-1641, 2008 USFWS BO, and the 2009 NMFS BO. The diversion patterns are implemented to maintain ratios of exports of the CVP and SWP facilities to the Delta inflow; ratios of San Joaquin River inflow to Delta exports; and reverse flow conditions in Old and Middle rivers (known as the OMR criteria). Operations of the Jones and Banks pumping plants are affected by downstream CVP and SWP water demands and reservoir operations in San Luis Reservoir that is jointly used by the CVP and SWP.

Facilities implemented in Suisun Marsh also affect hydrologic and water quality conditions throughout the Delta. To meet the Delta water quality requirements and water rights requirements of users located upstream of the Delta, the CVP and SWP are operated in a coordinated manner in accordance with Coordinated Operation Agreement (COA), as described in the following section.

Delta Cross Channel

The Delta Cross Channel (DCC) is a gated diversion channel in the Sacramento River near Walnut Grove and Snodgrass Slough, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. When the gates are open, water flows from the Sacramento River through the cross channel to channels of the lower Mokelumne and San Joaquin Rivers toward the interior Delta. The DCC operation improves water quality in the interior Delta by improving circulation patterns of good quality water from the Sacramento River towards Delta diversion facilities.

Reclamation operates the DCC in the open position to (1) improve the movement of water from the Sacramento River to the export facilities at the Banks and Jones Pumping Plants, (2) improve water quality in the southern Delta, and (3) reduce salt water intrusion rates in the western Delta. During the late fall, winter, and spring, the gates are often periodically closed to protect out migrating salmonids from entering the interior Delta. In addition, whenever flows in the Sacramento River at Sacramento reach 20,000 to 25,000 cfs (on a sustained basis) the gates are closed to reduce potential scouring and flooding that might occur in the channels on the downstream side of the gates.

Flow rates through the gates are determined by Sacramento River stage and are not affected by export rates in the south Delta. The DCC also serves as a link between the Mokelumne River and the Sacramento River for small craft, and is used extensively by recreational boaters and fishermen whenever it is open. The SWRCB D-1641 requires closure of the DCC gates for fisheries protection as follows.

- From November through January, the DCC may be closed for up to 45 days for fishery protection purposes.
- From February 1 through May 20, the gates are closed for fishery protection purposes.
- The gates may also be closed for 14 days for fishery protection purposes during the May 21 through June 15 time period.

Implementation of 2009 National Marine Fisheries Service Biological Opinion

The 2009 NMFS BO RPA requires Reclamation to close the DCC for additional days from October 1 through November 30, if fish are present; December 1 through December 14, unless closures cause adverse impacts on water quality conditions; and December 15 through January 31.

Temporary Agricultural Barriers

The DWR South Delta Temporary Barrier Project (TBP) was initiated in 1991to seasonally construct and demolish four rock barriers across south Delta channels, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. In various combinations, these barriers improve water levels and San Joaquin River salmon migration in the south Delta. The existing TBP consists of installation and removal of temporary rock barriers at the following locations.

- Middle River near Victoria Canal, about 0.5 miles south of the confluence of Middle River, Trapper Slough, and North Canal.
- Old River near Tracy, about 0.5 miles east of the DMC intake.
- Grant Line Canal near Tracy Boulevard Bridge, about 400 feet east of Tracy Boulevard Bridge.
- The head of Old River (HOR) at the confluence of Old River and San Joaquin River.

The barriers on Middle River, Old River near Tracy, and Grant Line Canal are flow control facilities designed to improve water levels for agricultural diversions and are in place during the irrigation season. The Head of Old River Barrier (HORB) is only installed from early September to November 30th when requested by CDFW if needed to improve dissolved oxygen in the San Joaquin River. The HORB also has been installed in the spring months to improve outmigrating conditions for juvenile salmonids.

The agricultural barriers at Middle River and Old River near Tracy can be installed as early as March 1 if the HORB is installed; and can be fully operated as early as April 1, if the HORB is installed, or May 15, if the HORB is not installed. From May 15 to May 31 (if the barrier at the head of Old River is removed), the barrier tide gates are tied open in Middle River and Old River near Tracy. After May 31, the barriers in Middle River, Old River near Tracy, and Grant Line Canal are permitted to be operational until they are completely removed by November 30.

Major Delta Water Diversions

Major water diversions in the Delta include the CVP Jones Pumping Plant, the SWP Banks Pumping Plant, the CVP Contra Costa Canal Pumping Plant at Rock Slough, the SWP Barker Slough Pumping Plant for the North Bay Aqueduct, Contra Costa Water District intakes on Old and Middle rivers, and over 1,800 municipal and agricultural diversions for in-Delta use (DWR 2010b).

Delta channels have been modified to allow transport of Delta inflow to the diversions throughout the Delta, including the CVP and SWP south Delta intakes, and to reduce the effects of pumping on the direction of flows and salinity intrusion within the Delta. The conveyance of water from the Sacramento River southward through the Delta to the CVP and SWP south Delta intakes is aided by the Delta Cross Channel (DCC), a constructed, gated channel that conveys water from the Sacramento River to the Mokelumne River.

CVP Jones Pumping Plant

The CVP Jones Pumping Plant, located about 5 miles north of Tracy, has a permitted diversion capacity of 4,600 cfs and sits at the end of a 2.5-mile long earth-lined intake channel that extends to Old River, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. Water diverted at the Jones Pumping Plant is discharged to the CVP Delta-Mendota Canal (DMC) which extends 117 miles to the Mendota Pool. Water from Jones Pumping Plant may be pumped from the DMC O’Neill Forebay, and then pumped into San Luis Reservoir by the Gianelli Pumping-Generating Plant. The DMC has an initial capacity of 4,600 cfs at Jones Pumping Plant that decreases to about 3,200 cfs at its terminus.

SWP Clifton Court and Banks Pumping Plant

The SWP facilities in the southern Delta include the 31-TAF Clifton Court Forebay (CCF), located about 10 miles northwest of the city of Tracy, and the Banks Pumping Plant, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. Water is diverted from Old River into CCF that provides storage for off-peak pumping, moderates the effect of the pumps on the fluctuation of flow and stage in adjacent Delta channels, and collects sediment upstream of the Banks Pumping Plant and the California Aqueduct. Water flows from CCF to Banks Pumping Plant which conveys the water to California Aqueduct. The California Aqueduct transports water to O’Neill Forebay, from which water can be released to the San Luis Canal, a portion of the California Aqueduct jointly owned by the SWP and CVP; or pumped into San Luis Reservoir at the Gianelli Pumping Plant. Water from San Luis Reservoir is released into the San Luis Canal which ends near Kettleman City. From that location, the California Aqueduct continues to southern California.

The nominal capacity of the Banks Pumping Plant is 10,300 cfs. Permits issued by the USACE regulate the rate of diversion of water into CCF. This diversion rate is normally restricted to 6,680 cfs as a three-day average inflow to CCF and 6,993 cfs as a one-day average inflow to CCF. CCF diversions may be greater than these rates between December 15 and March 15, when the inflow into CCF may be augmented by one-third of the San Joaquin River flow at Vernalis when those flows are equal to or greater than 1,000 cfs.

In 2000, the maximum diversion rate was increased for the months of July, August, and September through 2016 to recover export reductions that occurred due to actions taken to benefit fisheries resources. The expanded maximum allowable daily diversion rate into CCF was increased from 13,870 acre-feet to 14,860 acre-feet and three-day average diversions from 13,250 acre-feet to 14,240 acre-feet (500 cfs per day equals 990 acre-feet per day). Implementation of this action is contingent on meeting the following conditions.

- The increased diversion rate will not result in greater annual SWP water supply allocations than would occur in the absence of the increased diversion rate. Water pumped due to the increased capacity will only be used to offset reduced diversions that occurred or will occur because of actions taken to benefit fisheries.
- Use of the increased diversion rate will be in accordance with all terms and conditions of existing BOs governing SWP operations.
- All three temporary agricultural barriers (Middle River, Old River near Tracy and Grant Line Canal) must be in place and operating when SWP diversions are increased.

Between July 1 and September 30, if the combined salvage of listed fish species reaches a level of concern, the relevant fish regulatory agencies will determine whether the 500 cfs increased diversion is or continues to be implemented. Variations to hydrologic conditions coupled with regulatory requirements may limit the ability of the SWP to fully utilize the proposed increased diversion rate. Also, facility capabilities may limit the ability of the SWP to fully utilize the increased diversion rate. The CCF radial gates are closed during critical periods of the ebb/flood tidal cycle to protect water levels relied upon by local agricultural water diverters in the south Delta area.

Banks Pumping Plant is operated to minimize the impact on power loads on the California electrical grid to the extent practical. Generally more pump units are operated during off-peak periods and fewer during peak periods with water stored temporarily in CCF. Because the installed capacity of the pumping plant is 10,300 cfs, the plant can be operated to reduce power grid impacts by running all available pumps at night and fewer during the higher energy-demand hours.

SWP Barker Slough Pumping Plant

The SWP Barker Slough Pumping Plant (BSPP) diverts water from Barker Slough into the SWP North Bay Aqueduct (NBA) for delivery to the Solano County Water Agency and the Napa County Flood Control and Water Conservation District, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. The current 162.5-cfs NBA intake with a positive barrier fish screen, located approximately 10 miles from the Sacramento River at the end of Barker Slough.

The NBA was designed to deliver up to 131,181 acre-feet per year SWP water supply contracts. However, the ability of BSPP to deliver this amount of water is limited due to several factors. The current BSPP pumping capacity is limited due to a thick bio-film growth on the interior of the NBA pipeline and a need to reduce the pressure in the pipeline within safe limits. Water quality in Barker Slough becomes degraded during winter and spring rainfall events due to elevated levels of coliform bacteria, organic matter, turbidity, and pollutants from the upstream watershed, which limits the period of time that the BSPP can be operated each year. In 2008, USFWS issued a BO for preservation of delta smelt that reduced the total BSPP annual diversion to 71 TAF. In 2009, CDFW issued an incidental take permit for the preservation of longfin smelt that restricted pumping rates during dry and critical dry years from January 15 to March 31. As tidal wetlands in Suisun Marsh and Cache Slough and floodplains in the Yolo Bypass are restored in accordance with the 2008 USFWS BO and 2009 NMFS BO, respectively, Delta smelt, longfin smelt and salmonid populations in the Barker Slough area are anticipated to increase which could further restrict diversions at BSPP.

Contra Costa Water District Intakes

The CCWD diverts approximately 127 TAF per year, including approximately 110 TAF under the CVP water service contract. The CCWD diverts water at the CVP Rock Slough Intake, and at the CCWD Mallard Slough, Old River, and Middle River (on Victoria Canal) intakes, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. Water diverted at Mallard Slough, Old River, and Middle River intakes occur under water rights issued by the SWRCB to CCWD. Water diverted at Rock Slough, Old River, and Middle River intakes occur under water rights issued by the SWRCB to Reclamation for the CVP. All four intakes have positive barrier fish screens. Water from the Old River and Middle River intakes can be diverted to the 160-TAF Los Vaqueros Reservoir when Delta salinity is low. When Delta salinity is high, typically in the fall months, CCWD blends low salinity water from Los Vaqueros Reservoir with water from the Delta to meet CCWD water quality goals. Water from Los Vaqueros Reservoir is also used by CCWD when Delta diversions are restricted.

The Mallard Slough Intake, located on a channel that extends to Suisun Bay (across from Chipps Island), can divert water into the CCWD conveyance system, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. Generally, less than 3 percent of CCWD diversions are from Mallard Slough intake due to high salinity in Suisun Bay from late spring until winter.

The CVP Rock Slough Intake, located about four miles southeast of Oakley, can divert into the CVP Contra Costa Canal for conveyance into the CCWD water system. CCWD may divert approximately 30 percent to 50 percent of its total supply through the Rock Slough Intake depending upon salinity.

The Old River Intake, located on Old River near State Route 4, can divert water to the CVP Contra Costa Canal or to the 160-TAF Los Vaqueros Reservoir. Diversion to Los Vaqueros Reservoir storage is limited to 200 cfs by the terms of the Los Vaqueros Project BOs and SWRCB Decision 1629 (D-1629), the water right decision for the Los Vaqueros Project.

The Middle River Intake (formerly referred to as Alternative Intake Project), located on Victoria Canal, diverts water to the Contra Costa Canal or to

Los Vaqueros Reservoir. Salinity at the Middle River Intake is generally lower in the late summer and fall than at the other intakes. Therefore, CCWD can decrease winter and spring diversions while still meeting water quality goals in the summer and fall through use of the Middle River Intake.

Delta-Mendota Canal/California Aqueduct Intertie

The DMC/California Aqueduct Intertie between the DMC and the California Aqueduct allows water to flow in both directions between the CVP and SWP conveyance facilities, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. The DMC/California Aqueduct Intertie achieves multiple benefits, including meeting current water supply demands, allowing for the maintenance and repair of the CVP Delta export and conveyance facilities, and providing operational flexibility to respond to emergencies. The DMC/California Aqueduct Intertie can be used under one of the following three different scenarios.

- Up to 467 cfs may be pumped from the DMC to the California Aqueduct to ease DMC conveyance constraints related to Jones Pumping Plant capacity limitations.
- Up to 467 cfs may be pumped from the DMC to the California Aqueduct to minimize impacts on water deliveries due to temporary restrictions in flow or water levels on the lower DMC (south of the Intertie) or the upper California Aqueduct (north of the Intertie) for system maintenance or due to an emergency shutdown.
- Up to 900 cfs may be conveyed from the California Aqueduct to the DMC using gravity flow to minimize impacts on water deliveries due to temporary restrictions in flow or water levels on the lower California Aqueduct (downstream of the Intertie) or the upper DMC (upstream of the Intertie) for system maintenance or for an emergency shutdown.

San Luis Reservoir

The 2.027-MAF San Luis Reservoir, formed by Sisk Dam, is jointly operated by Reclamation and DWR, with approximately 0.965 MAF used by the CVP and 1.062 MAF used by the SWP. Water generally is diverted into San Luis Reservoir during late fall through early spring when irrigation water demands of CVP and SWP water users are low and are being met by Delta exports.

When all SWP demands are met, including diversion to storage facilities south of the Delta and Table A demands, and the Delta is in excess conditions, DWR would use available excess pumping capacity at Banks Pumping Plant to make excess water supplies, called Article 21 water under the long-term SWP water supply contracts, available to the SWP Contractors. Article 21 of the SWP water contracts describes the conditions under which water can be delivered in addition to the amounts specified in Table A of the contracts.

Unlike Table A water, which is an allocated annual SWP supply made available for scheduled delivery throughout the year, Article 21 water is an interruptible water supply made available only when certain conditions exist. However, while not a dependable supply, Article 21 water is an important part of the total SWP supplies provided to the SWP contractors. As with all SWP water, Article 21 water is pumped consistent with the existing terms and conditions of SWP water rights permits, and is pumped from the Delta under the same environmental, regulatory, and operational constraints that apply to all SWP operations.

Article 21 water is only available as long as the required conditions exist as determined by DWR. As Article 21 deliveries are in addition to scheduled Table A deliveries, this supply is delivered to SWP contractors that can, on relatively short notice, put it to beneficial use. SWP contractors have used Article 21 water to meet needs such as additional short-term irrigation demands, replenishment of local groundwater basins, short-term substitution of local supplies and storage in local surface reservoirs for later use by the requesting SWP contractor, all of which provide SWP contractors with opportunities for better water management through more efficient coordination with their local water supplies. Allocated Article 21 water to a SWP contractor cannot be transferred.

Article 21 water is typically offered to SWP contractors on a short-term (daily or weekly) basis when all of the following conditions exist: the SWP share of San Luis Reservoir is physically full, or projected to be physically full; other SWP reservoirs south of the Delta are at their storage targets or the SWP conveyance capacity to fill these reservoirs is maximized; the Delta is in excess condition; current Table A and SWP operational demands are being fully met; and Banks Pumping Plant has export capacity beyond that which is needed to meet all Table A and other SWP operational demands. The increment of available unused Banks Pumping Plant capacity is offered as the Article 21 delivery capacity. SWP contractors then indicate their desired rate of delivery of Article 21 water. DWR allocates the available Article 21 water in proportion to the requesting SWP contractors annual Table A amounts if requests exceed the amount offered. Deliveries can be discontinued at any time when SWP operations change. In the modeling for Article 21, deliveries are only made in months when the SWP share of San Luis Reservoir is full. In actual operations, Article 21 may be offered a short period in advance of actual filling.

By April or May, demands from both agricultural and M&I SWP Contractors usually exceed the pumping rate at Banks Pumping Plant, and releases from San Luis Reservoir to the SWP facilities are needed to supplement the Delta pumping at Banks Pumping Plant to meet SWP contractor demands for Table A water.

Historical water storage volumes and water storage elevations for San Luis Reservoir for Water Years 2001 through 2012 are presented on Figures 5.44 and 5.45 (DWR 2013as, 2013at).

The San Luis Complex consists of the following.

- O’Neill Pumping-Generating Plant (CVP facility)
- William R. Gianelli Pumping-Generating Plant (joint CVP and SWP facility)
- San Luis Canal (joint CVP and SWP facility)

- Dos Amigos Pumping Plant (joint CVP and SWP facility)
- Coalinga Canal (CVP facility)
- Pleasant Valley Pumping Plant (CVP facility)
- Los Banos and Little Panoche Detention Dams and Reservoirs (joint CVP and SWP facilities)

The CVP diverts water from San Luis Reservoir by the Pacheco Pumping Plant through the Pacheco Tunnel and Pacheco Conduit that conveys water to CVP water service contractors in Santa Clara and San Benito counties, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations.

Regulatory Limitations on Operations of Delta Water Diversions

Operations of the CVP and SWP are implemented in accordance with SWRCB water rights and water quality decisions, including SWRCB D-1641, and the 2008 USFWS BO and 2009 NMFS BO.

Decision 1641

The SWRCB adopted the 1995 Bay-Delta Plan on May 22, 1995, which became the basis of SWRCB D-1641 (adopted on December 29, 1999 and revised on March 15, 2000). The SWRCB D-1641 amended certain terms and conditions of the SWP and CVP water rights to include flow and water quality objectives to assure protection of beneficial uses in the Delta and Suisun Marsh. SWRCB also grants conditional changes to points of diversion for the CVP and SWP under SWRCB D-1641. The SWRCB adopted a revised Bay-Delta Plan on December 13, 2006; however, there were no changes to the beneficial uses or water quality objectives. The changes were primarily to improve readability and consistency to reflect current physical conditions and other regulations.

The requirements in SWRCB D-1641 address the standards for fish and wildlife protection, water supply water quality, and Suisun Marsh salinity. These objectives include specific Delta outflow requirements throughout the year, specific export limits in the spring, and export limits based on a percentage of estuary inflow throughout the year. The water quality objectives are designed to protect agricultural, municipal and industrial, and fishery uses, and vary throughout the year and by water year type. One of the requirements is to provide a minimum flow on the Sacramento River at Rio Vista in September through December of 3,000 to 4,500 cfs, depending on the month and water year type, to protect water quality for Delta water users.

The SWRCB D-1641 includes two Delta outflow criteria. A Net Delta Outflow Index is specified for all months in all water year types. A “spring X2” Delta outflow is specified from February through June to maintain freshwater and estuarine conditions in the western Delta to protect aquatic life. The criteria require operations of the CVP and SWP upstream reservoir releases and Delta exports in a manner that maintains a salinity objective at an “X2” location. X2 refers to the horizontal distance from the Golden Gate Bridge up the axis of the

Delta estuary to where tidally averaged near-bottom salinity concentration of 2 parts of salt in 1,000 parts of water occurs; the X2 standard was established to improve shallow water estuarine habitat in the months of February through June and relates to the extent of salinity movement into the Delta (DWR, Reclamation, USFWS and NMFS 2013). The location of X2 is important to both aquatic life and water supply beneficial uses.

During February through June, SWRCB D-1641 also limits CVP and SWP exports as compared to Delta inflows (also known as the "E/I Ratio") to reduce potential impacts on migrating salmon and spawning Delta smelt, Sacramento Splittail, and Striped Bass.

Historical mean daily Delta outflow flows for Water Years 2001 through 2012 are presented on Figure 5.46 (DWR 2013au).

Historical mean daily flows for Water Years 2001 through 2012 are presented on Figures 5.46 through 5.52 for diversions at Jones, Banks, Barker Slough, and Contra Costa Canal pumping plants; and Contra Costa Water District intakes at Old River and Middle River (DWR 2013av, 2103aw, 2013ax, 2013ay, 2013az, 2013ba).

Joint Point of Diversion

SWRCB D-1641 authorized the SWP and CVP to jointly use both Jones and Banks pumping plants in the southern Delta, with conditional limitations and required response coordination plans (referred to as Joint Point of Diversion [JPOD]). Use of JPOD is based on staged implementation and conditional requirements for each stage of implementation. The stages of JPOD in SWRCB D-1641 are:

- Stage 1—for water service to a group of CVP water service contractors (Cross Valley contractors, San Joaquin Valley National Cemetery and Musco Family Olive Company), and to recover export reductions implemented to benefit fish;
- Stage 2—for any purpose authorized under the current CVP and SWP water right permits; and
- Stage 3—for any purpose authorized, up to the physical capacity of the diversion facilities.

In general, JPOD capabilities are used to accomplish four basic CVP and SWP objectives:

- When wintertime excess pumping capacity becomes available during Delta excess conditions and total CVP and SWP San Luis storage is not projected to fill before the spring pulse flow period, the Project with the deficit in San Luis storage may elect to pursue the use of JPOD capabilities;
- When summertime pumping capacity is available at Banks Pumping Plant and CVP reservoir conditions can support additional releases, the CVP may elect to use JPOD capabilities to enhance annual CVP south of Delta water supplies;

- When summertime pumping capacity is available at Banks or Jones Pumping Plant to facilitate water transfers, JPOD may be used to further facilitate the water transfer; and
- During certain coordinated CVP and SWP operation scenarios for fishery entrainment management, JPOD may be used to shift CVP and SWP exports to the facility with the least fishery entrainment impact while minimizing export at the facility with the most fishery entrainment impact.

Each stage of JPOD has regulatory terms and conditions that must be satisfied in order to implement JPOD. All stages require a response plan to ensure water elevations in the southern Delta will not be lowered to the injury of local riparian water users (Water Level Response Plan); and a response plan to ensure the water quality in the southern and central Delta will not be significantly degraded through operations of the JPOD to the injury of water users in the southern and central Delta. Stage 2 has an additional requirement to complete an operations plan that will protect fish and wildlife and other legal users of water (Fisheries Response Plan). Stage 3 has an additional requirement to protect water levels in the southern Delta. All JPOD diversions under excess conditions in the Delta are junior to CCWD water right permits for the Los Vaqueros Project, and must have an X2 location west of certain compliance locations consistent with the 1993 Los Vaqueros BO for Delta smelt.

Implementation of 2008 USFWS and 2009 NMFS Biological Opinions

The 2008 USFWS BO and the 2009 NMFS BO restrict CVP and SWP diversions to reduce reverse flows in OMR. The 2008 USFWS BO also includes criteria for fall Delta outflow. The 2009 NMFS BO includes criteria for a San Joaquin River Inflow/Export (I:E) ratio.

2008 USFWS BO OMR Criteria

The 2008 USFWS BO restricts south Delta pumping to preserve certain OMR flows as prescribed in the following three actions.

- **Action 1:** to protect adult Delta smelt migration and entrainment. Limits exports so that the average daily OMR flow is no more negative than -2,000 cfs for a total duration of 14 days, with a 5-day running average no more negative than -2,500 cfs (within 25 percent).
  - December 1 to December 20 – Based upon turbidity data from turbidity stations (Prisoner’s Point, Holland Cut, and Victoria Canal) and salvage data from CVP and SWP fish handling facilities at the south Delta intakes, and other parameters important to the protection of delta smelt including, but not limited to, preceding conditions of X2, Fall Midwater Trawl Survey (FMWT), and river flows.
  - After December 20 – The action will begin if the three-day average turbidity at Prisoner’s Point, Holland Cut, and Victoria Canal exceeds 12 nephelometric turbidity units (NTU).

  - Triggers would be based on:
    - Three-day average of 12 NTU or greater at all three turbidity stations; or
    - Three days of delta smelt salvage after December 20 at either facility or cumulative daily salvage count that is above a risk threshold based upon the "daily salvage index" approach reflected in a daily salvage index value of greater than or equal to 0.5 (daily delta smelt salvage is greater than one-half prior year FMWT index value). The window for triggering Action 1 concludes when either off-ramp condition described below is met. These off-ramp conditions may occur without Action 1 ever being triggered. If this occurs, then Action 3 is triggered, unless the Service concludes on the basis of the totality of available information that Action 2 should be implemented instead.
  - Action 1 offramps occur when water temperature reaches 12 degrees Centigrade (°C) based on a three station daily mean at the temperature stations: Mossdale, Antioch, and Rio Vista; or the onset of spawning based upon the presence of spent females in the Spring Kodiak Trawl Survey or at the CVP or SWP fish handling facilities.

- **Action 2:** to protect adult Delta smelt migration and entrainment. An action implemented using an adaptive process to tailor protection to changing environmental conditions after Action 1. As in Action 1, the intent is to protect pre-spawning adults from entrainment and, to the extent possible, from adverse hydrodynamic conditions. The range of net daily OMR flows will be no more negative than -1,250 to -5,000 cfs. Depending on extant conditions, specific OMR flows within this range are recommended by the USFWS Smelt Working Group (SWG) from the onset of Action 2 through its termination. The SWG would provide weekly recommendations based upon review of the sampling data, from real-time salvage data at the CVP and SWP, and utilizing most up-to-date technological expertise and knowledge relating population status and predicted distribution to monitored physical variables of flow and turbidity. The USFWS will make the final determination.
  - Action 2 begins immediately following Action 1. If Action 1 is not implemented based upon triggers, the SWG may recommend a start date for Action 2.
  - Action 2 is suspended when whenever a three-day flow average is greater than or equal to 90,000 cfs in Sacramento River at Rio Vista and 10,000 cfs in San Joaquin River at Vernalis. Once such flows have abated, the OMR flow requirements of Action 2 are restarted.
  - Offramps for Action 2 are related to water temperature reaches 12°C based on a three-station daily average at the temperature stations: Rio Vista, Antioch, and Mossdale; or the onset of spawning based upon the presence of a spent female in the Spring Kodiak Trawl Survey or at the CVP or SWP fish handling facilities.

- **Action 3:** to protect larval and juvenile Delta Smelt. Minimize the number of larval delta smelt entrained at the facilities by managing the hydrodynamics in the Central Delta flow levels pumping rates spanning a time sufficient for protection of larval delta smelt. Net daily OMR flow will be no more negative than -1,250 to -5,000 cfs based on a 14-day running average with a simultaneous 5-day running average within 25 percent of the applicable requirement for OMR. Depending on extant conditions, specific OMR flows within this range are recommended by the SWG from the onset of Action 3 through its termination.
  - Action 3 begins when temperature reaches 12°C based on a three-station average at the temperature stations: Mossdale, Antioch, and Rio Vista; or onset of spawning based upon the presence of a spent female in the Spring Kodiak Trawl Survey or at the CVP or SWP fish handling facilities.
  - Offramps for Action 3 would occur by June 30; or if water temperature reaches a daily average of 25°C for three consecutive days 10 at Clifton Court Forebay.

2009 NMFS BO OMR Criteria

The 2009 NMFS BO includes OMR criteria to protect juvenile salmonids during winter and spring emigration downstream into the San Joaquin River, and to increase survival of salmonids and green sturgeon entering the San Joaquin River from Georgiana Slough and the lower Mokelumne River by reducing the potential for entrainment at the south Delta intakes. The action is implemented from January 1 through June 15, and reduces exports, as necessary, to limit negative flows to -2,500 to -5,000 cfs in Old and Middle Rivers, depending on the presence of salmonids. The reverse flow is managed within this range to reduce flows toward the pumps during periods of increased salmonid presence. The negative flow objective within the range is determine based on the decision tree presented in Table 5.8.

Table 5.8 Old and Middle River Criteria under the 2009 NMFS BO

Date	Action Triggers	Action Responses
January 1 – June 15	January 1 – June 15	-5,000 cfs
January 1 – June 15 First Stage Trigger (increasing level of concern)	Daily SWP/CVP older juvenile loss density (fish per TAF): 1) is greater than incidental take limit divided by 2000, with a minimum value of 2.5 fish per TAF, or 2) daily loss is greater than daily measured fish density divided by 12 TAF, or 3) Coleman National Fish Hatchery coded wire tag late-fall run or Livingston Stone National Fish Hatchery coded wire tag winter-run cumulative loss greater than 0.5%, or 4) daily loss of wild steelhead (intact adipose fin) is greater than the daily measured fish density divided by 12 TAF.	-3,500 to -5,000 cfs
January 1 – June 15 Second Stage Trigger (analogous to high concern level)	Daily SWP/CVP older juvenile loss density (fish per TAF) is: 1) greater than incidental take limit divided by 1000, with a minimum value of 2.5 fish per TAF, or 2) daily loss is greater than daily fish density divided by 8 TAF, or 3) Coleman National Fish Hatchery coded wire tag late-fall run or Livingston Stone National Fish Hatchery coded wire tag winter-run cumulative loss greater than 0.5%, or 4) daily loss of wild steelhead (intact adipose fin) is greater than the daily measured fish density divided by 8 TAF.	-2,500 to -5,000 cfs
End of Triggers	Continue action until June 15 or until average daily water temperature at Mossdale is greater than 72°F (22°C) for 7 consecutive days (1 week), whichever is earlier.	No OMR restriction

2009 NMFS BO San Joaquin River Inflow:Export Ratio

The 2009 NMFS BO requires south Delta exports to be reduced during April and May to protect emigrating steelhead from the lower San Joaquin River into the south Delta channels and intakes. The I:E ratio from April 1 through May 31 specifies that Reclamation operates the New Melones Reservoir to maintain the 2009 NMFS BO flow schedule for the Stanislaus River at Goodwin in accordance with Action III.1.3 and Appendix 2-E of the 2009 NMFS BO. In addition, the CVP and SWP pumps are operated to meet the ratios based upon a 14-day running average, as summarized in Table 5.9.

Table 5.9 Inflow:Export Ratios under the 2009 NMFS BO

San Joaquin Valley Classification	San Joaquin River flow at Vernalis (cfs):CVP/SWP combined export ratio (cfs)
Critically dry	1:1
Dry	2:1
Below normal	3:1
Above normal	4:1
Wet	4:1
Vernalis flow equal to or greater than 21,750 cfs	Unrestricted exports until flood recedes below 21,750 cfs.

During multiple dry years, the ratio will be limited to 1:1 if the New Melones Index related to storage is less than 1,000 TAF and the sum of the "indicator" numbers established for water year classifications in SWRCB D-1641 (based on the San Joaquin Valley 60-20-20 Water Year Classification in SWRCB D-1641) is greater than 6 for the past two years and the current year. The indicator numbers are 1 for a critically dry year, 2 for a dry year, 3 for a below normal year, 4 for an above normal year, and 5 for a wet year.

Implementation of the I:E ratio under all conditions would allow a minimum pumping rate of 1,500 cfs to meet public health and safety needs of communities that solely rely upon water diverted from the CVP and SWP pumping plants.

2008 USFWS BO Fall X2 Criteria

The 2008 USFWS BO also includes an additional Delta salinity requirement in September and October in wet and above normal water years. This new requirement is frequently referred to as "Fall X2." The action requires that 2 Practical Salinity Units (psu) is maintained at 74 kilometers (km) during wet years, and 81 km during above normal water years when the preceding year was wet or above normal based upon the Sacramento Basin 40-30-30 index in the SWRCB D-1641. In November of these years, there is no specific X2 requirement; however, there is a requirement that all inflow into SWP and CVP upstream reservoirs be conveyed downstream to augment Delta outflow to maintain X2 at the locations in September and October. If storage increases during November under this action, the increased storage volume is to be released in December in addition to the requirements under SWRCB D-1641 net Delta Outflow Index.

Coordinated Operation Agreement

The CVP and SWP are operated in a coordinated manner in accordance with Public Law 99-546 (October 27, 1986), directing the Secretary to execute the COA. The CVP and SWP are also operated under the SWRCB decisions and water right orders related to the CVP's and SWP's water right permits and licenses to appropriate water by diverting to storage, by directly diverting to use, or by re-diverting releases from storage later in the year or in subsequent years.

The CVP and SWP are permitted by SWRCB to store water, divert water and re-divert CVP and SWP water that has been stored in upstream reservoirs. The CVP and SWP have built water storage and water delivery facilities in the Central Valley to deliver water supplies to CVP and SWP contractors, including senior water users. The CVP's and SWP's water rights are conditioned by the SWRCB to protect the beneficial uses of water within the watersheds.

As conditions of the water right permits and licenses, SWRCB requires the CVP and SWP to meet specific water quality objectives within the Delta. Reclamation and DWR coordinate operation of the CVP and SWP, pursuant to the COA, to meet these and other operating requirements. The COA is an agreement between the Federal government and the State of California for the coordinated operation of the CVP and SWP. The agreement suspended a 1960 agreement and superseded annual coordination agreements that had been implemented following construction of the SWP.

Obligations for In-Basin Uses

In-basin uses are defined in the COA as legal uses of water in the Sacramento Basin, including the water required under the SWRCB D-1485.

Balanced water conditions are defined in the COA as periods when it is mutually agreed that releases from upstream reservoirs plus unregulated flows approximately equals the water supply needed to meet Sacramento Valley in-basin uses plus exports. Excess water conditions are periods when it is mutually agreed that releases from upstream reservoirs plus unregulated flow exceed Sacramento Valley in-basin uses plus exports.

During excess water conditions, sufficient water is available to meet all beneficial needs, and the CVP and SWP are not required to make additional releases. In excess water conditions, water accounting is not required and some of the excess water is available to CVP water contractors, SWP water contractors, and users located upstream of the Delta. However, during balanced water conditions, CVP and SWP share the responsibility in meeting in-basin uses.

When water must be withdrawn from reservoir storage to meet in-basin uses, 75 percent of the responsibility is borne by the CVP and 25 percent is borne by the SWP. When unstored water is available for export (i.e., Delta exports exceed storage withdrawals while balanced water conditions exist), the sum of CVP stored water, SWP stored water, and the unstored water for export is allocated 55/45 to the CVP and SWP, respectively. The percentages and ratios included in the COA were derived from negotiations between Reclamation and DWR for SWRCB D-1485 standards and CVP and SWP annual supplies existing at the time and projected into the future. Reclamation and DWR have continued to apply these ratios as new SWRCB standards and other statutory and regulatory changes have been adopted.

Accounting and Coordination of Operations

Reclamation and DWR coordinate on a daily basis to determine target Delta outflow for water quality, reservoir release levels necessary to meet in-basin demands, schedules for joint use of the San Luis Unit facilities, and for the use of each other's facilities for pumping and wheeling. During balanced water conditions, daily water accounting is maintained for the CVP and SWP obligations. This accounting allows for flexibility in operations and avoids the necessity of daily changes in reservoir releases that originate several days' travel time from the Delta.

The accounting language of the COA provides the mechanism for determining the responsibility of each project for Delta outflow influenced standards; however, real-time operations dictate actions. For example, conditions in the Delta can change rapidly. Weather conditions combined with tidal action can quickly affect Delta salinity conditions, and therefore, the Delta outflow required to maintain standards. If, in this circumstance, it is decided the reasonable course of action is to increase upstream reservoir releases, then the response may be to increase Folsom Reservoir releases first because the released water will reach the Delta before flows released from other CVP and SWP reservoirs. Lake Oroville water releases require about three days to reach the Delta, while water released from Shasta Lake requires five days to travel from Keswick Reservoir to the Delta. As water from the other reservoirs arrives in the Delta, Folsom Reservoir releases can be adjusted downward. Any imbalance in meeting each project's initial shared obligation would be captured by the COA accounting.

Reservoir release changes are one means of adjusting to changing in-basin conditions. Increasing or decreasing project exports can also immediately achieve changes to Delta outflow. As with changes in reservoir releases, imbalances in meeting the CVP and SWP initial shared obligations are captured by the COA accounting.

The duration of balanced water conditions varies from year to year. Some very wet years have had no periods of balanced conditions, while very dry years may have had long continuous periods of balanced conditions, and still other years may have had several periods of balanced conditions interspersed with excess water conditions.

Joint Facilities in Suisun Marsh

The Suisun Marsh Preservation Agreement (SMPA) requires DWR and Reclamation to meet salinity standards, sets a timeline for implementing the Plan of Protection, and delineates monitoring and mitigation requirements in accordance with SWRCB D-1641 to implement and operate physical facilities in the Marsh; and management of Delta outflow.

Suisun Marsh Salinity Control Gates

The Suisun Marsh Salinity Control Gates (SMSCG) are located on Montezuma Slough about two miles downstream from the confluence of the Sacramento and San Joaquin Rivers, near Collinsville. The objective of SMSCG operation is to decrease the salinity of the water in Montezuma Slough by restricting the flow of higher salinity water from Grizzly Bay into Montezuma Slough during incoming tides and retaining lower salinity Sacramento River water from the previous ebb tide. Operation of the gates in this fashion lowers salinity in Suisun Marsh channels and results in a net movement of water from east to west. When Delta outflow is low to moderate and the gates are not operating, tidal flow past the gate is approximately 5,000 to 6,000 cfs while the net flow is near zero. When operated, flood tide flows are arrested while ebb tide flows remain in the range of 5,000 to 6,000 cfs. The net flow in Montezuma Slough becomes approximately 2,500 to 2,800 cfs. The USACE permit for operating the SMSCG requires that it be operated between October and May only when needed to meet Suisun Marsh salinity standards. Historically, the gate has been operated as early as October 1, although in some years (e.g., 1996) the gate was not operated at all. When the channel water salinity decreases sufficiently below the salinity standards, or at the end of the control season, CVP and SWP provide unrestricted movement through Montezuma Slough.

The approximately 2,800 cfs net flow induced by SMSCG operation is effective at moving the salinity downstream in Montezuma Slough. Salinity is reduced by roughly 100 percent at Belden's Landing, and by lesser amounts farther west along Montezuma Slough. At the same time, the salinity field in Suisun Bay moves upstream as net Delta outflow (measured nominally at Chipps Island) is reduced by gate operation. Net outflow through Carquinez Strait is not affected. The SMSCG are operated during the salinity control season, which spans from October to May.

Roaring River Distribution System

The Roaring River Distribution System (RRDS) was constructed during 1979 and 1980 to provide lower salinity water to 5,000 acres of private and 3,000 acres of CDFW-managed wetlands on Simmons, Hammond, Van Sickle, Wheeler, and Grizzly islands.

The RRDS includes a 40-acre intake pond that supplies water to Roaring River Slough. Motorized slide gates in Montezuma Slough and flap gates in the pond control flows through the culverts into the pond. A manually operated flap gate and flashboard riser are located at the confluence of Roaring River and Montezuma Slough to allow drainage back into Montezuma Slough for controlling water levels in the distribution system and for flood protection. DWR owns and operates this drain gate to ensure the Roaring River levees are not compromised during extremely high tides.

Water is diverted through a bank of eight 60-inch-diameter culverts equipped with fish screens into the Roaring River intake pond on high tides to raise the water surface elevation in RRDS above the adjacent managed wetlands. Managed wetlands north and south of the RRDS receive water, as needed, through publicly and privately owned turnouts on the system.

Morrow Island Distribution System

The Morrow Island Distribution System (MIDS) was constructed in 1979 and 1980 in the southwestern Suisun Marsh to channel drainage water from the adjacent managed wetlands for discharge into Suisun Slough and Grizzly Bay. This approach increases circulation and reduces salinity in Goodyear Slough.

The MIDS is used year-round, but most intensively from September through June. When managed wetlands are filling and circulating, water is tidally diverted from Goodyear Slough just south of Pierce Harbor through three 48-inch culverts. Drainage water from Morrow Island is discharged into Grizzly Bay by way of the C-Line Outfall (two 36-inch culverts) and into the mouth of Suisun Slough by way of the M-Line Outfall (three 48-inch culverts), rather than back into Goodyear Slough. This helps prevent increases in salinity due to drainage water discharges into Goodyear Slough. The M-Line ditch is approximately 1.6 miles long and the C-Line ditch is approximately 0.8 miles long.

5.3.2.3 CVP and SWP Conveyance Facilities Downstream of San Luis Reservoir

Water is released from the San Luis Reservoir into the lower portion the California Aqueduct that extends to Lake Perris in Riverside County and delivers water to the San Joaquin Valley, Central Coast, and southern California. The first reach of the California Aqueduct, the San Luis Canal, is jointly owned by the SWP and CVP and extends from San Luis Reservoir to Kettleman City. This reach includes Dos Amigos, Buena Vista, Teerink, and Chrisman pumping plants.

Near Kettleman City, water is diverted into the SWP Coastal Branch Aqueduct to serves agricultural areas west of the California Aqueduct and communities in San Luis Obispo and Santa Barbara counties.

The California Aqueduct continues into southern California through the Edmonston Pumping Plant, located at the foot of the Tehachapi Mountains, that raises the water 1,926 feet into approximately 8 miles of tunnels and siphons that convey water into Antelope Valley. At that location, the California Aqueduct divides into two branches; the East Branch and the West Branch.

The East Branch conveys water through the Tehachapi East Afterbay, Alamo Powerplant, Pearblossom Pumping Plant, and Mojave Siphon Powerplant into Silverwood Lake in the San Bernardino Mountains, which stores 73,000 acre-feet of water. From Silverwood Lake, water flows through the San Bernardino Tunnel into Devil Canyon Powerplant to Lake Perris. Lake Perris, located near the City of Riverside, provides up to 131,500 acre-feet of storage, and serves as a regulatory and emergency water supply facility for the East Branch. The Phase I of the East Branch Extension was completed in 2003 and conveys water to San Gorgonio Pass Water Agency and the eastern portion of the San Bernardino Valley Municipal Water District.

The West Branch conveys water through Oso Pumping Plant, Quail Lake, Lower Quail Canal, and William E. Warne Powerplant into Pyramid Lake in Los Angeles County. Water from Pyramid Lake is conveyed through the Angeles Tunnel, Castaic Powerplant, Elderberry Forebay, and Castaic Lake. Castaic Lake, located north of the City of Santa Clarita, provides 324,000 acre-feet of storage, and is a regulatory and emergency water supply facility for the West Branch. The Castaic Powerplant is owned and operated by the Los Angeles Department of Water and Power.

5.3.2.4 Non-CVP and SWP Reservoirs that Store CVP and SWP Water

The CVP and SWP water is delivered to water agencies. Some of those water agencies store the water in regional and local reservoirs. These reservoirs frequently store non-CVP and SWP water supplies, including local runoff or water diverted under separate water rights or contracts. The capacities of these reservoirs are listed in Tables 5.5, 5.6, and 5.7.

In the San Francisco Bay Area Region, CVP water is stored in the Contra Costa Water District Los Vaqueros Reservoir and the East Bay Municipal Utility District Upper San Leandro, San Pablo, Briones, and Lafayette reservoirs and Lake Chabot. The Los Vaqueros Reservoir, as previously described, also stores water diverted from the Delta under separate water rights. The East Bay Municipal Utility District reservoirs primarily store water diverted under water rights on the Mokelumne River.

In the Central Coast Region, a portion of the SWP water supply diverted in the Coastal Branch can be stored in Cachuma Lake for use by southern Santa Barbara County communities. Cachuma Lake is a facility owned and operated by Reclamation in Santa Barbara County as part of the Cachuma Project (not the CVP).

In the Southern California Region, SWP water is stored in the Metropolitan Water District of Southern California’s Diamond Valley Lake and Lake Skinner; United Water Conservation District’s Lake Piru; City of Escondido’s Dixon Lake; City of San Diego’s San Vicente, El Capitan, Lower Otay, Hodges, and Murray reservoirs; Helix Water District’s Lake Jennings; Sweetwater Authority’s Sweetwater Reservoir; and San Diego County Water Authority’s Olivenhain Reservoir. There are future plans to expand local and regional water surface water storage.

5.3.3 Water Supplies Used by Central Valley Project and State Water Project Water Users

The CVP and SWP water supplies are the only water supplies available to some water users, many of the CVP Sacramento River Settlement Contractors, communities near Redding (Centerville, Clear Creek, and Shasta community services districts; Shasta County Water Agency), communities in the San Joaquin Valley (cities of Avenal, Coalinga, and Huron), and some communities served by the Antelope Valley-East Kern Water Agency. Other CVP and SWP water users rely upon other surface water supplies and groundwater. However, when the CVP and SWP water supplies are limited due to climate conditions and hydrology, the other surface water supplies are also limited.

Several CVP and SWP water users also rely upon other imported water supplies, including water from Solano Project (used by the Solano County Water Agency), San Francisco Public Utilities Commission (used by portions of the service areas of Alameda County Water District, Santa Clara Valley Water District, and Zone 7 Water Agency), and the Colorado River (used by portions of the service area of the Metropolitan Water District of Southern California and Coachella Valley Water District). These surface water supplies are also subject to reductions due to hydrologic conditions. In the case of water users that rely upon Colorado River water supplies, Delta water is used to dilute the salts and trace elements (e.g., selenium) in the Colorado River water in addition to providing direct water supplies (Reclamation 2012).

In response to recent reductions in CVP and SWP water supply reliability, water agencies have been improving regional and local water supply reliability through enhanced water conservation efforts, wastewater effluent and stormwater recycling, construction of surface water and groundwater storage facilities, and construction of desalination treatment plants for brackish water sources and ocean water sources. In addition, many agencies have constructed conveyance facilities to allow sharing of water supplies between communities, including the recent Bay Area Regional Water Supply Reliability project that provided conveyance opportunities between several CVP and SWP water users in the San Francisco Bay Area Region.

Water conservation is an integral part of water management in the study area. Water use efficiency programs and initiatives reduce the need for more expensive water supplies by facilitating the efficient use of existing water supplies. For example, a cost-effective component of many water plans is to reduce water use through educational tools that include commercial and residential guidance for water efficient landscapes, water use calculators for agricultural and municipal users, and conservation websites. All of these efforts are implemented to meet the statewide goals to reduce municipal per capita water use by 20 percent by 2020 and to optimize agricultural water use efficiency.

Water transfers also are an integral part of water management. Historically, water transfers primarily were in-basin transfers (e.g., Sacramento Valley water seller to Sacramento Valley water user) (Reclamation 2013b; DWR, Reclamation, USFWS and NMFS 2013). However, between 2001 and 2012, water transfers from the Sacramento Valley to the areas located south of the Delta of up to 298,806 acre-feet occurred (not including water transfers under the Environmental Water Account Program in the early 2000s) (DWR, Reclamation, USFWS and NMFS 2013). These transfers occurred in drier years. In the 2012 and 2013, the following types of water transfers occurred (DWR and SWRCB 2014).

- Water transfers involving CVP and SWP water:
    - 2012: 47,420 acre-feet of water transfers (43 percent were between agricultural water users, 36 percent were between municipal water users, and 21 percent were between agricultural and municipal water users).
    - 2013: 63,790 acre-feet of water transfers (28 percent were between agricultural water users, and 72 percent were between agricultural and municipal water users).
- Water transfers involving non-CVP and SWP water:
    - 2012: 188,074 acre-feet of water transfers (72 percent were between agricultural water users, 14 percent were from agricultural water users to

wildlife refuges, and 14 percent were between agricultural and municipal water users).

  - 2013: 268,370 acre-feet of water transfers (72 percent were between agricultural water users, 1 percent were from agricultural water users to wildlife refuges, and 27 percent were between agricultural and municipal water users).

Until recently, most of the water transfers extended for one or two years. In 2008, one of the first long-term water transfer agreements was approved by the SWRCB for the Lower Yuba River Accord. The plan was designed to protect and enhance fisheries resources in the Lower Yuba River, increase local water supply reliability, provide DWR with increased operational flexibility for protection of Delta fisheries resources, and provide added dry-year water supplies to CVP and SWP water users, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. In 2013, Reclamation approved an overall program for a 25-year period (2014 to 2038) to transfer up to 150,000 acre-feet per year of water from the San Joaquin River Exchange Contractors Water Authority to DOI for refuge water supplies or CVP and SWP water users (Reclamation 2013b). Reclamation is currently evaluating a long-term water transfer program (2015 to 2024) between water sellers in the Sacramento Valley and water users located in the San Francisco Bay Area and south of the Delta (Reclamation 2014b).

5.3.4 Surface Water Resources and Water Supplies During Droughts

Drought is a gradual phenomenon and can best be thought of as a condition of water shortage for a particular user in a particular location. Although persistent drought may be characterized as an emergency, it differs from typical emergency events. Most natural disasters, such as floods or forest fires, occur relatively rapidly and afford little time for preparing for disaster response. Droughts occur slowly, over a period of time. There is no universal definition of when a drought begins or ends. Impacts of drought are typically felt first by those most reliant on annual rainfall -- ranchers engaged in dryland grazing, rural residents relying on wells in low-yield rock formations, or small water systems lacking a reliable water source. Criteria used to identify statewide drought conditions do not address these localized impacts. Drought impacts increase with the length of a drought, as carry-over supplies in reservoirs are depleted and water levels in groundwater basins decline.

Measurements of California water conditions cover only a small slice of the past. Widespread collection of rainfall and streamflow information began around the turn of the 20th century. During our period of recorded hydrology, the most significant statewide droughts occurred during 1928-34, 1976-77, 1987-92, and 2007-09. A significant regional drought occurred in parts of Southern California in 1999-2002. Historical data combined with estimates created from indirect indicators such as tree rings suggest that the 1928-34 event may have been the driest period in the Sacramento River watershed since about the mid-1550s.

5.3.4.1 Prior General Drought Responses

Previous droughts that have occurred throughout California's history are constantly shaping and innovating the ways in which DWR and Reclamation handle both public health standards and urban and agricultural water demand, as well as protecting the Delta ecosystem and its inhabitants. The most notable droughts in recent history are the droughts that occurred in 1976-77 and 1987-92. The climactic situation helped shape legislation and stressed the importance of maintaining water supplies for all water users.

The impacts of a dry hydrology in 1976 were mitigated by reservoir storage and groundwater availability. The immediate succession of an even drier 1977, however, set the stage for widespread impacts. In 1977 CVP agricultural water contractors received 25 percent of their allocations, municipal contractors received 25 to 50 percent, and the exchange contractors received 75 percent. SWP agricultural contractors received 40 percent of their allocations and urban contractors received 90 percent.

Managing Delta salinity is a major challenge, given the competing needs to preserve critical carry-over storage and to release water from storage to meet Bay-Delta water quality standards. In February 1977, the SWRCB adopted an interim water quality control plan to modify Delta standards to allow the SWP to conserve storage in Lake Oroville. As extremely dry conditions continued that spring, the SWRCB subsequently adopted an emergency regulation superseding its interim water quality control plan, temporarily eliminating most water quality standards and forbidding the SWP to export stored water. As a further measure to conserve reservoir storage, DWR constructed temporary facilities (i.e., rock barriers, new diversions for Sherman Island agricultural water users, and facilities to provide better water quality for duck clubs in Suisun Marsh) in the Delta to help manage salinity with physical, rather than hydraulic, approaches.

In 1977, SWP and CVP contractors used water exchanges to respond to drought. One of the largest exchanges involved 435,000 acre-feet of SWP contract water made available by Metropolitan Water District of Southern California and three other SWP Southern California water contractors for use by San Joaquin Valley irrigators and urban agencies in the San Francisco Bay area.

During the 1987-92 drought, the state's 1990 population was close to 80 percent of present amounts and irrigated acreage was roughly the same as that of the present, but the institutional setting for water management differed significantly. Delta regulatory constraints affecting CVP and SWP operations were based on SWRCB D-1485, which had taken effect in 1978 immediately following the 1976-77 drought. In addition to SWRCB D-1485 requirements on CVP and SWP operations in the Delta, other operational constraints included water temperature standards imposed by the SWRCB through Water Rights Orders 90-5 and 91-01 for portions of the Sacramento and Trinity rivers. As part of managing salinity during the drought, DWR installed temporary barriers at two South Delta locations (along Middle River and in Old River near the Delta-Mendota Canal intake) to improve water levels and water quality/water circulation for agricultural diverters.

5.3.4.2 Recent General Drought Response

As a result of more recent drought conditions, California Governor Edmund G. Brown issued a Drought Emergency Proclamation on January 17, 2014 that is effective through May 31, 2016. This proclamation directs the SWRCB to, among other things, consider petitions, such as Temporary Urgency Change Petitions (TUCP), to modify requirements for reservoir releases or diversion limitations that were established to implement a water quality control plan.

On January 29, 2014, Reclamation and DWR sought a temporary modification to their water rights permits and licenses through a TUCP, allowing the CVP and SWP to reduce Delta outflow and thus conserve upstream storage for later use. The resultant January 31, 2014, Governor's Executive Order (January Order) also allowed the projects to pump at a minimum level (up to a total of 1,500 cfs) to supply essential public health and safety needs when Delta outflow was lower than would typically allow such pumping. Reclamation and DWR convened a Real Time Drought Operations Management Team (RTDOMT) comprised of representatives from Reclamation, DWR, USFWS, NMFS, CDFW, and SWRCB to discuss more flexible operations of the projects while protecting beneficial uses. Throughout 2014, the federal and state fish and wildlife agencies worked in close coordination with Reclamation and DWR to receive, analyze, and respond to the CVP and SWP operators' requests for additional operational flexibility while still remaining within the boundaries of the applicable environmental laws and regulations.

The January Order was amended several times to allow project operators to pump at higher levels to capture storm run-off. The January Order was also extended and/or amended to modify SWRCB D-1641 Delta Outflow requirements. The *CVP and SWP Drought Operations Plan and Operational Forecast for April 1, 2014 through November 15, 2014* (DOP) (Reclamation and DWR 2014a), outlined critical CVP/SWP operational considerations including providing for essential human health and safety needs; maintaining salinity control; planning for installation of three emergency drought barriers; maintaining adequate water supply reserves for 2015; providing for cold water species' needs, CVP and SWP water supplies, and refuge water supplies; and providing for operational flexibility, exchanges, and transfers. The DOP included upstream tributary operations as well as further modifications to D-1641 provisions associated with Delta outflow levels, maximum export limits, Delta E:I averaging period, combined export limitations, Vernalis base and pulse flows, and agricultural salinity compliance locations. Modifications to the DOP were requested in September 2014, regarding changes to San Joaquin River flows at Vernalis and extension of the water transfer window.

The *CVP and SWP Drought Contingency Plan for October 15, 2014 through January 15, 2015* (Drought Contingency Plan) (Reclamation and DWR 2015a), was prepared by Reclamation and DWR in response to the SWRCB October 7, 2014 Modified TUC Order. This Plan provided an overview of current conditions and available supplies as they related to projected flow and storage conditions for assumed hydrology, and addressed projected water operations based on various hydrologic scenarios and potential adjustments to regulatory requirement through January 15, 2015.

The subsequent *Drought Contingency Plan for January 15, 2015 through September 30, 2015*, was prepared to incorporate changes in snowpack, reservoir storage, and updated hydrologic forecasts. The January 15, 2015, *Drought Contingency Plan* appended a December 12, 2014 working draft of the *Interagency 2015 Drought Strategy for the CVP and SWP* (Reclamation and DWR 2014b). The 2015 Drought Strategy described the anticipated coordination, process, planning, and potential drought response actions for 2015.

Similar to 2014, Reclamation and DWR jointly filed several TUCPs starting on January 23, 2015, to temporarily modify requirements in their water right permits and licenses for the SWP and CVP. The TUCPs requested temporary modification of requirements included in SWRCB Revised D-1641 to meet water quality objectives in the *Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary*. Specifically, the TUCPs during 2015 requested modifications to Delta outflow, San Joaquin River flow, DCC gate operation, and export limit objectives/or requirements, as well as upstream tributary operations, Rio Vista flows, western Delta salinity, and San Joaquin River salinity objectives.

The combination of virtually no snowpack and diminished reservoir storage in the spring of 2015 convinced federal and state wildlife and water agency managers that an emergency salinity barrier on West False River in the Sacramento-San Joaquin Delta was needed to repel salinity that could threaten a source of water used by 25 million Californians. Installation of a single emergency salinity barrier across West False River began in early May; with removal scheduled by mid-November. The barrier helped to limit the tidal push of saltwater from San Francisco Bay into the central Delta and helped minimize the amount of fresh water that must be released during the summer from upstream reservoirs to repel saltwater. Sufficient reserves in upstream reservoirs are needed to repel saltwater and prevent the contamination of water supplies for residents of the Delta; Contra Costa, Alameda and Santa Clara counties, and the 25 million people who rely on the Delta-based federal and state water projects for at least some of their supplies. Removal of the emergency barrier by November 15 is needed to avoid the flood season and harm to migratory fish. While it is in place, boaters used alternative routes between the San Joaquin River and the Delta's interior.

5.3.4.3 Recent Drought Effects on Surface Water Resources and Supplies

California is currently in its fourth consecutive year of below-average rainfall and very low snowpack. Water Year 2015 is also the eighth of 9 years with below-average runoff, which has resulted in chronic and significant shortages to municipal and industrial, agricultural, and refuge water supplies and historically low levels of groundwater. As of October 2015, 46 percent of the state was experiencing an Extreme Drought and 25 percent was experiencing an Exceptional Drought, as recorded by the National Drought Mitigation Center, U.S. Drought Monitor (Drought Monitor 2015). Of particular concern has been the state's critically low snow pack which typically provides much of California's seasonal water storage. On April 1, 2015, for the first time in 75 years of early-April measurements, DWR found no snow at the Phillips snow course, a primary snowpack measurement site in the Sierra Nevada mountain range. Lack of precipitation the last several years has also contributed to low reservoir storage levels in the Sacramento watershed. Shasta Reservoir on the Sacramento River and Lake Oroville on the Feather River, and Folsom Lake on the American River were at 35 and 30 percent of capacity, respectively, on October 5, 2015 (58 and 49 percent of historical average, respectively). Trinity Lake on the Trinity River was at 22 percent of capacity and 32 percent of historical average. The San Joaquin River watershed in particular has experienced severely dry conditions for the past three years, with and New Melones Reservoir at 11 percent capacity (20 percent historical average as of October 5, 2015.

Recently, one of the most critical reservoir water elevations has occurred at Folsom Lake. On October 5, 2015, the storage was at 17 percent of capacity, or 21 percent of historical average at this time of the year. When the water elevations in Folsom Lake decline substantially, the intakes along Folsom Dam may not be able to operate at full capacity. Therefore, in 2015, Reclamation installed a barge and pump system in Folsom Lake to allow diversions when low water surface elevations would cause capacity issues for existing intakes.

Overall, in 2014 and 2015, CVP and SWP water allocations were substantially reduced. The final 2014 water allocations and the February 2015 water allocations were as follows (Reclamation 2015; DWR 2014e, 2015):

- CVP agricultural water contractors: zero percent in 2014 and 2015.
- CVP municipal and industrial contractors: 50 percent in 2014 and 25 percent in 2015.
- CVP Eastside Division contractors: 55 percent in 2014 and zero percent in 2015.
- CVP Friant Water Division Class I and II contractors: zero percent in 2014 and 2015.
- CVP Sacramento River Water Rights Settlement Contractors and Sacramento Valley wildlife refuges (Level 2 water supplies): 75 percent in 2014 and 2015 (based on preliminary allocations in February 2016).
- CVP San Joaquin River Exchange Contractors and San Joaquin Valley wildlife refuges (Level 2 water supplies): 65 percent in 2014 and 75 percent in 2015 (based on preliminary allocations in February 2016). In 2014 and 2015, San Joaquin River Exchange Contractors received a portion of the contract amounts from Millerton Lake.
- SWP agricultural and urban contractors: up to 20 percent of the Table A water contract amounts in 2014 and 2015.

- SWP Feather River water rights contractors: 100 percent in 2014 and 50 percent in 2015.

The Congressional Research Service summarized the following information prepared by the SWRCB to describe the economic impacts of the 2014 drought period (CRS 2015):

- 428,000 acres agricultural lands idled in the Central Valley, Central Coast, and Southern California regions.
- $447 million of increased cost to increase groundwater pumping.
- $2.2 billion total economic loss, including $1.5 billion direct loss to agriculture (or 3 percent of the total average agricultural production value).
- 17,100 agricultural-related jobs lost (including 3.8 percent of total farm employment).
- Unaccounted loses for commercial and recreational fishing, reservoir and river recreation, and non-agricultural water dependent industrial job losses.

Responses to droughts have changed since the 1976-77 drought. The federal and state governments have acknowledged the droughts early in the process and implemented emergency actions to preserve water supplies for future years in case the droughts extend over long-periods. As discussed above in this section, these actions have included reductions in water supply allocations as well as modification of regulatory requirements to protect future water supplies for all beneficial uses. The responses to drought are generally limited to short-term actions, including stringent water conservation by municipal users, increased groundwater pumping by municipal and agricultural users, and modification of regulatory requirements. However, these short-term responses generally cannot be maintained on a long-term basis without economic effects. Following the drought in 1987-92, longer term programs were initiated by both municipal and industrial water users. For example, water recycling increased 144 percent between 1977 and 1987, and 251 percent between 2009 and 1987 (SWRCB 2009). Other long-term water supply reduction programs were initiated after the previous droughts, including increased use of drip irrigation. For example, Westlands Water District increased the use of drip irrigation from 3 percent of the crops in 1990 to 65 percent of the crops in 2011 (WWD 2013). However, these types of long-term responses take time to implement and once the savings are realized, there is less flexibility to respond to future droughts because the savings have occurred on a long-term basis.

It is also recognized that some effects of droughts do not occur within the year that the drought occurs. For example, increased use of groundwater in one year may result in subsidence in following years. Effects in commercial and sport fishing ocean salmon fishing also would not be realized in the years that the drought occurs because loss of spawning populations affects available salmon stocks for several years and future spawning populations. For example, coded wire tag recoveries of Sacramento River fall-run Chinook Salmon for commercial fishing noticeably declined following the 1987-1992 and 2007-09 droughts up to 95 percent (PFMC 2015).

5.4 Impact Analysis

This section describes the potential mechanisms and analytical methods for change in surface water resources, results of the impact analysis, potential mitigation measures, and cumulative effects.

5.4.1 Potential Mechanisms for Change and Analytical Methods

As described in Chapter 4, Approach to Environmental Analysis, the impact assessment considers changes in surface water resources conditions related to changes in CVP and SWP operations under the alternatives as compared to the No Action Alternative and Second Basis of Comparison.

5.4.1.1 Changes in CVP and SWP Reservoir Storage and Downstream River Flows

Changes in CVP and SWP operations under the alternatives as compared to the No Action Alternative and the Second Basis of Comparison would result in changes to reservoir storage volumes (and elevations) and flow patterns in the downstream rivers. Numerical models are available to quantitatively analyze the changes in CVP and SWP reservoirs and pumping plants in the Central Valley, affected surface water bodies, and deliveries of CVP and SWP water. Changes in reservoirs that store CVP and SWP water outside of the Central Valley are not included in the CVP and SWP numerical models, and are evaluated qualitatively.

The surface water supply analysis was conducted using the CalSim II model, as described in Appendix 5A, CalSim II and DSM2 Modeling, to simulate the operational assumptions of each alternative that were described in Chapter 3, Description of Alternatives.

5.4.1.1.1 Use of CalSim II Model

CalSim II is a reservoir-river basin planning model developed by DWR and Reclamation to simulate the operation of the CVP and SWP over a range of different hydrologic conditions. Inputs to CalSim II include water demands (including water rights), stream accretions and depletions, reservoir inflows, irrigation efficiencies, and parameters to calculate return flows, non-recoverable losses and groundwater operations. Sacramento Valley and tributary rim basin hydrology uses an adjusted historical sequence of monthly stream flows over an 82-year period (1922 to 2003) to represent a sequence of flows at a future level of development. Adjustments to historic water supplies are imposed based on future land use conditions and historical meteorological and hydrologic conditions. The resulting hydrology represents the water supply available from Central Valley streams to the CVP and SWP at a future level of development. Water rights deliveries to non-CVP and non-SWP water rights holders are not modified in the CalSim II simulations of the alternatives. CalSim II produces outputs for river flows and diversions, reservoir storage, Delta flows and exports, Delta inflow and outflow, deliveries to project and non-project users, and controls on project operations.

The CalSim II model monthly simulation of an actual daily (or even hourly) operation of the CVP and SWP results in several limitations in use of the model results. The model results must be used in a comparative manner to reduce the effects of use of monthly assumptions and other assumptions that are indicative of real-time operations, but do not specific match real-time observations. The CalSim II model output is based upon a monthly time step. The CalSim II model output includes minor fluctuations of up to 5 percent due to model assumptions and approaches. Therefore, if the quantitative changes between a specific alternative and the No Action Alternative and/or Second Basis of Comparison are 5 percent or less, the conditions under the specific alternative would be considered to be “similar” to conditions under the No Action Alternative and/or Second Basis of Comparison.

Under extreme hydrologic and operational conditions where there is not enough water supply to meet all requirements, CalSim II utilizes a series of operating rules to reach a solution to allow for the continuation of the simulation. It is recognized that these operating rules are a simplified version of the very complex decision processes that CVP and SWP operators would use in actual extreme conditions. Therefore, model results and potential changes under these extreme conditions should be evaluated on a comparative basis between alternatives and are an approximation of extreme operational conditions. As an example, CalSim II model results show simulated occurrences of extremely low storage conditions at CVP and SWP reservoirs during critical drought periods when storage is at dead pool levels at or below the elevation of the lowest level outlet. Simulated occurrences of reservoir storage conditions at dead pool levels may occur coincidentally with simulated impacts that are determined to be potentially significant. When reservoir storage is at dead pool levels, there may be instances in which flow conditions fall short of minimum flow criteria, salinity conditions may exceed salinity standards, diversion conditions fall short of allocated diversion amounts, and operating agreements are not met.

5.4.1.1.2 Analysis of Changes in Reservoir Storage and Downstream River Flows

CalSim II outputs for the alternatives are compared to the CalSim II outputs for the No Action Alternative and the Second Basis of Comparison to evaluate changes in reservoir storages at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, New Melones Reservoir, and San Luis Reservoir; flows downstream of CVP and SWP reservoirs in Trinity, Sacramento, Feather, American, Stanislaus rivers and Clear Creek; flows from the Sacramento River at Fremont Weir into the Yolo Bypass; Delta outflow; and reverse flows in Old and Middle rivers (OMR criteria).

The analyses discussed in Chapters 5 through 21 do not include specific analysis for Millerton Lake and the San Joaquin River between Friant Dam and the confluence with the Stanislaus River under Alternatives 1 through 5 as compared to the No Action Alternative and Second Basis of Comparison. The results of these analyses (presented in Appendix 5A, CalSim II and DSM2 Modeling) indicated that there were no differences in Millerton Lake storage or San Joaquin River flows upstream of the confluence with the Stanislaus River between Alternatives 1 through 5 as compared to the No Action Alternative and Second Basis of Comparison because implementation of the alternatives would not affect the operations of Millerton Lake. Therefore, conditions at Millerton Lake and the San Joaquin River between Friant Dam and the confluence of the Stanislaus River are not analyzed in this EIS.

The analyses discussed in Chapters 5 through 21 do not include specific analysis for creeks downstream of San Luis Reservoir complex. Unlike the rivers located downstream of CVP and SWP reservoirs (e.g., Sacramento River downstream of Shasta Dam), river channels located downstream of the San Luis Reservoir complex are not used to convey CVP and SWP water. Instream flows in these rivers would not be affected by changes in CVP and SWP operations. Therefore, flows in streams downstream of San Luis Reservoir are not analyzed in this EIS.

Reservoirs that store CVP and SWP water are also located in the San Francisco Bay Area, Central Coast, and Southern California regions. Many of these reservoirs also store water from other water supplies including CVP and SWP water. These reservoirs are not included in the CalSim II model simulation. Storage volumes in non-CVP and SWP reservoirs located south of the Delta that store CVP or SWP water also are affected by the availability local runoff stored in these reservoirs; and from imported Colorado River water in some Southern California reservoirs. This EIS does not analyze availability of future local runoff or imported Colorado River water supplies in 2030. For this EIS, it is assumed that under a worst-case scenario, changes in CVP and SWP water deliveries would result in similar changes to storage in these reservoirs. For example, reductions in CVP or SWP deliveries would result in reductions in storage in reservoirs located south of the Delta. Generally, river channels located downstream of these reservoirs are not used to convey CVP and SWP water. Instream flows in these rivers would not be affected by changes in CVP and SWP operations. Therefore, flows in these streams are not analyzed in this EIS.

5.4.1.2 Changes in Flows over Fremont Weir into Yolo Bypass

All of the alternatives, including the No Action Alternative and the Second Basis of Comparison, include operations of an operable gate at Fremont Weir, as described in Chapter 3, Description of Alternatives. Results of the CalSim II model were used to assess changes in average monthly flows that would flow into the Yolo Bypass over an operable gate at Fremont Weir. Operational assumptions for the operable gate were developed for the purposes of this EIS analysis, and are the same in all alternatives and the Second Basis of Comparison. Specific operational assumptions are being developed by Reclamation and others in a separate analysis that includes separate environmental documentation. Although the operational assumptions for an operable gate at Fremont Weir would be the same under all alternatives and the Second Basis of Comparison; the flow patterns into the Yolo Bypass would change based upon the magnitude of flows in the Sacramento River at Fremont Weir, as evaluated quantitatively using CalSim II model output. Assumptions used in the CalSim II model are described in Appendix 5A, CalSim II and DSM2 Modeling.

Flows also enter the Yolo Bypass at the Sacramento Weir (downstream of Fremont Weir) at a lower flow rate. However, the Sacramento Weir operations are assumed to remain as described in Section 5.3, Affected Environment, in all alternatives and the Second Basis of Comparison.

5.4.1.3 Changes in Delta Conditions

Changes in CVP and SWP operations under the alternatives as compared to the No Action Alternative and Second Basis of Comparison would change the Delta inflows from the tributary watersheds, Delta outflow, and reverse flows in Old and Middle River (as indicated by OMR flows). Results of the CalSim II model were used to assess changes in Delta outflow and positive and negative OMR flows. Assumptions used in the CalSim II model are described in Appendix 5A, CalSim II and DSM2 Modeling.

5.4.1.4 Changes in Delta Exports and CVP and SWP Deliveries

Changes in CVP and SWP operations under the alternatives as compared to the No Action Alternative and Second Basis of Comparison would change CVP and SWP exports and deliveries, as analyzed using the CalSim II model. Assumptions used in the CalSim II model are described in Appendix 5A, CalSim II and DSM2 Modeling.

It should be noted that deliveries to CVP and SWP water users located to the south of the Delta are not necessarily the same volume as the Delta export patterns because a portion of the exported water is stored in San Luis Reservoir and released on a different pattern than Delta exports.

It also should be noted that the monthly CalSim II model results do not represent daily water operations decisions, especially for extreme conditions. For example, in very dry years, the model simulates minimum reservoir volumes (also known as “dead pool conditions”) that appear to prevent Reclamation and DWR from meeting their contractual obligations, including water deliveries to CVP Sacramento River Settlement Contractors, CVP San Joaquin River Exchange Contractors, SWP Feather River Service Area Contractors, and Level II refuge water supplies. Such model results are anomalies that reflect the inability of the monthly model to make real-time policy decisions under extreme circumstances. Projected reservoir storage conditions near dead pool conditions should only be considered as an indicator of stressed water supply conditions, and not necessarily reflective of actual CVP and SWP operations in the future.

5.4.1.5 Effects Related to Water Transfers

Historically water transfer programs have been developed on an annual basis. The demand for water transfers is dependent upon the availability of water supplies to meet water demands. Water transfer transactions have increased over time as CVP and SWP water supply availability has decreased, especially during drier water years.

Parties seeking water transfers generally acquire water from sellers who have available surface water who can make the water available through releasing previously stored water, pumping groundwater instead of using surface water (groundwater substitution), idle crops, or substitute crops that uses less water in order to reduce normal consumptive use of surface water.

Water transfers using CVP and SWP Delta pumping plants and south of Delta canals generally occur when there is unused capacity in these facilities. These conditions generally occur during drier water year types when the flows from upstream reservoirs plus unregulated flows are adequate to meet the Sacramento Valley water demands and the CVP and SWP export allocations (defined as “balanced Delta conditions” in the COA, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations). In nonwet years, the CVP and SWP water allocations would be less than full contract amounts; therefore, capacity may be available in the CVP and SWP conveyance facilities to move water from other sources.

Water transfers using CVP and SWP conveyance facilities frequently do not occur when releases from upstream reservoirs plus unregulated flows are greater than the Sacramento Valley water demands and the CVP and SWP export allocations (defined as “excess Delta conditions in the COA) because the available water is being conveyed to meet the CVP and SWP contract demands. This condition generally occurs in winter and spring months of wet years.

Without implementation of the 2008 USFWS BO and 2009 NMFS BO, water transfers could occur in most months when exports are less than conveyance capacity. The 2008 USFWS BO and 2009 NMFS BO include export restrictions in the winter and spring months that limit use of the conveyance capacity.

Transfers requiring conveyance through the Delta occur when pumping and conveyance capacity at the CVP or SWP export facilities is available. Reclamation and DWR must coordinate review of the transfer proposals and related CVP and SWP operations to assure that the CVP and SWP are not impacted including the ability to exercise their own water rights or to meet their legal and regulatory requirements are not diminished or limited in any way. To avoid impacts to Delta water quality the individual transfer is assessed a carriage water loss to account for flows required to avoid impacts to Delta water quality or flow objectives. All transfers are required to be implemented in accordance with all existing regulations and requirements, including not causing adverse impacts on other water users in accordance with SWRCB requirements.

Reclamation recently prepared a long-term regional water transfer environmental document which evaluated potential changes in surface water conditions related to water transfer actions (Reclamation 2014i). Results from this analysis were used to inform the impact assessment of potential effects of water transfers under the alternatives as compared to the No Action Alternative and the Second Basis of Comparison.

5.4.2 Conditions in Year 2030 without implementation of Alternatives 1 through 5

The impact analysis in this EIS is based upon the comparison of the alternatives to the No Action Alternative and the Second Basis of Comparison in the Year 2030. Changes that would occur over the next 15 years without implementation of the alternatives are not analyzed in this EIS. However, the changes that are assumed to occur by 2030 under the No Action Alternative and the Second Basis of Comparison are summarized in this section.

Many of the changed conditions would occur in the same manner under both the No Action Alternative and the Second Basis of Comparison. Other future conditions would be different under the No Action Alternative as compared to the Second Basis of Comparison due to the implementation of the 2008 USFWS BO and 2009 NMFS BO under the No Action Alternative.

This section of Chapter 5 provides qualitative projections of the No Action Alternative as compared to existing conditions described under the Affected Environment; and qualitative projections of the Second Basis of Comparison as compared to “recent historical conditions.” Recent historical conditions are not the same as existing conditions which include implementation of the 2008 USFWS BO and 2009 NMFS BO; and consider changes that would have occurred without implementation of the 2008 USFWS BO and the 2009 NMFS BO.

5.4.2.1 Common Changes in Conditions under the No Action Alternative and Second Basis of Comparison

Conditions in 2030 would be different than existing conditions due to:

- Climate change and sea-level rise
- General plan development throughout California, including increased water demands in portions of Sacramento Valley
- Implementation of reasonable and foreseeable water resources management projects to provide water supplies

These changes would result in a decline of the long-term average CVP and SWP water supply deliveries by 2030 as compared to recent historical long-term average deliveries.

5.4.2.1.1 Changes in Conditions due to Climate Change and Sea-Level Rise

It is anticipated that climate change would result in more short-duration high-rainfall events and less snowpack in the winter and early spring months. The reservoirs would be full more frequently by the end of April or May by 2030 than in recent historical conditions. However, as the water is released in the spring, there would be less snowpack to refill the reservoirs. This condition would reduce reservoir storage and available water supplies to downstream uses in the summer. The reduced end-of-September storage also would reduce the ability to release stored water to downstream regional reservoirs. These conditions would occur for all reservoirs in the California foothills and mountains, including non-CVP and SWP reservoirs.

Sea level rise also would result in reduced CVP and SWP reservoir storage. As sea level rise occurs, the location of the salt water-freshwater zone moves further inland. However, the CVP and SWP must continue to meet the salinity criteria to protect Delta water users and Delta aquatic resources, including the SWRCB D-1641 and other salinity criteria to protect Delta water users. To meet these criteria, the amount of water released from CVP and SWP reservoirs must be increased as compared to recent historical conditions.

Climate change also would cause changes in stream flows. During the storm events, the flows would be higher than in recent historical conditions because a larger portion of the precipitation would occur as rainfall instead of snowfall. Flows would increase in the spring as more water is released from CVP and SWP reservoirs to meet Delta salinity criteria. In the summer and fall months, flows could be lower due to reduced amounts of water remaining in reservoir storage.

Climate change also would reduce groundwater supplies due to reduced groundwater recharge potential and increased groundwater overdraft potential as surface water supplies decline. However, in some locations, sustainable groundwater supplies could remain similar to recent historical conditions or rise due to implementation of groundwater management plans to reduce groundwater overdraft, including the completion of ongoing groundwater recharge and recovery programs.

5.4.2.1.2 General Plan Development in California

Counties and cities throughout California have adopted general plans which identify land use classifications including those for municipal and industrial uses and those for agricultural uses. Preparation of general plans includes an environmental evaluation under the California Environmental Quality Act to identify adverse impacts to the physical environment and to provide mitigation measures to reduce those impacts to a level of less than significance. Most of the counties where CVP and SWP water supplies are delivered have adopted general plans following the environmental review of the plans and appropriate alternatives. Population projections from those general plan evaluations are provided to the State Department of Finance and are used to project future water needs and the potential for conversion of existing undeveloped lands and agricultural lands. Many of the existing general plans for counties with municipal areas recently have been modified to include land use and population projections through 2030. The No Action Alternative and the Second Basis of Comparison assume that land uses will develop through 2030 in accordance with existing general plans.

Development in accordance with the general plans in the Sacramento Valley would result in increased water demands. By 2030, water demands associated with water rights and CVP and SWP contracts in the Sacramento Valley is projected to increase by 443,000 acre-feet per year, especially in the communities in El Dorado, Placer, and Sacramento Counties. Increased water demands in the Sacramento Valley would result in reductions in CVP and SWP water supply availability for other water users under the No Action Alternative and the Second Basis of Comparison.

5.4.2.1.3 Reasonable and Foreseeable Water Resources Management Projects

The No Action Alternative and the Second Basis of Comparison assumes completion of water resources management and environmental restoration projects that would have occurred without implementation of the 2008 USFWS BO and 2009 NMFS BO by 2030, as described in Chapter 3, Description of Alternatives.

The No Action Alternative and the Second Basis of Comparison would include the following actions included in the 2008 USFWS BO and 2009 NMFS BO that are ongoing.

- Restoration of more than 10,000 acres of intertidal and associated subtidal wetlands in Suisun Marsh and Cache Slough and at least 17,000 to 20,000 acres of seasonal floodplain restoration in Yolo Bypass
- Gravel augmentation in the Sacramento Valley watershed
- Replacement of the Spring Creek Temperature Control Curtain
- Restoration of Battle Creek
- Implementation of Red Bluff Pumping Plant
- Implementation of the CVPIA Anadromous Fish Screen Program
- Implementation of the American River Flow Management Standard

Under the No Action Alternative and Second Basis of Comparison, it is assumed that water demands would be met on a long-term basis and in dry and critical dry years using a combination of conservation, CVP and SWP water supplies, other imported water supplies, groundwater, recycled water, infrastructure improvements, desalination water treatment, and water transfers and exchanges. It is anticipated that individual communities or users could be in a situation that would not allow for affordable water supply options, and that water demands could not be fully met. However, on a regional scale, it is anticipated that water demands would be met.

The assumptions related to 2030 municipal water demands are based upon a review of the 2010 Urban Water Management Plans (UWMPs) prepared by CVP and SWP water users. The No Action Alternative and the Second Basis of Comparison assumptions related to future water supplies presented in the UWMPs were evaluated to determine if the projects were reasonable and certain to occur by 2030. Projects that had undergone environmental review, were under design, or under construction were included in the future water supply assumptions for 2030 in the No Action Alternative and the Second Basis of Comparison. Projects described in the UWMPs that currently were under evaluation were included in the Cumulative Effects analysis for future water supplies. Future water supplies considered for municipalities by 2030 are presented in Appendix 5D and summarized in Table 5.10.

Table 5.10 Future Long-Term Average Municipal Water Supply Assumptions for CVP and SWP Water Users

	2030 Water Demands and Water Supplies				
	Central Valley Region – Sacramento Valley	**Central Valley Region – San Joaquin Valley**	**San Francisco Bay Area Region**	**Central Coast and Southern California Regions**	**Total**
2030 Water Demand (after conservation)	747,771	378,999	784,313	5,653,807	7,564,890
CVP Deliveries	214,187	131,150	311,370	–	656,707
SWP Deliveries	88,192	82,946	143,045	1,798,353	2,112,536
Water Rights	724,583	170,600	127,400	240,333	1,262,916
Groundwater	136,759	188,346	101,704	2,216,118	2,642,927
Recycled Wastewater	24,324	25,000	44,270	404,449	498,043
Recycled Stormwater	–	–	–	21,400	21,400
Desalination Water Treatment	–	–	5,100	454,145	459,245
Transfers and Exchanges	156,325	30,000	16,700	–	203,025
Non-CVP and SWP Imported Water Supplies	205,276	–	76,400	1,319,321	1,600,997
Total Supplies	**1,549,646**	**628,042**	**825,989**	**6,454,119**	**9,457,796**

Note: Does not include the East Bay Municipal Utility District dry year water supply.

The No Action Alternative and the Second Basis of Comparison assume that several CVP and SWP water users also rely upon other imported water supplies, including water from Solano Project (used by the Solano County Water Agency), San Francisco Public Utilities Commission (used by portions of the service areas of Alameda County Water District, Santa Clara Valley Water District, and Zone 7 Water Agency), and the Colorado River (used by portions of the service area of the Metropolitan Water District of Southern California).

The No Action Alternative and the Second Basis of Comparison assume that groundwater would continue to be used even if groundwater overdraft conditions continue or become worse. It is recognized that in September 2014 the Sustainable Groundwater Management Act (SGMA) was enacted. The SGMA provides for the establishment of a Groundwater Sustainability Agencies (GSAs) to prepare Groundwater Sustainability Plans (GSPs) that will include best management practices for sustainable groundwater management. The SGMA defines sustainable groundwater management as "the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results." Undesirable results are defined as any of the following effects.

- Chronic lowering of groundwater levels (not including overdraft during a drought if a basin is otherwise managed)
- Significant and unreasonable reduction of groundwater storage
- Significant and unreasonable seawater intrusion
- Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies
- Significant and unreasonable land subsidence that substantially interferes with surface land uses
- Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water

The SGMA requires the formation of GSPs in groundwater basins or subbasins that DWR designates as medium or high priority based upon groundwater conditions identified using the CAGESM results by 2022. Sustainable groundwater operations must be achieved within 20 years following completion of the GSPs. In some areas with adjudicated groundwater basins, sustainable groundwater management could be achieved and/or maintained by 2030. However, to achieve sustainable conditions in many areas, measures could require several years to design and construct water supply facilities to replace groundwater, such as seawater desalination. Therefore, it does not appear to be reasonable and foreseeable that sustainable groundwater management would be achieved by 2030; and it is assumed that groundwater pumping will continue to be used to meet water demands not fulfilled with surface water supplies or other alternative water supplies in 2030.

The No Action Alternative and the Second Basis of Comparison assumptions also include implementation of numerous conservation efforts and major water supply projects, including regional and local recycling projects, surface water and groundwater storage projects, conveyance improvement projects, and desalination projects, as described in Chapter 3, Description of Alternatives. There are over 50 projects considered in the study area to be included in the No Action Alternative, including the following major water supply projects.

- Cambria Emergency Water Supply Project desalination project (CCSD 2014)
- Carlsbad Metropolitan Water District (MWD) water recycling project (Carlsbad MWD 2012)
- Central Basin Municipal Water District Southeast Water Reliability Project (CBMWD 2011)
- City of Los Angeles Department of Water and Power groundwater recharge projects (City of Los Angeles 2011, 2013)
- City of Oxnard GREAT Program Desalter (City of Oxnard 2013)
- Eastern Municipal Water District (EMWD) water recycling programs (EMWD 2014a, 2014b)
- Fresno Irrigation District (FID) groundwater recharge projects (FID 2015)
- Inland Empire Utilities Agency (IEUA) groundwater recharge projects (IEUA 2015).
- Kern County and Antelope Valley-East Kern Water Agency (AVEK 2011)
- Los Angeles County Sanitation District expansion of water recycling programs (LACSD 2005)
- San Benito County Water District (SBCWD) expansion of water treatment plant to treat CVP water (SBCWD 2014)
- San Diego County Water Authority (SDCWA) Carlsbad Seawater Desalination Facility (SDCWA 2014)
- Santa Barbara desalination water treatment plant (KEYT News [KEYT] 2015).
- SCVWD wastewater recycling projects (SCVWD 2012a)
- Victor Valley Wastewater Reclamation Authority (VVWRA) water recycling programs (VVWRA 2015)
- Water Replenishment District (WRD) Groundwater Reliability Improvement Program and water recycling programs (WRD 2012, 2015)
- West Basin Municipal Water District recycling water programs (WBMWD 2011)
- Western Development and Storage Antelope Valley Water Bank (Reclamation 2010b)
- Western Municipal Water District (WMD) Arlington Desalter Expansion to use saline groundwater (WMD 2015)
- Woodland-Davis Clean Water Agency (WDCWA) water treatment plant (WDCWA 2013)

Water transfer programs, including those that require Warren Act contracts with Reclamation to convey non-CVP water in CVP facilities, are anticipated to continue under the No Action Alternative and the Second Basis of Comparison. Transfer programs generally involve annual crop changes using temporary crop idling or shifting, release of stored water in reservoirs on different patterns for the purchasers' water demands, and/or groundwater substitution (DWR and Reclamation 2014). The transfers must be approved by the CVP and/or SWP if the transfer involves CVP or SWP water or utilizes CVP or SWP facilities. Except for water transfers among CVP water users, water transfers also require approval from the SWRCB. Environmental documentation is required for all water transfers involving CVP and/or SWP water supplies or facilities. Under State law, water transfers cannot result in injury to other legal users of water; unreasonable impacts on fish and wildlife and instream uses; and unreasonable economic or environmental impact on the county in which the transfer water originates. It is assumed that transfers would continue under the No Action Alternative and the Second Basis of Comparison in a similar manner as have occurred for the past 10 years. It is anticipated that the number of long-term transfer agreements could increase to facilitate annual decisions for water transfers.

5.4.2.2 Changes in Conditions under the No Action Alternative

CVP and SWP operational criteria under the No Action Alternative would be the same as described under the Affected Environment. However, due to the climate change and sea-level rise and increased water demands in the Sacramento Valley, CVP and SWP water deliveries would be less in 2030 than under recent historical conditions. It is anticipated that climate change and sea level rise conditions would result in lower reservoir storage and elevations and flows in the rivers by the end of September.

5.4.2.3 Changes in Conditions under the Second Basis of Comparison

CVP and SWP operational criteria under the Second Basis of Comparison would not include implementation of the 2008 USFWS BO and 2009 NMFS BO. As described in Section 5.4.4.1, CVP and SWP water deliveries would higher than under existing conditions which include implementation of the BOs. However, due to the climate change and sea level rise and increased water demands in the Sacramento Valley, CVP and SWP water supply availability and deliveries would be less in 2030 than under recent historical conditions that existed prior to implementation of the BOs. It is anticipated that climate change and sea level rise conditions would result in lower reservoir storage and elevations and flows in the rivers by the end of September.

5.4.3 Evaluation of Alternatives

As described in Chapter 4, Approach to Environmental Analysis, Alternatives 1 through 5 have been compared to the No Action Alternative; and the No Action Alternative and Alternatives 1 through 5 have been compared to the Second Basis of Comparison.

During review of the numerical modeling analyses used in this EIS, two issues were discovered. First, it was discovered that the demands for the El Dorado Irrigation District (EID) and El Dorado County Water Agency (EDCWA) contracts were not included in Alternatives 3 and 5, as intended. Second, an error was determined in the CalSim II model assumptions related to the Stanislaus River operations for the Second Basis of Comparison, Alternative 1, and Alternative 4 model runs.

With respect to the water demands, the 17 TAF per year Warren Act Contract for EIS and 15 TAF per year under a CVP water service contract for EDCWA were not included in Alternatives 3 and 5, as intended. These demands are not included in the analysis presented in Chapters 5 through 21 of the EIS. A sensitivity analysis comparing the results of the analysis with and without these demands is presented in Appendix 5B of this EIS for Alternatives 3 and 5. The sensitivity analysis focuses on potential changes that would occur within Folsom Lake and along the American River. The results of this analysis indicate that surface water and water temperature conditions in Folsom Lake and in the American River would be similar (within 5 percent or less) in the model run with these demands as compared to model runs without these demands; except in August of critical dry years. In August of critical dry years, the American River flows under Alternative 3 would be 6 percent less with these demands than without these demands. It is anticipated that similar results would occur under the No Action Alternative. The results of these model runs indicated that there was not sensitivity with the addition of these demands in the analyses; therefore, no further model simulations were necessary to capture potential effects and the inclusion of these contracts would not change the previous conclusions in Chapters 5 through 21.

With respect to the CalSim II model assumptions related to the Stanislaus River operations for the Second Basis of Comparison, Alternative 1, and Alternative 4 model runs, a sensitivity analysis was conducted as presented in Appendix 5C. Appendix 5C includes a comparison of the CalSim II model run results presented in this chapter and CalSim II model run results with the error corrected. Appendix 5C also includes a discussion of changes in the comparison of the following alternative analysis.

- No Action Alternative compared to the Second Basis of Comparison
- Alternative 1 compared to the No Action Alternative
- Alternative 3 compared to the Second Basis of Comparison
- Alternative 5 compared to the Second Basis of Comparison

Model results for Alternatives 1, 4, and Second Basis of Comparison are the same, therefore Alternative 4 results are not presented separately. Model results for Alternative 2 and No Action Alternative are the same, therefore Alternative 2 results are not presented separately. Alternative 3 was not compared to the No Action Alternative because the model error did not occur in either of these model runs.

5.4.3.1 No Action Alternative

As described in Chapter 4, Approach to Environmental Analysis, the No Action Alternative is compared to the Second Basis of Comparison.

5.4.3.1.1 Trinity River Region

Changes in CVP and SWP Reservoir Storage and Downstream River Flows

Changes in Trinity Lake storage and surface water elevations under the No Action Alternative as compared to the Second Basis of Comparison in Trinity Lake are summarized in Tables 5.11 and 5.12. A summary of the results is provided following Table 5.12.

Table 5.11 Changes in Trinity Lake Storage under the No Action Alternative as Compared to the Second Basis of Comparison

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
No Action Alternative												
Wet	1,490	1,516	1,630	1,756	1,921	2,053	2,220	2,245	2,190	2,067	1,939	1,784
Above Normal	1,159	1,178	1,286	1,455	1,658	1,847	2,025	1,999	1,907	1,773	1,619	1,495
Below Normal	1,393	1,400	1,417	1,488	1,575	1,662	1,817	1,743	1,637	1,470	1,304	1,185
Dry	1,152	1,148	1,174	1,182	1,274	1,403	1,539	1,490	1,413	1,253	1,104	1,008
Critical Dry	747	731	746	750	790	872	923	888	862	745	612	536
Second Basis of Comparison												
Wet	1,501	1,535	1,644	1,767	1,931	2,055	2,224	2,250	2,194	2,068	1,939	1,805
Above Normal	1,208	1,245	1,363	1,524	1,718	1,901	2,079	2,053	1,955	1,815	1,647	1,513
Below Normal	1,451	1,472	1,492	1,554	1,641	1,729	1,872	1,799	1,696	1,515	1,337	1,204
Dry	1,178	1,184	1,210	1,230	1,322	1,453	1,586	1,536	1,466	1,302	1,152	1,055
Critical Dry	819	803	813	825	868	949	999	962	929	811	667	598
No Action Alternative as Compared to Second Basis of Comparison												
Wet	-11	-19	-14	-11	-9	-2	-4	-5	-4	0	1	-21
Above Normal	-49	-68	-77	-69	-60	-54	-55	-54	-49	-42	-27	-18
Below Normal	-59	-72	-74	-66	-67	-67	-54	-57	-60	-44	-33	-18
Dry	-26	-36	-36	-48	-48	-49	-47	-46	-53	-48	-48	-48
Critical Dry	-73	-72	-68	-75	-78	-78	-76	-74	-66	-66	-56	-61
No Action Alternative as Compared to Second Basis of Comparison (percent change)												
Wet	-0.7	-1.3	-0.9	-0.6	-0.5	-0.1	-0.2	-0.2	-0.2	0.0	0.0	-1.2
Above Normal	-4.0	-5.4	-5.7	-4.5	-3.5	-2.9	-2.6	-2.7	-2.5	-2.3	-1.7	-1.2
Below Normal	-4.0	-4.9	-5.0	-4.2	-4.1	-3.9	-2.9	-3.1	-3.5	-2.9	-2.5	-1.5
Dry	-2.2	-3.1	-3.0	-3.9	-3.6	-3.4	-3.0	-3.0	-3.6	-3.7	-4.1	-4.5
Critical Dry	-8.9	-9.0	-8.3	-9.1	-8.9	-8.2	-7.6	-7.7	-7.2	-8.1	-8.4	-10.3

Table 5.12 Changes in Trinity Lake Elevation under the No Action Alternative as Compared to the Second Basis of Comparison

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
No Action Alternative												
Wet	2,300	2,303	2,313	2,324	2,338	2,347	2,357	2,358	2,355	2,347	2,338	2,327
Above Normal	2,261	2,264	2,276	2,294	2,314	2,330	2,343	2,341	2,335	2,325	2,313	2,302
Below Normal	2,289	2,289	2,291	2,299	2,307	2,315	2,327	2,321	2,313	2,299	2,283	2,272
Dry	2,263	2,265	2,268	2,269	2,279	2,292	2,305	2,301	2,294	2,279	2,264	2,254
Critical Dry	2,210	2,207	2,210	2,213	2,220	2,235	2,242	2,238	2,235	2,220	2,196	2,182
Second Basis of Comparison												
Wet	2,301	2,305	2,314	2,325	2,339	2,347	2,357	2,358	2,355	2,347	2,338	2,328
Above Normal	2,270	2,273	2,286	2,303	2,320	2,335	2,347	2,346	2,339	2,329	2,315	2,304
Below Normal	2,295	2,296	2,298	2,305	2,313	2,320	2,331	2,326	2,318	2,303	2,287	2,274
Dry	2,266	2,269	2,272	2,274	2,284	2,296	2,309	2,304	2,298	2,284	2,269	2,259
Critical Dry	2,218	2,216	2,217	2,222	2,229	2,243	2,250	2,246	2,243	2,227	2,204	2,191
No Action Alternative as Compared to Second Basis of Comparison												
Wet	-1	-2	-1	-1	-1	0	0	0	0	0	0	-2
Above Normal	-8	-10	-10	-9	-7	-5	-4	-4	-4	-4	-2	-2
Below Normal	-6	-7	-7	-6	-6	-6	-4	-5	-5	-4	-3	-3
Dry	-3	-4	-4	-5	-5	-4	-4	-4	-5	-5	-5	-5
Critical Dry	-8	-8	-8	-9	-8	-8	-8	-8	-7	-8	-8	-9
No Action Alternative as Compared to Second Basis of Comparison (percent change)												
Wet	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
Above Normal	-0.4	-0.4	-0.5	-0.4	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2	-0.1	-0.1
Below Normal	-0.3	-0.3	-0.3	-0.3	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.1
Dry	-0.1	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Critical Dry	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.3	-0.3	-0.3	-0.4	-0.4	-0.4

The following changes in Trinity Lake storage and surface water elevation would occur under the No Action Alternative as compared to the Second Basis of Comparison.

- In wet years, below normal, and dry years, storage would be similar (within 5 percent) in all months.
- In above-normal years, storage would be similar in January through October and less in November and December (up to 5.7 percent).
- In critical dry years, storage would be less in all months (up to 10.3 percent).

- In all months, in all water year types, surface water elevations would be similar.

The following changes would occur on the Trinity River under the No Action Alternative as compared to the Second Basis of Comparison, as shown on Figures 5.53 through 5.55.

- Over long-term conditions (over the 82-year analysis period), flows would be similar in March through November and reduced in December through February (up to 9.5 percent).
- In wet years, flows would be similar in April through November and reduced in December through March (up to 11.2 percent).
- In dry years, flows would be similar all months.

5.4.3.1.2 Central Valley Region

Changes in CVP and SWP Reservoir Storage and Downstream River Flows

Shasta Lake and Sacramento River

Storage levels and surface water elevations in Shasta Lake under the No Action Alternative as compared to the Second Basis of Comparison are summarized in Tables 5.13 and 5.14. Changes in flows in the Sacramento River downstream of Keswick Dam and at Freeport are shown on Figures 5.56 through 5.61. The results are summarized in Table 5.14.

Table 5.13 Changes in Shasta Lake Storage under the No Action Alternative as Compared to the Second Basis of Comparison

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
No Action Alternative												
Wet	2,700	2,719	3,077	3,384	3,589	3,836	4,298	4,460	4,242	3,735	3,410	2,985
Above Normal	2,369	2,385	2,600	3,167	3,453	4,021	4,404	4,429	4,039	3,407	3,069	2,834
Below Normal	2,587	2,548	2,686	3,062	3,442	3,814	4,026	3,957	3,588	3,002	2,643	2,608
Dry	2,345	2,283	2,428	2,621	3,034	3,505	3,737	3,668	3,284	2,767	2,496	2,462
Critical Dry	1,702	1,633	1,717	1,871	2,031	2,274	2,202	2,088	1,719	1,253	986	937
Second Basis of Comparison												
Wet	2,817	2,926	3,154	3,406	3,597	3,841	4,301	4,453	4,228	3,733	3,362	3,252
Above Normal	2,499	2,578	2,808	3,313	3,515	4,038	4,416	4,417	3,979	3,347	2,975	2,921
Below Normal	2,826	2,846	2,977	3,299	3,646	3,966	4,164	4,042	3,599	3,010	2,601	2,574
Dry	2,409	2,431	2,578	2,755	3,168	3,644	3,861	3,774	3,333	2,800	2,539	2,496
Critical Dry	1,873	1,826	1,911	2,050	2,222	2,460	2,386	2,270	1,861	1,409	1,151	1,086
No Action Alternative as Compared to Second Basis of Comparison												
Wet	-117	-208	-77	-22	-8	-5	-3	7	14	2	49	-267
Above Normal	-130	-193	-208	-146	-62	-17	-12	11	60	60	94	-87
Below Normal	-239	-298	-291	-237	-204	-152	-138	-86	-10	-8	42	33
Dry	-64	-148	-150	-135	-134	-139	-123	-106	-48	-33	-42	-35
Critical Dry	-171	-193	-194	-179	-190	-186	-184	-183	-142	-155	-165	-149
No Action Alternative as Compared to Second Basis of Comparison (percent change)												
Wet	-4.2	-7.1	-2.4	-0.6	-0.2	-0.1	-0.1	0.2	0.3	0.1	1.4	-8.2
Above Normal	-5.2	-7.5	-7.4	-4.4	-1.8	-0.4	-0.3	0.3	1.5	1.8	3.2	-3.0
Below Normal	-8.5	-10.5	-9.8	-7.2	-5.6	-3.8	-3.3	-2.1	-0.3	-0.3	1.6	1.3
Dry	-2.6	-6.1	-5.8	-4.9	-4.2	-3.8	-3.2	-2.8	-1.5	-1.2	-1.7	-1.4
Critical Dry	-9.1	-10.6	-10.1	-8.7	-8.6	-7.5	-7.7	-8.0	-7.6	-11.0	-14.4	-13.8

Table 5.14 Changes in Shasta Lake Elevation under the No Action Alternative as Compared to the Second Basis of Comparison

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
No Action Alternative												
Wet	991	992	1,008	1,023	1,031	1,041	1,058	1,064	1,056	1,037	1,024	1,005
Above Normal	967	968	982	1,012	1,025	1,048	1,062	1,063	1,049	1,024	1,009	999
Below Normal	986	985	991	1,009	1,025	1,040	1,048	1,045	1,031	1,006	989	987
Dry	969	967	975	986	1,006	1,027	1,037	1,034	1,018	995	982	980
Critical Dry	927	923	929	939	951	968	965	958	935	899	876	872
Second Basis of Comparison												
Wet	997	1,002	1,012	1,024	1,032	1,041	1,058	1,063	1,055	1,037	1,022	1,017
Above Normal	974	978	992	1,019	1,028	1,048	1,062	1,062	1,046	1,021	1,005	1,003
Below Normal	997	998	1,004	1,019	1,034	1,046	1,053	1,049	1,031	1,006	987	986
Dry	972	974	982	992	1,012	1,032	1,041	1,038	1,020	997	984	982
Critical Dry	938	935	941	950	961	977	974	967	943	910	889	884
No Action Alternative as Compared to Second Basis of Comparison												
Wet	-6	-10	-4	-1	0	0	0	0	1	0	2	-12
Above Normal	-7	-10	-10	-7	-3	-1	0	0	2	3	4	-4
Below Normal	-11	-14	-13	-10	-9	-6	-5	-4	-1	-1	2	1
Dry	-3	-7	-7	-6	-6	-6	-5	-4	-2	-2	-3	-2
Critical Dry	-11	-12	-12	-11	-10	-9	-9	-9	-8	-11	-13	-12
No Action Alternative as Compared to Second Basis of Comparison (percent change)												
Wet	-0.6	-1.0	-0.4	-0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.2	-1.2
Above Normal	-0.7	-1.0	-1.0	-0.7	-0.3	-0.1	0.0	0.0	0.2	0.3	0.4	-0.4
Below Normal	-1.1	-1.4	-1.3	-1.0	-0.8	-0.6	-0.5	-0.3	-0.1	-0.1	0.2	0.1
Dry	-0.3	-0.7	-0.7	-0.6	-0.6	-0.5	-0.5	-0.4	-0.2	-0.2	-0.3	-0.2
Critical Dry	-1.2	-1.3	-1.3	-1.1	-1.0	-0.9	-1.0	-1.0	-0.8	-1.2	-1.4	-1.4

The following changes in Shasta Lake storage and surface water elevations would occur under the No Action Alternative as compared to the Second Basis of Comparison.

- In wet years, storage would be similar in October and December through August and reduced in September and November (up to 8.2 percent).
- In above-normal years, storage would be similar in January through September and reduced in October through December (up to 7.5 percent).
- In below-normal years, storage would be similar in March through September and reduced in October through February (up to 10.5 percent).

- In dry years, storage would be similar in January through October and reduced in November and December (up to 6.1 percent).
- In critical dry years, storage would be reduced under all months (up to 14.4 percent).
- In all months, in all water year types, surface water elevations would be similar.

The following changes in Sacramento River flows would occur under the No Action Alternative as compared to the Second Basis of Comparison, as shown on Figures 5.56 through 5.61.

- Sacramento River downstream of Keswick Dam (Figures 5.56 through 5.58).
  - Over long-term conditions, similar flows would occur in October, February through May, July, and August; increased flows in September and November (up to 37.7 percent); and reduced flows in December, January, and June (up to 7.8 percent).
  - In wet years, similar flows would occur in January through July; increased flows in September through November (up to 77.7 percent); and reduced flows in December and August (up to 14.6 percent).
  - In dry years, similar flows would occur in July through October, December through March, and May; increased flows in November (33.4 percent); and reduced flows in April and June (up to 7.3 percent).
- Sacramento River near Freeport (near the northern boundary of the Delta) (Figures 5.59 through 5.61).
  - Over long-term conditions, similar flows would occur in October, December through May, and August; increased flows in September, November, and July (up to 43.3 percent); and reduced flows in June (11.4 percent).
  - In wet years, similar flows would occur in January through June and October; increased flows in July through September and November (up to 90.3 percent); and reduced flows in December (10.7 percent).
  - In dry years, similar flows would occur in August through October and December through April; increased flows in November and July (up to 15.8 percent); and reduced flows in May and June (up to 11.9 percent).

Lake Oroville and Feather River

Storage levels and surface water elevations in Lake Oroville under the No Action Alternative as compared to the Second Basis of Comparison are summarized in Tables 5.15 and 5.16. Changes in flows in the Feather River downstream of Thermalito Complex are shown on Figures 5.62 through 5.64. The results are summarized in Table 5.16.

Table 5.15 Changes in Lake Oroville Storage under the No Action Alternative as Compared to the Second Basis of Comparison

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
No Action Alternative												
Wet	1,691	1,732	2,189	2,554	2,832	2,942	3,300	3,488	3,445	2,964	2,626	2,109
Above Normal	1,279	1,322	1,485	1,959	2,519	2,892	3,247	3,393	3,232	2,600	2,117	1,659
Below Normal	1,542	1,497	1,507	1,719	2,122	2,397	2,653	2,714	2,530	1,923	1,513	1,307
Dry	1,206	1,158	1,177	1,305	1,582	1,938	2,178	2,210	1,951	1,478	1,287	1,144
Critical Dry	1,092	1,029	1,019	1,108	1,223	1,381	1,408	1,392	1,243	1,018	917	865
Second Basis of Comparison												
Wet	1,936	1,984	2,354	2,636	2,871	2,942	3,300	3,477	3,402	2,976	2,728	2,569
Above Normal	1,465	1,523	1,702	2,173	2,648	2,937	3,271	3,357	3,081	2,493	2,087	1,827
Below Normal	1,823	1,783	1,831	2,037	2,361	2,627	2,875	2,836	2,461	1,930	1,637	1,424
Dry	1,371	1,324	1,344	1,473	1,764	2,120	2,363	2,357	2,031	1,688	1,427	1,261
Critical Dry	1,117	1,044	1,041	1,125	1,235	1,406	1,423	1,407	1,219	1,027	911	839
No Action Alternative as Compared to Second Basis of Comparison												
Wet	-245	-252	-165	-82	-39	0	0	10	43	-12	-102	-459
Above Normal	-187	-201	-217	-214	-129	-44	-24	37	150	107	29	-167
Below Normal	-281	-285	-324	-318	-239	-230	-222	-122	69	-7	-125	-117
Dry	-165	-165	-167	-168	-182	-182	-185	-147	-80	-210	-140	-117
Critical Dry	-25	-15	-22	-17	-12	-25	-16	-15	25	-8	6	26
No Action Alternative as Compared to Second Basis of Comparison (percent change)												
Wet	-12.6	-12.7	-7.0	-3.1	-1.4	0.0	0.0	0.3	1.3	-0.4	-3.7	-17.9
Above Normal	-12.7	-13.2	-12.7	-9.9	-4.9	-1.5	-0.7	1.1	4.9	4.3	1.4	-9.2
Below Normal	-15.4	-16.0	-17.7	-15.6	-10.1	-8.8	-7.7	-4.3	2.8	-0.4	-7.6	-8.2
Dry	-12.0	-12.5	-12.4	-11.4	-10.3	-8.6	-7.8	-6.2	-3.9	-12.4	-9.8	-9.3
Critical Dry	-2.2	-1.5	-2.1	-1.5	-1.0	-1.8	-1.1	-1.1	2.0	-0.8	0.7	3.1

Table 5.16 Changes in Lake Oroville Elevation under the No Action Alternative as Compared to the Second Basis of Comparison

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
No Action Alternative												
Wet	743	748	794	829	852	859	884	897	894	861	836	790
Above Normal	698	703	722	776	828	856	880	890	879	835	794	746
Below Normal	730	725	726	751	793	818	838	842	828	773	729	704
Dry	688	683	686	704	737	775	798	800	775	724	702	684
Critical Dry	674	667	664	678	693	712	715	712	693	663	648	640
Second Basis of Comparison												
Wet	768	773	810	837	854	859	884	896	891	861	844	831
Above Normal	717	723	745	796	838	859	882	888	869	826	790	763
Below Normal	757	752	757	779	812	834	854	852	823	775	743	719
Dry	706	701	705	721	755	791	814	813	784	748	718	698
Critical Dry	677	668	668	680	694	715	716	714	691	664	647	636
No Action Alternative as Compared to Second Basis of Comparison												
Wet	-24	-25	-16	-8	-3	0	0	1	3	0	-8	-41
Above Normal	-19	-21	-24	-20	-10	-3	-2	3	10	10	4	-18
Below Normal	-27	-27	-31	-28	-20	-17	-16	-9	5	-1	-14	-14
Dry	-18	-18	-18	-17	-18	-16	-15	-14	-9	-24	-17	-15
Critical Dry	-3	-1	-3	-3	-1	-3	-2	-2	2	0	1	4
No Action Alternative as Compared to Second Basis of Comparison (percent change)												
Wet	-3.2	-3.2	-1.9	-0.9	-0.3	0.0	0.0	0.1	0.3	-0.1	-0.9	-5.0
Above Normal	-2.7	-2.9	-3.2	-2.5	-1.2	-0.4	-0.2	0.3	1.2	1.2	0.5	-2.3
Below Normal	-3.6	-3.6	-4.0	-3.6	-2.4	-2.0	-1.9	-1.1	0.6	-0.2	-1.9	-2.0
Dry	-2.5	-2.6	-2.6	-2.4	-2.4	-2.0	-1.9	-1.7	-1.2	-3.2	-2.3	-2.1
Critical Dry	-0.4	-0.2	-0.5	-0.4	-0.2	-0.4	-0.2	-0.3	0.4	0.0	0.2	0.6

The following changes in Lake Oroville storage and surface water elevations would occur under the No Action Alternative as compared to the Second Basis of Comparison.

- In wet years, storage would be similar in January through August and reduced in September through December (up to 17.9 percent).
- In above-normal years, storage would be similar in February through August and reduced in September through January (up to 13.2 percent).
- In below-normal years, storage would be similar in May through July and reduced in August through April (up to 17.7 percent).

- In dry years, storage would be similar in June and reduced in all other months (up to 12.5 percent).
- In critical dry years, storage would be similar under all months.
- In all months, in all water year types, surface water elevations would be similar.

The following changes in Feather River flows would occur under the No Action Alternative as compared to the Second Basis of Comparison, as shown on Figures 5.62 through 5.64.

- Over long-term conditions, similar flows would occur in November and April; increased flows in July through September (up to 76.1 percent); and reduced flows in October, December through March, May, and June (up to 27.2 percent).
- In wet years, similar flows would occur in October through November and March through May; increased flows in July through September (up to 184 percent) and reduced flows in December through February (up to 26.0 percent).
- In dry years, similar flows would occur in November through March; increased flows in April and July (up to 52.4 percent); and reduced flows in August through October and May and June (up to 27.6 percent).

Folsom Lake and American River

Storage levels and surface water elevations in Folsom Lake under the No Action Alternative as compared to the Second Basis of Comparison are summarized in Tables 5.17 and 5.18. Changes in flows in the American River downstream of Nimbus Dam are shown on Figures 5.65 through 5.67. The results are summarized in Table 5.18.

Table 5.17 Changes in Folsom Lake Storage under the No Action Alternative as Compared to the Second Basis of Comparison

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
No Action Alternative												
Wet	454	435	514	518	515	632	785	951	941	800	712	576
Above Normal	377	380	429	513	531	640	787	946	887	621	552	477
Below Normal	446	431	467	484	533	619	757	843	780	527	472	453
Dry	394	383	408	423	479	579	691	760	658	495	443	419
Critical Dry	324	305	315	320	366	432	475	486	415	327	267	231
Second Basis of Comparison												
Wet	483	470	522	524	515	632	785	951	937	793	688	646
Above Normal	390	412	467	537	538	640	787	946	857	591	522	485
Below Normal	506	489	502	514	541	626	761	847	739	475	408	387
Dry	405	399	423	437	486	585	698	769	664	486	432	408
Critical Dry	339	317	323	325	369	436	469	482	430	352	288	258
No Action Alternative as Compared to Second Basis of Comparison												
Wet	-29	-35	-8	-6	0	0	0	0	4	7	25	-70
Above Normal	-13	-33	-38	-24	-7	0	0	1	30	31	30	-8
Below Normal	-59	-58	-35	-30	-8	-7	-4	-4	41	52	64	66
Dry	-12	-16	-15	-14	-7	-6	-7	-9	-5	9	11	11
Critical Dry	-14	-11	-9	-5	-3	-3	6	4	-16	-25	-21	-28
No Action Alternative as Compared to Second Basis of Comparison (percent change)												
Wet	-6.1	-7.4	-1.5	-1.2	0.0	0.0	0.0	0.0	0.5	0.9	3.6	-10.8
Above Normal	-3.4	-7.9	-8.2	-4.5	-1.3	0.0	0.0	0.1	3.5	5.2	5.7	-1.6
Below Normal	-11.7	-11.9	-7.0	-5.8	-1.4	-1.1	-0.5	-0.5	5.5	11.0	15.6	17.1
Dry	-2.9	-4.0	-3.5	-3.2	-1.4	-1.0	-1.1	-1.1	-0.8	1.9	2.5	2.8
Critical Dry	-4.2	-3.6	-2.7	-1.6	-0.7	-0.7	1.2	0.8	-3.6	-7.2	-7.2	-10.8

Table 5.18 Changes in Folsom Lake Elevation under the No Action Alternative as Compared to the Second Basis of Comparison

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
No Action Alternative												
Wet	409	407	418	418	418	432	448	464	464	449	440	425
Above Normal	394	395	405	418	420	433	449	464	458	430	422	413
Below Normal	408	406	411	414	420	431	445	454	447	418	411	409
Dry	400	399	403	405	413	426	438	445	434	414	408	405
Critical Dry	386	384	389	390	396	406	411	412	401	386	374	366
Second Basis of Comparison												
Wet	412	412	419	419	418	432	448	465	464	449	438	433
Above Normal	397	400	410	421	421	433	448	465	456	427	419	414
Below Normal	415	414	416	417	421	432	446	455	443	410	401	398
Dry	401	401	405	407	414	427	439	446	435	413	406	403
Critical Dry	389	386	390	391	397	406	410	411	404	391	378	372
No Action Alternative as Compared to Second Basis of Comparison												
Wet	-4	-5	-1	-1	0	0	0	-1	0	1	3	-8
Above Normal	-2	-5	-5	-3	-1	0	0	-1	3	4	4	-1
Below Normal	-7	-7	-4	-4	-1	-1	-1	-1	4	8	10	10
Dry	-1	-2	-2	-2	-1	-1	-1	-1	-1	1	1	1
Critical Dry	-3	-2	-2	-1	0	0	1	0	-2	-5	-4	-6
No Action Alternative as Compared to Second Basis of Comparison (percent change)												
Wet	-0.9	-1.1	-0.2	-0.2	0.0	0.0	0.0	-0.2	-0.1	0.2	0.6	-1.9
Above Normal	-0.6	-1.3	-1.2	-0.7	-0.2	0.0	0.0	-0.1	0.6	0.9	0.8	-0.2
Below Normal	-1.8	-1.8	-1.1	-0.9	-0.2	-0.2	-0.1	-0.2	0.9	1.9	2.5	2.6
Dry	-0.3	-0.5	-0.5	-0.4	-0.2	-0.2	-0.2	-0.3	-0.2	0.3	0.3	0.4
Critical Dry	-0.7	-0.6	-0.4	-0.2	-0.1	-0.1	0.2	0.1	-0.6	-1.2	-1.1	-1.7

The following changes in Folsom Lake storage would occur under the No Action Alternative as compared to the Second Basis of Comparison.

- In wet years, storage would be similar in December through August and reduced in September through November (up to 10.8 percent).
- In above-normal years, storage would be similar in January through June, September, and October; reduced in November and December (up to 8.2 percent); and increased in July and August (up to 5.7 percent).
- In below-normal years, storage would be similar in February through May; reduced in October through January (up to 11.9 percent); and increased in July through September (up to 17.1 percent).

- In dry years, storage would be similar in all months.
- In critical dry years, storage would be similar in October through June and reduced in July through September (up to 10.8 percent).
- In all months, in all water year types, surface water elevations would be similar.

The following changes in American River flows would occur under the No Action Alternative as compared to the Second Basis of Comparison, as shown on Figures 5.65 through 5.67.

- Over long-term conditions, similar flows would occur in November through May and July; increased flows in September and October (up to 44.7 percent); and reduced flows in June and August (up to 6.1 percent).
- In wet years, similar flows would occur in October through November and January through July; increased flows in September (91.1 percent) and reduced flows in December and August (up to 10.7 percent).
- In dry years, similar flows would occur in all months except October, February and July; increased flows in October (16.5 percent); and reduced flows in February and July (up to 7.3 percent).

Clear Creek

Changes in flows in Clear Creek downstream of Whiskeytown Dam are summarized in Table 5.19. Monthly Clear Creek flows under the No Action Alternative as compared to the Second Basis of Comparison are identical except in May. In May, under the No Action Alternative, flows are up to 40.7 percent higher than under the Second Basis of Comparison in accordance with the 2009 NMFS BO.

Table 5.19 Changes in Clear Creek Flows below Whiskeytown Dam under the No Action Alternative as Compared to the Second Basis of Comparison

Water Year	Average Monthly Flow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
No Action Alternative												
Wet	200	200	200	309	356	272	200	277	200	85	85	150
Above Normal	181	182	188	192	196	196	196	277	200	85	85	150
Below Normal	195	195	195	195	195	195	195	274	191	85	85	150
Dry	175	184	188	190	190	190	190	267	183	85	85	150
Critical Dry	163	167	167	167	167	167	167	214	111	85	85	133
Second Basis of Comparison												
Wet	200	200	200	309	356	272	200	200	200	85	85	150
Above Normal	181	182	188	192	196	196	196	200	200	85	85	150
Below Normal	195	195	195	195	195	195	195	195	191	85	85	150
Dry	178	184	188	190	190	190	190	190	183	85	85	150
Critical Dry	163	167	167	167	167	167	167	167	111	85	85	133
No Action Alternative as Compared to Second Basis of Comparison												
Wet	0	0	0	0	0	0	0	77	0	0	0	0
Above Normal	0	0	0	0	0	0	0	77	0	0	0	0
Below Normal	0	0	0	0	0	0	0	78	0	0	0	0
Dry	-3	0	0	0	0	0	0	77	0	0	0	0
Critical Dry	0	0	0	0	0	0	0	47	0	0	0	0
No Action Alternative as Compared to Second Basis of Comparison (percent change)												
Wet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.7	0.0	0.0	0.0	0.0
Above Normal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.7	0.0	0.0	0.0	0.0
Below Normal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40.1	0.0	0.0	0.0	0.0
Dry	-1.6	0.0	0.0	0.0	0.0	0.0	0.0	40.7	0.0	0.0	0.0	0.0
Critical Dry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.3	0.0	0.0	0.0	0.0

New Melones Reservoir and Stanislaus River

Storage levels and surface water elevations in New Melones Reservoir under the No Action Alternative as compared to the Second Basis of Comparison, are summarized in Tables 5.20 and 5.21. Changes in flows in the Stanislaus River downstream of Goodwin Dam are shown on Figures 5.68 through 5.70. The results are summarized in Table 5.21.

Table 5.20 Changes in New Melones Reservoir Storage under the No Action Alternative as Compared to the Second Basis of Comparison

Water Year	End of Month Storage (TAF)											
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
No Action Alternative												
Wet	1,379	1,390	1,454	1,562	1,666	1,724	1,758	1,878	1,968	1,890	1,773	1,703
Above Normal	1,029	1,060	1,125	1,214	1,317	1,406	1,413	1,484	1,467	1,372	1,277	1,232
Below Normal	1,294	1,305	1,326	1,351	1,413	1,438	1,390	1,383	1,359	1,268	1,175	1,133
Dry	1,094	1,094	1,106	1,121	1,156	1,188	1,154	1,132	1,087	997	914	871
Critical Dry	624	623	638	645	661	656	602	554	526	476	431	408
Second Basis of Comparison												
Wet	1,443	1,446	1,502	1,606	1,709	1,794	1,833	1,962	1,994	1,917	1,803	1,731
Above Normal	1,092	1,116	1,175	1,261	1,360	1,455	1,481	1,543	1,516	1,419	1,321	1,274
Below Normal	1,364	1,366	1,378	1,397	1,453	1,479	1,461	1,447	1,415	1,322	1,228	1,183
Dry	1,149	1,143	1,149	1,161	1,191	1,221	1,210	1,176	1,131	1,039	956	912
Critical Dry	667	663	674	680	696	690	646	585	557	498	449	426
No Action Alternative as Compared to Second Basis of Comparison												
Wet	-64	-56	-49	-44	-43	-70	-75	-84	-25	-27	-30	-28
Above Normal	-62	-56	-50	-46	-43	-48	-68	-59	-49	-46	-44	-42
Below Normal	-69	-61	-52	-46	-40	-41	-71	-63	-55	-54	-52	-51
Dry	-55	-49	-43	-40	-35	-33	-56	-45	-44	-43	-42	-42
Critical Dry	-44	-40	-37	-36	-35	-34	-45	-31	-31	-23	-18	-18
No Action Alternative as Compared to Second Basis of Comparison (percent change)												
Wet	-4.4	-3.9	-3.2	-2.7	-2.5	-3.9	-4.1	-4.3	-1.3	-1.4	-1.6	-1.6
Above Normal	-5.7	-5.0	-4.2	-3.7	-3.2	-3.3	-4.6	-3.8	-3.3	-3.3	-3.3	-3.3
Below Normal	-5.1	-4.5	-3.8	-3.3	-2.8	-2.8	-4.9	-4.4	-3.9	-4.1	-4.3	-4.3
Dry	-4.8	-4.3	-3.8	-3.4	-3.0	-2.7	-4.6	-3.8	-3.9	-4.1	-4.4	-4.6
Critical Dry	-6.6	-6.1	-5.4	-5.2	-5.0	-5.0	-6.9	-5.3	-5.5	-4.5	-4.0	-4.2

Table 5.21 Changes in New Melones Reservoir Elevation under the No Action Alternative as Compared to the Second Basis of Comparison

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
No Action Alternative												
Wet	980	982	990	1,004	1,016	1,023	1,026	1,039	1,047	1,040	1,029	1,022
Above Normal	932	937	945	960	974	986	988	997	996	985	973	967
Below Normal	968	969	972	975	985	988	985	985	983	972	960	955
Dry	943	943	944	947	951	957	955	953	948	934	922	915
Critical Dry	856	856	862	864	870	871	860	848	840	828	818	812
Second Basis of Comparison												
Wet	989	990	997	1,009	1,021	1,030	1,034	1,047	1,050	1,043	1,032	1,025
Above Normal	941	944	951	966	979	992	995	1,003	1,001	990	978	972
Below Normal	977	977	979	982	991	994	994	993	991	980	968	962
Dry	951	950	950	953	957	962	963	960	954	941	929	922
Critical Dry	866	866	870	872	878	879	871	856	850	835	823	817
No Action Alternative as Compared to Second Basis of Comparison												
Wet	-9	-8	-7	-6	-5	-8	-8	-8	-3	-3	-3	-3
Above Normal	-9	-7	-6	-6	-6	-6	-8	-7	-5	-5	-5	-5
Below Normal	-9	-8	-7	-7	-6	-6	-9	-8	-7	-8	-8	-8
Dry	-8	-7	-6	-6	-5	-5	-8	-7	-7	-7	-7	-7
Critical Dry	-10	-10	-9	-8	-8	-8	-11	-8	-10	-6	-5	-6
No Action Alternative as Compared to Second Basis of Comparison (percent change)												
Wet	-0.9	-0.8	-0.7	-0.6	-0.5	-0.7	-0.8	-0.8	-0.3	-0.3	-0.3	-0.3
Above Normal	-0.9	-0.8	-0.7	-0.6	-0.6	-0.6	-0.8	-0.7	-0.5	-0.5	-0.5	-0.5
Below Normal	-0.9	-0.8	-0.7	-0.7	-0.6	-0.6	-0.9	-0.8	-0.7	-0.8	-0.8	-0.8
Dry	-0.8	-0.8	-0.7	-0.7	-0.6	-0.5	-0.9	-0.7	-0.7	-0.7	-0.8	-0.8
Critical Dry	-1.2	-1.1	-1.0	-1.0	-0.9	-0.9	-1.2	-1.0	-1.2	-0.8	-0.6	-0.7

The following changes in New Melones Reservoir storage would occur under the No Action Alternative as compared to the Second Basis of Comparison.

- In wet, below-normal, and dry years, storage would be similar in all months.
- In above-normal years, storage would be similar in all months except October when storage would be reduced by 5.7 percent.
- In critical dry years, storage would be similar in February, March, and July through September and reduced in October through January and April through June (up to 6.9 percent).

- In all months, in all water year types, surface water elevations would be similar.

Flows in the Stanislaus River downstream of Goodwin Dam are shown on Figures 5.68 to 5.70. Changes in flows in these rivers are summarized below.

- Over long-term conditions, similar flows would occur in May and July through September; increased flows in October, March, and April (up to 148.7 percent); and reduced flows in November through February and June (up to 33.8 percent).
- In wet years, similar flows would occur in February and April; increased flows in October, March, May, July, and August (up to 117.1 percent); and reduced flows in September, November through January, and June (up to 50.8 percent).
- In dry years, similar flows would occur in July through September; increased flows in October and April (up to 154.3 percent); and reduced flows in November through March, May, and June (up to 35.7 percent).

San Joaquin River at Vernalis

Flows in the San Joaquin River at Vernalis are summarized below, as shown on Figures 5.71 through 5.73.

- Over long-term conditions, similar flows would occur in July through September and November through May; increased flows in October (19 percent); and reduced flows in June (8 percent).
- In wet years, similar flows would occur in July through September and November through May; increased flows in October (16.8 percent); and reduced flows in June (9.4 percent).
- In dry years, similar flows would occur in November through March and May through September; and increased flows in October and April (up to 18.3 percent).

San Luis Reservoir

Storage levels and surface water elevations in San Luis Reservoir under the No Action Alternative as compared to the Second Basis of Comparison are summarized in Tables 5.22 and 5.23. A summary of the results is provided following Table 5.23.

Table 5.22 Changes in San Luis Reservoir Storage under the No Action Alternative as Compared to the Second Basis of Comparison

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
No Action Alternative												
Wet	555	681	931	1,236	1,526	1,788	1,598	1,251	946	741	628	679
Above Normal	490	649	957	1,223	1,441	1,661	1,444	1,048	666	466	433	513
Below Normal	525	624	907	1,141	1,314	1,473	1,312	967	555	500	426	467
Dry	476	590	867	1,150	1,339	1,494	1,413	1,167	840	763	476	469
Critical Dry	478	556	752	1,040	1,204	1,252	1,192	1,028	739	544	343	323
Second Basis of Comparison												
Wet	790	1,017	1,365	1,748	1,965	2,033	2,031	1,852	1,487	1,167	889	925
Above Normal	658	883	1,213	1,671	1,913	2,001	1,995	1,717	1,263	861	612	631
Below Normal	854	1,064	1,334	1,742	1,908	1,980	1,908	1,628	1,251	964	635	591
Dry	617	764	998	1,427	1,728	1,925	1,870	1,665	1,341	1,007	660	596
Critical Dry	622	709	910	1,257	1,556	1,664	1,623	1,451	1,168	808	545	472
No Action Alternative as Compared to Second Basis of Comparison												
Wet	-234	-336	-433	-513	-439	-245	-433	-601	-541	-426	-261	-245
Above Normal	-168	-234	-257	-448	-471	-341	-551	-669	-598	-395	-179	-117
Below Normal	-329	-439	-427	-601	-594	-507	-596	-660	-696	-465	-209	-124
Dry	-141	-174	-130	-277	-390	-431	-457	-498	-501	-244	-185	-127
Critical Dry	-144	-153	-158	-217	-352	-412	-431	-423	-429	-263	-202	-149
No Action Alternative as Compared to Second Basis of Comparison (percent change)												
Wet	-25.2	-19.8	-21.2	-29.1	-11.8	9.4	-57.2	-51.8	-2.3	5.8	9.6	-3.2
Above Normal	-12.2	-13.6	-12.2	-43.4	-31.3	-12.9	-71.2	-71.0	-24.1	2.6	9.5	-3.5
Below Normal	-29.6	-23.4	-5.3	-42.6	-28.7	-21.2	-60.1	-67.1	-49.5	4.5	20.4	0.7
Dry	-14.0	-16.3	-6.7	-32.3	-39.1	-35.5	-40.7	-44.9	-29.3	34.2	-9.2	-2.8
Critical Dry	-7.7	-15.2	-15.7	-19.4	-38.4	-32.7	-30.7	-25.3	-51.1	60.2	-13.0	-3.0

Table 5.23 Changes in San Luis Reservoir Elevation under the No Action Alternative as Compared to the Second Basis of Comparison

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
No Action Alternative												
Wet	399	414	443	473	500	523	507	475	444	422	409	416
Above Normal	391	411	445	472	492	512	493	456	415	389	386	398
Below Normal	397	410	442	465	481	496	481	448	400	393	383	389
Dry	391	406	437	466	484	498	490	468	434	426	390	389
Critical Dry	390	400	423	454	470	475	469	453	422	399	369	366
Second Basis of Comparison												
Wet	426	451	485	520	538	543	543	529	497	468	440	443
Above Normal	412	437	470	513	534	541	540	518	477	437	409	411
Below Normal	435	457	483	519	533	539	533	510	476	448	412	406
Dry	407	425	450	492	518	535	530	513	484	453	415	406
Critical Dry	409	419	441	475	502	512	509	494	468	432	400	389
No Action Alternative as Compared to Second Basis of Comparison												
Wet	-26	-37	-42	-46	-38	-20	-36	-53	-53	-46	-30	-27
Above Normal	-21	-26	-25	-41	-41	-29	-47	-61	-62	-48	-23	-14
Below Normal	-38	-47	-42	-54	-52	-43	-52	-62	-76	-56	-30	-17
Dry	-17	-19	-12	-25	-34	-37	-40	-45	-51	-27	-25	-18
Critical Dry	-19	-20	-18	-21	-32	-38	-40	-41	-45	-32	-32	-24
No Action Alternative as Compared to Second Basis of Comparison (percent change)												
Wet	-6.2	-8.2	-8.7	-8.9	-7.0	-3.7	-6.7	-10.1	-10.7	-9.8	-6.9	-6.1
Above Normal	-5.1	-6.0	-5.4	-8.1	-7.7	-5.3	-8.7	-11.8	-13.0	-11.0	-5.7	-3.3
Below Normal	-8.6	-10.2	-8.6	-10.4	-9.8	-8.0	-9.7	-12.1	-16.0	-12.4	-7.2	-4.1
Dry	-4.1	-4.4	-2.8	-5.1	-6.6	-6.9	-7.5	-8.8	-10.4	-5.9	-6.0	-4.3
Critical Dry	-4.7	-4.7	-4.1	-4.5	-6.4	-7.3	-7.8	-8.3	-9.7	-7.4	-7.9	-6.2

The following changes in San Luis Reservoir storage would occur under the No Action Alternative as compared to the Second Basis of Comparison.

- In wet years, storage would be similar in June and September; increased in March, July, and August (up to 9.6 percent); and reduced in October through February, April, and May (up to 57.2 percent).
- In above-normal years, storage would be similar in July and September; increased in August (9.5 percent); and reduced in October through June (up to 71.2 percent).

- In below-normal years, storage would be similar in July and September; increased in August (20.4 percent); and reduced in October through June (up to 67.1 percent).
- In dry years, storage would be similar in September; increased in July (34.2 percent); and reduced in October through June and August (up to 44.0 percent).
- In critical dry years, storage would be similar in September; increased in July (60.2 percent); and reduced in August and October through June (up to 51.1 percent).

The following changes in San Luis Reservoir surface water elevations would occur under the No Action Alternative as compared to the Second Basis of Comparison.

- In wet years, surface water elevations would be less in all months (up to 10.7 percent).
- In above-normal years, surface water elevations would be less in all months (up to 13.0 percent).
- In below-normal years, surface water elevations would be less in all months (up to 16.0 percent).
- In dry years, surface water elevations would be similar in September through January and less in February through August (up to 10.4 percent).
- In critical dry years, surface water elevations would be similar in October through January and reduced in February through September (up to 9.7 percent).

Changes in Flows into the Yolo Bypass at Fremont Weir

Flows from the Sacramento River into the Yolo Bypass at Fremont Weir under the No Action Alternative as compared to the Second Basis of Comparison are summarized in Table 5.24. The results are summarized following Table 5.24.

Table 5.24 Changes in Flows into the Yolo Bypass at Fremont Weir under the No Action Alternative as Compared to the Second Basis of Comparison

Water Year	Average Monthly Flow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
No Action Alternative												
Wet	183	910	8,420	24,291	29,547	18,493	5,627	289	113	0	0	100
Above Normal	100	100	2,765	5,997	13,013	7,928	1,688	100	100	0	0	100
Below Normal	100	100	242	1,004	3,031	883	293	100	100	0	0	100
Dry	100	100	322	902	2,024	1,393	407	100	100	0	0	100
Critical Dry	100	100	149	528	534	396	106	100	100	0	0	100
Second Basis of Comparison												
Wet	147	996	9,888	25,442	30,547	18,997	5,602	289	113	0	0	100
Above Normal	100	100	2,659	6,349	15,114	8,566	1,765	100	100	0	0	100
Below Normal	100	100	262	1,256	4,057	1,166	292	100	100	0	0	100
Dry	100	100	342	932	2,032	1,411	411	100	100	0	0	100
Critical Dry	100	100	149	542	533	408	106	100	100	0	0	100
No Action Alternative as Compared to Second Basis of Comparison												
Wet	37	-86	-1,468	-1,151	-1,000	-504	25	0	0	0	0	0
Above Normal	0	0	106	-352	-2,102	-638	-77	0	0	0	0	0
Below Normal	0	0	-20	-253	-1,026	-283	1	0	0	0	0	0
Dry	0	0	-20	-30	-7	-17	-4	0	0	0	0	0
Critical Dry	0	0	-1	-15	1	-12	0	0	0	0	0	0
No Action Alternative as Compared to Second Basis of Comparison (percent change)												
Wet	25.0	-8.7	-14.8	-4.5	-3.3	-2.7	0.4	-0.1	-0.1	0.0	0.0	0.0
Above Normal	0.0	0.0	4.0	-5.5	-13.9	-7.4	-4.3	0.0	0.0	0.0	0.0	0.0
Below Normal	0.0	0.0	-7.5	-20.1	-25.3	-24.3	0.3	0.0	0.0	0.0	0.0	0.0
Dry	0.0	0.0	-5.9	-3.2	-0.4	-1.2	-1.0	0.0	0.0	0.0	0.0	0.0
Critical Dry	0.0	0.0	-0.5	-2.7	0.2	-2.9	0.0	0.0	0.0	0.0	0.0	0.0

The following changes in flows from the Sacramento River into Yolo Bypass at Fremont Weir would occur under the No Action Alternative as compared to the Second Basis of Comparison.

- In wet years, flows into Yolo Bypass would be similar in January through September; increased in October (25 percent); and reduced in November and December (up to 14.8 percent).
- In above-normal years, flows into Yolo Bypass would be similar in April through December and reduced in January through March (up to 13.9 percent).

- In below-normal years, flows into Yolo Bypass would be similar in April through November and reduced in December through March (up to 25.3 percent).

- In dry years, flows into Yolo Bypass would be similar in January through November and reduced in December (5.9 percent).

- In critical dry years, flows into Yolo Bypass would be similar in all months.

Changes in Delta Conditions

Delta outflow under the No Action Alternative as compared to the Second Basis of Comparison are summarized below and shown on Figures 5.74 through 5.76.

- In wet years, average monthly Delta outflow in July through November, January, April, and May (up to 13,683 cfs) and decrease in December, February, March, and June (up to 1,590 cfs).

- In dry years, average monthly Delta outflow would be similar or increase (up to 3,114 cfs).

The OMR conditions under the No Action Alternative as compared to the Second Basis of Comparison are summarized below and shown on Figures 5.76 through 5.78.

- Under the No Action Alternative, OMR flows are negative except in April and May of wet and above normal years and April of below normal years. Under the Second Basis of Comparison, OMR flows are negative in all months of all water year types.

- In wet years, average monthly OMR flows would be more positive in September through February, April, and May (up to 10,005 cfs) and more negative in March and June through August (up to 923 cfs).

- In dry years, average monthly OMR flows would be more positive in August through June (up to 3,489 cfs) and more negative in June (2,073 cfs).

Changes in CVP and SWP Exports and Deliveries

Delta exports under the No Action Alternative as compared to the Second Basis of Comparison are summarized in Table 5.25.

Table 5.25 Changes in Exports at Jones and Banks Pumping Plants under the No Action Alternative as Compared to the Second Basis of Comparison

Water Year	Monthly Volume (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
No Action Alternative												
Wet	410	497	564	513	537	594	204	207	445	669	717	638
Above Normal	376	450	562	406	401	496	130	105	315	587	709	628
Below Normal	386	456	590	387	354	394	134	100	209	657	622	542
Dry	374	398	510	392	315	318	153	126	194	541	296	426
Critical Dry	314	293	384	349	250	179	93	90	64	223	176	242
Second Basis of Comparison												
Wet	549	619	716	724	609	543	476	430	456	632	655	660
Above Normal	428	521	641	716	584	570	453	363	415	572	647	651
Below Normal	548	595	623	674	497	500	337	304	414	629	517	539
Dry	435	475	546	579	518	493	259	228	274	403	325	438
Critical Dry	340	345	455	433	406	266	134	121	132	139	203	249
No Action Alternative as Compared to Second Basis of Comparison												
Wet	-139	-123	-152	-211	-72	51	-272	-223	-11	37	63	-21
Above Normal	-52	-71	-78	-311	-183	-73	-322	-257	-100	15	61	-23
Below Normal	-162	-139	-33	-287	-143	-106	-203	-204	-205	28	105	4
Dry	-61	-77	-36	-187	-202	-175	-105	-102	-80	138	-30	-12
Critical Dry	-26	-52	-71	-84	-156	-87	-41	-31	-67	84	-26	-8
No Action Alternative as Compared to Second Basis of Comparison (percent change)												
Wet	-25.2	-19.8	-21.2	-29.1	-11.8	9.4	-57.2	-51.8	-2.3	5.8	9.6	-3.2
Above Normal	-12.2	-13.6	-12.2	-43.4	-31.3	-12.9	-71.2	-71.0	-24.1	2.6	9.5	-3.5
Below Normal	-29.6	-23.4	-5.3	-42.6	-28.7	-21.2	-60.1	-67.1	-49.5	4.5	20.4	0.7
Dry	-14.0	-16.3	-6.7	-32.3	-39.1	-35.5	-40.7	-44.9	-29.3	34.2	-9.2	-2.8
Critical Dry	-7.7	-15.2	-15.7	-19.4	-38.4	-32.7	-30.7	-25.3	-51.1	60.2	-13.0	-3.0

The following changes would occur in CVP and SWP exports under the No Action Alternative as compared to the Second Basis of Comparison.

- Long-term average annual exports would be 1,051 TAF (18 percent) less under the No Action Alternative as compared to the Second Basis of Comparison.
- In wet years, total exports would be similar in June and September; reduced in October through February, April, and May (up to 57.2 percent); and increased in March, July, and August (up to 9.6 percent).
- In above-normal and below-normal years, total exports would be similar in July and September; reduced in October through June (up to 71.2 and

67.1 percent, respectively); and increased in August (up to 9.5 and 20.4 percent, respectively).

- In dry and critical dry years, total exports would be similar in September; reduced in October through June and August (up to 44.9 and 51.1 percent, respectively); and increased in July (34.2 and 60.2 percent, respectively).

Deliveries to CVP and SWP water users decline under the No Action Alternative as compared to the Second Basis of Comparison, as summarized in Tables 5.26 and 5.27, respectively, due to reduced water supply availability and export limitations.

Table 5.26 Changes in CVP Water Deliveries under the No Action Alternative as Compared to the Second Basis of Comparison

Annual Average Deliveries (TAF)					
				No Action Alternative as Compared to the Second Basis of Comparison	
		No Action Alternative	Second Basis of Comparison	Difference	Percent Change
North of Delta					
CVP Agricultural Water Service Contractors	Long Term	185	219	-34	-16
	Dry	86	122	-37	-30
	Critical Dry	24	35	-12	-34
CVP Municipal and Industrial (M&I) (Including American River Contractors and CCWD)	Long Term	386	392	-7	-2
	Dry	385	390	-5	-1
	Critical Dry	383	383	1	0
CVP M&I American River Contractors	Long Term	113	120	-7	-6
	Dry	97	105	-8	-8
	Critical Dry	75	79	-5	-6
CVP Sacramento River Settlement Contractors	Long Term	1,859	1,858	1	0
	Dry	1,906	1,905	1	0
	Critical Dry	1,737	1,732	5	0
CVP Refuge Level 2 Deliveries	Long Term	146	155	-8	-5
	Dry	146	151	-5	-3
	Critical Dry	102	105	-3	-3

Annual Average Deliveries (TAF)				**No Action Alternative as Compared to the Second Basis of Comparison**	
		No Action Alternative	**Second Basis of Comparison**	**Difference**	**Percent Change**
Total CVP Agricultural, M&I, Sacramento River Settlement Contractors, and Refuge Level 2 Deliveries	Long Term	2,576	2,624	-48	-2
	Dry	2,523	2,568	-45	-2
	Critical Dry	2,246	2,255	-9	0
South of Delta (Does not include Eastside Contractors)					
CVP Agricultural Water Service Contractors	Long Term	847	1,100	-253	-23
	Dry	445	650	-206	-32
	Critical Dry	131	195	-64	-33
CVP M&I Users	Long Term	112	125	-13	-10
	Dry	99	109	-10	-9
	Critical Dry	80	85	-4	-5
San Joaquin River Exchange Contractors	Long Term	852	852	0	0
	Dry	875	875	0	0
	Critical Dry	741	741	0	0
CVP Refuge Level 2 Deliveries	Long Term	273	272	1	0
	Dry	281	280	1	0
	Critical Dry	234	232	3	1
Total CVP Agricultural, M&I, San Joaquin River Exchange Contractors, and Refuge Level 2 Deliveries	Long Term	2,084	2,349	-266	-11
	Dry	1,700	1,914	-216	-11
	Critical Dry	1,186	1,253	-68	-5
Eastside Contractors Deliveries					
Water Rights	Long Term	508	514	-6	-1
	Dry	524	524	0	0
	Critical Dry	445	486	-42	-9

Annual Average Deliveries (TAF)					
		No Action Alternative	Second Basis of Comparison	No Action Alternative as Compared to the Second Basis of Comparison	
				Difference	Percent Change
CVP Water Service Contracts	Long Term	104	118	-15	-13
	Dry	84	98	-13	-13
	Critical Dry	4	25	-21	-84
Total Water Rights and CVP Service Contracts Deliveries	Long Term	612	632	-21	-3
	Dry	608	622	-13	-2
	Critical Dry	449	511	-63	-12

The following changes in CVP water deliveries would occur under the No Action Alternative as compared to the Second Basis of Comparison.

- Deliveries to CVP North of Delta agricultural water service contractors would be reduced by 16 percent over the long-term conditions (averaged over the 82-year period analyzed with CalSim II), 30 percent in dry years, and 34 percent in critical dry years.
- Deliveries to CVP North of Delta M&I contractors would be similar in total; however, deliveries to the American River CVP contractors would be reduced by 6 percent over the long-term conditions, 8 percent in dry years, and 6 percent in critical dry years.
- Deliveries to CVP South of Delta agricultural water service contractors would be reduced by 23 percent over the long-term conditions, 32 percent in dry years, and 33 percent in critical dry years.
- Deliveries to CVP South of Delta M&I contractors would be reduced by 10 percent over the long-term conditions, 9 percent in dry years, and 5 percent in critical dry years.
- Deliveries to the Eastside contractors would be similar under the long-term conditions and dry years, but reduce by 12 percent in critical dry years.

Table 5.27 Changes in SWP Water Deliveries under the No Action Alternative as Compared to the Second Basis of Comparison

Annual Average Deliveries (TAF)					
				No Action Alternative as Compared to the Second Basis of Comparison	
		No Action Alternative	Second Basis of Comparison	Difference	Percent Change
North of Delta					
SWP Agricultural Uses	Long Term	0	0	0	0
	Dry	0	0	0	0
	Critical Dry	0	0	0	0
SWP M&I (without Article 21)	Long Term	68	83	-15	-18
	Dry	51	62	-11	-18
	Critical Dry	43	53	-11	-20
SWP M&I Article 21 Deliveries	Long Term	13	12	1	9
	Dry	14	13	1	7
	Critical Dry	13	12	1	9
Total SWP Agricultural and M&I (without Article 21)	Long Term	68	83	-15	-18
	Dry	51	62	-11	-18
	Critical Dry	43	53	-11	-20
Total SWP Agricultural and M&I Article 21 Deliveries	Long Term	13	12	1	9
	Dry	14	13	1	7
	Critical Dry	13	12	1	9
South of Delta					
SWP Agricultural Users (without Article 21)	Long Term	610	750	-139	-19
	Dry	455	567	-112	-20
	Critical Dry	378	484	-106	-22

Annual Average Deliveries (TAF)					
				No Action Alternative as Compared to the Second Basis of Comparison	
		No Action Alternative	**Second Basis of Comparison**	**Difference**	**Percent Change**
SWP Agricultural Article 21 Deliveries	Long Term	27	178	-152	-85
	Dry	5	143	-138	-96
	Critical Dry	7	100	-93	-93
SWP M&I Users (without Article 21)	Long Term	1,800	2,183	-383	-18
	Dry	1,406	1,732	-327	-19
	Critical Dry	1,173	1,494	-321	-21
SWP M&I Article 21 Deliveries	Long Term	20	104	-84	-81
	Dry	5	86	-82	-95
	Critical Dry	5	58	-53	-91
Total SWP Agricultural and M&I Users (without Article 21)	Long Term	2,410	2,933	-523	-18
	Dry	1,861	2,299	-439	-19
	Critical Dry	1,551	1,978	-427	-22
Total SWP Agricultural and M&I Article 21 Deliveries	Long Term	47	282	-236	-83
	Dry	10	229	-219	-96
	Critical Dry	12	158	-146	-92

The following changes in SWP water deliveries would occur under the No Action Alternative as compared to the Second Basis of Comparison.

- Deliveries without Article 21 water to SWP North of Delta water contractors would be reduced by 18 percent over the long-term conditions; 18 percent in dry years; and 20 percent in critical dry years.
- Deliveries without Article 21 water to SWP South of Delta water contractors would be reduced by 18 percent over the long-term conditions; 19 percent in dry years; and 22 percent in critical dry years.

- Deliveries of Article 21 water to SWP North of Delta water contractors would be increased by 9 percent over the long-term conditions; 7 percent in dry years; and 9 percent in critical dry years.
- Deliveries of Article 21 water to SWP South of Delta water contractors would be reduced by 83 percent over the long-term conditions; 96 percent in dry years; and 92 percent in critical dry years.

Effects Related to Cross Delta Water Transfers

Potential effects to surface water resources could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014i). Potential effects were identified as reduced surface water storage in upstream reservoirs and changes in flow patterns in river downstream of the reservoirs if water was released from the reservoirs in patterns that were different than would have been used by the water seller's. Because all water transfers would be required to avoid adverse impacts to other water users and biological resources (see Section 3.A.6.3, Transfers), including impacts associated with changes in reservoir storage and river flow patterns; the analysis indicated that water transfers would not result in substantial changes in storage or river flows. For the purposes of this EIS, it is anticipated that similar conditions would occur due to cross Delta water transfers under the No Action Alternative and the Second Basis of Comparison.

Under the No Action Alternative, the timing of cross Delta water transfers would be limited to July through September in accordance with the 2008 USFWS BO and 2009 NMFS BO. The maximum amount of water to be transferred would be 600,000 acre-feet per year in critical dry years or in dry years following a dry or critical dry year. In all other water year types, the maximum amount of water would be 360,000 acre-feet per year. The maximum amount of water that can be exported in the CVP and SWP facilities is approximately 770,000 acre-feet per month. As indicated in Table 5.25, capacity would be available under the No Action Alternative between July and September for water transfers in all water year types.

Under the Second Basis of Comparison, water could be transferred throughout the year. As indicated in Table 5.25, capacity would be available under the Second Basis of Comparison in all months of all water year types without a maximum volume of transferred water.

Overall, the potential for water transfer conveyance would be less under the No Action Alternative than under the Second Basis of Comparison.

5.4.3.1.3 San Francisco Bay Area, Central Coast, and Southern California Regions

Potential Changes in Surface Water Resources at Reservoirs that Store CVP and SWP Water

The San Francisco Bay Area, Central Coast, and Southern California regions include numerous reservoirs that store CVP and SWP water supplies, including

CVP and SWP reservoirs, that primarily provide water supplies for M&I water users. Changes in the availability of CVP and SWP water supplies for storage in these reservoirs under the No Action Alternative as compared to the Second Basis of Comparison would be consistent with the following changes in water deliveries to M&I water users, as summarized in Tables 5.26 and 5.27.

- Deliveries to CVP South of Delta M&I contractors and reservoirs in the San Francisco Bay Area would be reduced by 10 percent over the long-term conditions; 9 percent in dry years; and 7 percent in critical dry years.
- Deliveries without Article 21 water to SWP South of Delta water contractors and reservoirs in the San Francisco Bay Area, Central Coast, and Southern California regions would be reduced by 18 percent over the long-term conditions; 19 percent in dry years; and 22 percent in critical dry years.
- Deliveries of Article 21 water to SWP South of Delta water contractors and reservoirs in the San Francisco Bay Area, Central Coast, and Southern California regions would be reduced by 83 percent over the long-term conditions; 96 percent in dry years; and 92 percent in critical dry years.

Changes in CVP and SWP Deliveries

Deliveries to CVP and SWP water users are described in Section 5.4.3.1.2, Central Valley Region.

5.4.3.2 Alternative 1

As described in Chapter 3, Description of Alternatives, Alternative 1 is identical to the Second Basis of Comparison. Alternative 1 is compared to the No Action Alternative and the Second Basis of Comparison. However, because water resource conditions under Alternative 1 are identical to water resource conditions under the Second Basis of Comparison; Alternative 1 is only compared to the No Action Alternative.

5.4.3.2.1 Alternative 1 Compared to the No Action Alternative

Trinity River Region

Changes in CVP and SWP Reservoir Storage and Downstream River Flows

Changes in Trinity Lake storage and surface water elevations under Alternative 1 as compared to the No Action Alternative are summarized in Tables 5.28 and 5.29. A summary of the results is provided following Table 5.29.

Table 5.28 Changes in Trinity Lake Storage under Alternative 1 as Compared to the No Action Alternative

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 1												
Wet	1,501	1,535	1,644	1,767	1,931	2,055	2,224	2,250	2,194	2,068	1,939	1,805
Above Normal	1,208	1,245	1,363	1,524	1,718	1,901	2,079	2,053	1,955	1,815	1,647	1,513
Below Normal	1,451	1,472	1,492	1,554	1,641	1,729	1,872	1,799	1,696	1,515	1,337	1,204
Dry	1,178	1,184	1,210	1,230	1,322	1,453	1,586	1,536	1,466	1,302	1,152	1,055
Critical Dry	819	803	813	825	868	949	999	962	929	811	667	598
No Action Alternative												
Wet	1,490	1,516	1,630	1,756	1,921	2,053	2,220	2,245	2,190	2,067	1,939	1,784
Above Normal	1,159	1,178	1,286	1,455	1,658	1,847	2,025	1,999	1,907	1,773	1,619	1,495
Below Normal	1,393	1,400	1,417	1,488	1,575	1,662	1,817	1,743	1,637	1,470	1,304	1,185
Dry	1,152	1,148	1,174	1,182	1,274	1,403	1,539	1,490	1,413	1,253	1,104	1,008
Critical Dry	747	731	746	750	790	872	923	888	862	745	612	536
Alternative 1 as Compared to No Action Alternative												
Wet	11	19	14	11	9	2	4	5	4	0	-1	21
Above Normal	49	68	77	69	60	54	55	54	49	42	27	18
Below Normal	59	72	74	66	67	67	54	57	60	44	33	18
Dry	26	36	36	48	48	49	47	46	53	48	48	48
Critical Dry	73	72	68	75	78	78	76	74	66	66	56	61
Alternative 1 as Compared to No Action Alternative (percent change)												
Wet	0.7	1.3	0.9	0.6	0.5	0.1	0.2	0.2	0.2	0.0	0.0	1.2
Above Normal	4.2	5.7	6.0	4.7	3.6	2.9	2.7	2.7	2.5	2.4	1.7	1.2
Below Normal	4.2	5.2	5.2	4.4	4.2	4.0	3.0	3.2	3.6	3.0	2.5	1.5
Dry	2.2	3.2	3.1	4.1	3.8	3.5	3.0	3.1	3.7	3.9	4.3	4.7
Critical Dry	9.7	9.9	9.1	10.1	9.8	8.9	8.2	8.4	7.7	8.8	9.1	11.5

Table 5.29 Changes in Trinity Lake Elevation under Alternative 1 as Compared to the No Action Alternative

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 1												
Wet	2,301	2,305	2,314	2,325	2,339	2,347	2,357	2,358	2,355	2,347	2,338	2,328
Above Normal	2,270	2,273	2,286	2,303	2,320	2,335	2,347	2,346	2,339	2,329	2,315	2,304
Below Normal	2,295	2,296	2,298	2,305	2,313	2,320	2,331	2,326	2,318	2,303	2,287	2,274
Dry	2,266	2,269	2,272	2,274	2,284	2,296	2,309	2,304	2,298	2,284	2,269	2,259
Critical Dry	2,218	2,216	2,217	2,222	2,229	2,243	2,250	2,246	2,243	2,227	2,204	2,191
No Action Alternative												
Wet	2,300	2,303	2,313	2,324	2,338	2,347	2,357	2,358	2,355	2,347	2,338	2,327
Above Normal	2,261	2,264	2,276	2,294	2,314	2,330	2,343	2,341	2,335	2,325	2,313	2,302
Below Normal	2,289	2,289	2,291	2,299	2,307	2,315	2,327	2,321	2,313	2,299	2,283	2,272
Dry	2,263	2,265	2,268	2,269	2,279	2,292	2,305	2,301	2,294	2,279	2,264	2,254
Critical Dry	2,210	2,207	2,210	2,213	2,220	2,235	2,242	2,238	2,235	2,220	2,196	2,182
Alternative 1 as Compared to No Action Alternative												
Wet	1	2	1	1	1	0	0	0	0	0	0	2
Above Normal	8	10	10	9	7	5	4	4	4	4	2	2
Below Normal	6	7	7	6	6	6	4	5	5	4	3	3
Dry	3	4	4	5	5	4	4	4	5	5	5	5
Critical Dry	8	8	8	9	8	8	8	8	7	8	8	9
Alternative 1 as Compared to No Action Alternative (percent change)												
Wet	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Above Normal	0.4	0.4	0.5	0.4	0.3	0.2	0.2	0.2	0.2	0.2	0.1	0.1
Below Normal	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.1
Dry	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Critical Dry	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.4	0.4	0.4

The following changes in Trinity Lake storage and surface water elevation would occur under Alternative 1 as compared to the No Action Alternative.

- In wet years and dry years, storage would be similar in all months.
- In above-normal years, storage would be similar in January through October and increased in November and December (up to 6.0 percent).
- In below-normal years, storage would be similar in January through October and increased in November and December (up to 5.2 percent).
- In critical dry years, storage would be increased in all months (up to 11.5 percent).
- In all months, in all water year types, surface water elevations would be similar.

The following changes would occur on the Trinity River under Alternative 1 as compared to the No Action Alternative, as shown on Figures 5.53 through 5.55.

- Over long-term conditions, flows would be similar in March through November and increased in December through February (up to 10.5 percent).
- In wet years, flows would be similar in April through November and increased in December through March (up to 12.6 percent).
- In dry years, flows would be similar all months.

Central Valley Region

Changes in CVP and SWP Reservoir Storage and Downstream River Flows

Shasta Lake and Sacramento River

Storage levels and surface water elevations in Shasta Lake under Alternative 1 as compared to the No Action Alternative are summarized in Tables 5.30 and 5.31. Changes in flows in the Sacramento River downstream of Keswick Dam and at Freeport are shown on Figures 5.56 through 5.61. The results are summarized following Table 5.31.

Table 5.30 Changes in Shasta Lake Storage under Alternative 1 as Compared to the No Action Alternative

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 1												
Wet	2,817	2,926	3,154	3,406	3,597	3,841	4,301	4,453	4,228	3,733	3,362	3,252
Above Normal	2,499	2,578	2,808	3,313	3,515	4,038	4,416	4,417	3,979	3,347	2,975	2,921
Below Normal	2,826	2,846	2,977	3,299	3,646	3,966	4,164	4,042	3,599	3,010	2,601	2,574
Dry	2,409	2,431	2,578	2,755	3,168	3,644	3,861	3,774	3,333	2,800	2,539	2,496
Critical Dry	1,873	1,826	1,911	2,050	2,222	2,460	2,386	2,270	1,861	1,409	1,151	1,086
No Action Alternative												
Wet	2,700	2,719	3,077	3,384	3,589	3,836	4,298	4,460	4,242	3,735	3,410	2,985
Above Normal	2,369	2,385	2,600	3,167	3,453	4,021	4,404	4,429	4,039	3,407	3,069	2,834
Below Normal	2,587	2,548	2,686	3,062	3,442	3,814	4,026	3,957	3,588	3,002	2,643	2,608
Dry	2,345	2,283	2,428	2,621	3,034	3,505	3,737	3,668	3,284	2,767	2,496	2,462
Critical Dry	1,702	1,633	1,717	1,871	2,031	2,274	2,202	2,088	1,719	1,253	986	937
Alternative 1 as Compared to No Action Alternative												
Wet	117	208	77	22	8	5	3	-7	-14	-2	-49	267
Above Normal	130	193	208	146	62	17	12	-11	-60	-60	-94	87
Below Normal	239	298	291	237	204	152	138	86	10	8	-42	-33
Dry	64	148	150	135	134	139	123	106	48	33	42	35
Critical Dry	171	193	194	179	190	186	184	183	142	155	165	149
Alternative 1 as Compared to No Action Alternative (percent change)												
Wet	4.3	7.6	2.5	0.6	0.2	0.1	0.1	-0.2	-0.3	-0.1	-1.4	8.9
Above Normal	5.5	8.1	8.0	4.6	1.8	0.4	0.3	-0.3	-1.5	-1.8	-3.1	3.1
Below Normal	9.3	11.7	10.8	7.7	5.9	4.0	3.4	2.2	0.3	0.3	-1.6	-1.3
Dry	2.7	6.5	6.2	5.1	4.4	4.0	3.3	2.9	1.5	1.2	1.7	1.4
Critical Dry	10.1	11.8	11.3	9.6	9.4	8.2	8.4	8.7	8.3	12.4	16.8	16.0

Table 5.31 Changes in Shasta Lake Elevation under Alternative 1 as Compared to the No Action Alternative

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 1												
Wet	997	1,002	1,012	1,024	1,032	1,041	1,058	1,063	1,055	1,037	1,022	1,017
Above Normal	974	978	992	1,019	1,028	1,048	1,062	1,062	1,046	1,021	1,005	1,003
Below Normal	997	998	1,004	1,019	1,034	1,046	1,053	1,049	1,031	1,006	987	986
Dry	972	974	982	992	1,012	1,032	1,041	1,038	1,020	997	984	982
Critical Dry	938	935	941	950	961	977	974	967	943	910	889	884
No Action Alternative												
Wet	991	992	1,008	1,023	1,031	1,041	1,058	1,064	1,056	1,037	1,024	1,005
Above Normal	967	968	982	1,012	1,025	1,048	1,062	1,063	1,049	1,024	1,009	999
Below Normal	986	985	991	1,009	1,025	1,040	1,048	1,045	1,031	1,006	989	987
Dry	969	967	975	986	1,006	1,027	1,037	1,034	1,018	995	982	980
Critical Dry	927	923	929	939	951	968	965	958	935	899	876	872
Alternative 1 as Compared to No Action Alternative												
Wet	6	10	4	1	0	0	0	0	-1	0	-2	12
Above Normal	7	10	10	7	3	1	0	0	-2	-3	-4	4
Below Normal	11	14	13	10	9	6	5	4	1	1	-2	-1
Dry	3	7	7	6	6	6	5	4	2	2	3	2
Critical Dry	11	12	12	11	10	9	9	9	8	11	13	12
Alternative 1 as Compared to No Action Alternative (percent change)												
Wet	0.6	1.0	0.4	0.1	0.0	0.0	0.0	0.0	-0.1	0.0	-0.2	1.2
Above Normal	0.7	1.0	1.0	0.7	0.3	0.1	0.0	0.0	-0.2	-0.3	-0.4	0.4
Below Normal	1.1	1.4	1.3	1.0	0.8	0.6	0.5	0.3	0.1	0.1	-0.2	-0.1
Dry	0.3	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.2	0.2	0.3	0.2
Critical Dry	1.2	1.3	1.3	1.2	1.0	0.9	1.0	1.0	0.8	1.2	1.5	1.4

The following changes in Shasta Lake storage and surface water elevations would occur under Alternative 1 as compared to the No Action Alternative.

- In wet years, storage would be similar in December through August and October and increased in September and November (up to 8.9 percent).
- In above-normal years, storage would be similar in January through September and increased in October through December (up to 8.1 percent).
- In below-normal years, storage would be similar in March through September and increased in October through February (up to 11.7 percent).

- In dry years, storage would be similar in February through October and increased in November through January (up to 6.5 percent).
- In critical dry years, storage would be increased under all months (up to 16.8 percent).
- In all months, in all water year types, surface water elevations would be similar.

The following changes in Sacramento River flows would occur under Alternative 1 as compared to the No Action Alternative, as shown on Figures 5.56 through 5.61.

- Sacramento River downstream of Keswick Dam (Figures 5.56 through 5.58).
  - Over long-term conditions, similar flows would occur in October, February through May, July, and August; reduced flows in September and November (up to 27.4 percent); and increased flows in December, January, and June (up to 8.4 percent).
  - In wet years, similar flows would occur in January through July; reduced flows in September through November (up to 43.7 percent); and increased flows in December and August (up to 17.0 percent).
  - In dry years, similar flows would occur in July through October, December through March, and May; reduced flows in November (25.0 percent); and increased flows in April and June (up to 7.8 percent).
- Sacramento River near Freeport (near the northern boundary of the Delta) (Figures 5.59 through 5.61).
  - Over long-term conditions, similar flows would occur in October, December through May, and August; reduced flows in September, November, and July (up to 30.2 percent); and increased flows in June (12.8 percent).
  - In wet years, similar flows would occur in January through June and October; reduced flows in July through September and November (up to 47.4 percent); and increased flows in December (6.6 percent).
  - In dry years, similar flows would occur in August through October and December through April; reduced flows in November and July (up to 13.6 percent); and increased flows in May and June (up to 13.5 percent).

Lake Oroville and Feather River

Storage levels and surface water elevations in Lake Oroville under Alternative 1 as compared to the No Action Alternative are summarized in Tables 5.32 and 5.33. Changes in flows in the Feather River downstream of Thermalito Complex are shown on Figures 5.62 through 5.64. The results are summarized following Table 5.33.

Table 5.32 Changes in Lake Oroville Storage under Alternative 1 as Compared to the No Action Alternative

Water Year	End of Month Storage (TAF)											
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Alternative 1												
Wet	1,936	1,984	2,354	2,636	2,871	2,942	3,300	3,477	3,402	2,976	2,728	2,569
Above Normal	1,465	1,523	1,702	2,173	2,648	2,937	3,271	3,357	3,081	2,493	2,087	1,827
Below Normal	1,823	1,783	1,831	2,037	2,361	2,627	2,875	2,836	2,461	1,930	1,637	1,424
Dry	1,371	1,324	1,344	1,473	1,764	2,120	2,363	2,357	2,031	1,688	1,427	1,261
Critical Dry	1,117	1,044	1,041	1,125	1,235	1,406	1,423	1,407	1,219	1,027	911	839
No Action Alternative												
Wet	1,691	1,732	2,189	2,554	2,832	2,942	3,300	3,488	3,445	2,964	2,626	2,109
Above Normal	1,279	1,322	1,485	1,959	2,519	2,892	3,247	3,393	3,232	2,600	2,117	1,659
Below Normal	1,542	1,497	1,507	1,719	2,122	2,397	2,653	2,714	2,530	1,923	1,513	1,307
Dry	1,206	1,158	1,177	1,305	1,582	1,938	2,178	2,210	1,951	1,478	1,287	1,144
Critical Dry	1,092	1,029	1,019	1,108	1,223	1,381	1,408	1,392	1,243	1,018	917	865
Alternative 1 as Compared to No Action Alternative												
Wet	245	252	165	82	39	0	0	-10	-43	12	102	459
Above Normal	187	201	217	214	129	44	24	-37	-150	-107	-29	167
Below Normal	281	285	324	318	239	230	222	122	-69	7	125	117
Dry	165	165	167	168	182	182	185	147	80	210	140	117
Critical Dry	25	15	22	17	12	25	16	15	-25	8	-6	-26
Alternative 1 as Compared to No Action Alternative (percent change)												
Wet	14.5	14.6	7.6	3.2	1.4	0.0	0.0	-0.3	-1.2	0.4	3.9	21.8
Above Normal	14.6	15.2	14.6	10.9	5.1	1.5	0.8	-1.1	-4.6	-4.1	-1.4	10.1
Below Normal	18.2	19.1	21.5	18.5	11.2	9.6	8.4	4.5	-2.7	0.4	8.2	8.9
Dry	13.7	14.3	14.2	12.9	11.5	9.4	8.5	6.6	4.1	14.2	10.8	10.2
Critical Dry	2.3	1.5	2.2	1.5	1.0	1.8	1.1	1.1	-2.0	0.8	-0.7	-3.0

Table 5.33 Changes in Lake Oroville Elevation under Alternative 1 as Compared to the No Action Alternative

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 1												
Wet	768	773	810	837	854	859	884	896	891	861	844	831
Above Normal	717	723	745	796	838	859	882	888	869	826	790	763
Below Normal	757	752	757	779	812	834	854	852	823	775	743	719
Dry	706	701	705	721	755	791	814	813	784	748	718	698
Critical Dry	677	668	668	680	694	715	716	714	691	664	647	636
No Action Alternative												
Wet	743	748	794	829	852	859	884	897	894	861	836	790
Above Normal	698	703	722	776	828	856	880	890	879	835	794	746
Below Normal	730	725	726	751	793	818	838	842	828	773	729	704
Dry	688	683	686	704	737	775	798	800	775	724	702	684
Critical Dry	674	667	664	678	693	712	715	712	693	663	648	640
Alternative 1 as Compared to No Action Alternative												
Wet	24	25	16	8	3	0	0	-1	-3	0	8	41
Above Normal	19	21	24	20	10	3	2	-3	-10	-10	-4	18
Below Normal	27	27	31	28	20	17	16	9	-5	1	14	14
Dry	18	18	18	17	18	16	15	14	9	24	17	15
Critical Dry	3	1	3	3	1	3	2	2	-2	0	-1	-4
Alternative 1 as Compared to No Action Alternative (percent change)												
Wet	3.3	3.3	2.0	0.9	0.3	0.0	0.0	-0.1	-0.3	0.1	1.0	5.2
Above Normal	2.7	2.9	3.3	2.6	1.2	0.4	0.2	-0.3	-1.2	-1.1	-0.5	2.4
Below Normal	3.7	3.8	4.2	3.7	2.5	2.0	1.9	1.1	-0.6	0.2	2.0	2.0
Dry	2.6	2.6	2.7	2.5	2.5	2.1	1.9	1.7	1.2	3.3	2.4	2.1
Critical Dry	0.4	0.2	0.5	0.4	0.2	0.4	0.2	0.3	-0.4	0.0	-0.2	-0.6

The following changes in Lake Oroville storage and surface water elevations would occur under Alternative 1 as compared to the No Action Alternative.

- In wet years, storage would be similar in January through August and reduced in September through December (up to 21.8 percent).
- In above-normal years, storage would be similar in February through August and reduced in September through January (up to 15.2 percent).
- In below-normal years, storage would be similar in May through July and reduced in August through April (up to 21.5 percent).

- In dry years, storage would be similar in June and reduced in all other months (up to 14.2 percent).
- In critical dry years, storage would be similar under all months.
- In all months, in all water year types, surface water elevations would be similar.

The following changes in Feather River flows would occur under Alternative 1 as compared to the No Action Alternative, as shown in Figures 5.62 through 5.64.

- Over long-term conditions, similar flows would occur in November and April; reduced flows in July through September (up to 43.2 percent); and increased flows in October, December through March, May, and June (up to 37.4 percent).
- In wet years, similar flows would occur in October, November, and March through May; reduced flows in July through September (up to 64.9 percent); and increased flows in December through February and June (up to 35.1 percent).
- In dry years, similar flows would occur in December through April; reduced flows in July (34.4 percent); and increased flows in August through October, May, and June (up to 38.1 percent).

Folsom Lake and American River

Storage levels and surface water elevations in Folsom Lake under Alternative 1 as compared to the No Action Alternative are summarized in Tables 5.34 and 5.35. Changes in flows in the American River downstream of Nimbus Dam are shown on Figures 5.65 through 5.67. The results are summarized following Table 5.35.

Table 5.34 Changes in Folsom Lake Storage under Alternative 1 as Compared to the No Action Alternative

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 1												
Wet	483	470	522	524	515	632	785	951	937	793	688	646
Above Normal	390	412	467	537	538	640	787	946	857	591	522	485
Below Normal	506	489	502	514	541	626	761	847	739	475	408	387
Dry	405	399	423	437	486	585	698	769	664	486	432	408
Critical Dry	339	317	323	325	369	436	469	482	430	352	288	258
No Action Alternative												
Wet	29	35	8	6	0	0	0	0	-4	-7	-25	70
Above Normal	13	33	38	24	7	0	0	-1	-30	-31	-30	8
Below Normal	59	58	35	30	8	7	4	4	-41	-52	-64	-66
Dry	12	16	15	14	7	6	7	9	5	-9	-11	-11
Critical Dry	14	11	9	5	3	3	-6	-4	16	25	21	28
Alternative 1 as Compared to No Action Alternative												
Wet	29	35	8	6	0	0	0	0	-4	-7	-25	70
Above Normal	13	33	38	24	7	0	0	-1	-30	-31	-30	8
Below Normal	59	58	35	30	8	7	4	4	-41	-52	-64	-66
Dry	12	16	15	14	7	6	7	9	5	-9	-11	-11
Critical Dry	14	11	9	5	3	3	-6	-4	16	25	21	28
Alternative 1 as Compared to No Action Alternative (percent change)												
Wet	6.5	8.0	1.5	1.2	0.0	0.0	0.0	0.0	-0.5	-0.9	-3.5	12.1
Above Normal	3.5	8.6	8.9	4.7	1.3	0.0	0.0	-0.1	-3.4	-5.0	-5.4	1.7
Below Normal	13.3	13.5	7.5	6.1	1.4	1.1	0.5	0.5	-5.2	-9.9	-13.5	-14.6
Dry	2.9	4.2	3.6	3.3	1.4	1.0	1.1	1.2	0.8	-1.8	-2.5	-2.7
Critical Dry	4.4	3.7	2.8	1.6	0.7	0.7	-1.2	-0.8	3.8	7.7	7.8	12.1

Table 5.35 Changes in Folsom Lake Elevation under Alternative 1 as Compared to the No Action Alternative

Water Year	End of Month Elevation (Feet)											
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Alternative 1												
Wet	412	412	419	419	418	432	448	465	464	449	438	433
Above Normal	397	400	410	421	421	433	448	465	456	427	419	414
Below Normal	415	414	416	417	421	432	446	455	443	410	401	398
Dry	401	401	405	407	414	427	439	446	435	413	406	403
Critical Dry	389	386	390	391	397	406	410	411	404	391	378	372
No Action Alternative												
Wet	409	407	418	418	418	432	448	464	464	449	440	425
Above Normal	394	395	405	418	420	433	449	464	458	430	422	413
Below Normal	408	406	411	414	420	431	445	454	447	418	411	409
Dry	400	399	403	405	413	426	438	445	434	414	408	405
Critical Dry	386	384	389	390	396	406	411	412	401	386	374	366
Alternative 1 as Compared to No Action Alternative												
Wet	4	5	1	1	0	0	0	1	0	-1	-3	8
Above Normal	2	5	5	3	1	0	0	1	-3	-4	-4	1
Below Normal	7	7	4	4	1	1	1	1	-4	-8	-10	-10
Dry	1	2	2	2	1	1	1	1	1	-1	-1	-1
Critical Dry	3	2	2	1	0	0	-1	0	2	5	4	6
Alternative 1 as Compared to No Action Alternative (percent change)												
Wet	0.9	1.1	0.2	0.2	0.0	0.0	0.0	0.2	0.1	-0.2	-0.6	1.9
Above Normal	0.6	1.4	1.3	0.7	0.2	0.0	0.0	0.1	-0.6	-0.8	-0.8	0.2
Below Normal	1.8	1.8	1.1	0.9	0.2	0.2	0.1	0.2	-0.9	-1.9	-2.5	-2.6
Dry	0.3	0.5	0.5	0.5	0.2	0.2	0.2	0.3	0.2	-0.3	-0.3	-0.4
Critical Dry	0.7	0.6	0.4	0.2	0.1	0.1	-0.2	-0.1	0.6	1.2	1.1	1.8

The following changes in Folsom Lake storage would occur under Alternative 1 as compared to the No Action Alternative.

- In wet years, storage would be similar in December through August and increased in September through December (up to 12.1 percent).
- In above-normal years, storage would be similar in January through July and September through October; increased in November and December (up to 8.9 percent); and reduced in August (5.4 percent).
- In below-normal years, storage would be similar in February through May; reduced in June through September (up to 14.6 percent); and increased in October through January (up to 13.5 percent).

- In dry years, storage would be similar in all months.
- In critical dry years, storage would be similar in October through June and increased in July through September (up to 12.1 percent).
- In all months, in all water year types, surface water elevations would be similar.

The following changes in American River flows would occur under Alternative 1 as compared to the No Action Alternative, as shown on Figures 5.65 through 5.67.

- Over long-term conditions, similar flows would occur in November through May and July; reduced flows in September and October (up to 30.9 percent); and increased flows in June (5.4 percent).
- In wet years, similar flows would occur in October, November, and January through July; reduced flows in September (47.7 percent); and increased flows in August (12.0 percent).
- In dry years, similar flows would occur in November through January, March through June, August, and September; reduced flows in October (14.1 percent); and increased flows in February and July (up to 7.9 percent).

Clear Creek

Changes in flows in Clear Creek downstream of Whiskeytown Dam are summarized in Table 5.36.

Monthly Clear Creek flows under Alternative 1 as compared to the No Action Alternative are identical except in May. In May, under Alternative 1, flows are up to 28.9 percent lower than under the No Action Alternative.

Table 5.36 Changes in Clear Creek Flows below Whiskeytown Dam under the Alternative 1 as Compared to the No Action Alternative

Water Year	Average Monthly Flow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 1												
Wet	200	200	200	309	356	272	200	200	200	85	85	150
Above Normal	181	182	188	192	196	196	196	200	200	85	85	150
Below Normal	195	195	195	195	195	195	195	195	191	85	85	150
Dry	178	184	188	190	190	190	190	190	183	85	85	150
Critical Dry	163	167	167	167	167	167	167	167	111	85	85	133
No Action Alternative												
Wet	200	200	200	309	356	272	200	277	200	85	85	150
Above Normal	181	182	188	192	196	196	196	277	200	85	85	150
Below Normal	195	195	195	195	195	195	195	274	191	85	85	150
Dry	175	184	188	190	190	190	190	267	183	85	85	150
Critical Dry	163	167	167	167	167	167	167	214	111	85	85	133
Alternative 1 as Compared to No Action Alternative												
Wet	0	0	0	0	0	0	0	-77	0	0	0	0
Above Normal	0	0	0	0	0	0	0	-77	0	0	0	0
Below Normal	0	0	0	0	0	0	0	-78	0	0	0	0
Dry	3	0	0	0	0	0	0	-77	0	0	0	0
Critical Dry	0	0	0	0	0	0	0	-47	0	0	0	0
Alternative 1 as Compared to No Action Alternative (percent change)												
Wet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-27.9	0.0	0.0	0.0	0.0
Above Normal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-27.9	0.0	0.0	0.0	0.0
Below Normal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-28.6	0.0	0.0	0.0	0.0
Dry	1.6	0.0	0.0	0.0	0.0	0.0	0.0	-28.9	0.0	0.0	0.0	0.0
Critical Dry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-22.1	0.0	0.0	0.0	0.0

New Melones Reservoir and Stanislaus River

Storage levels and surface water elevations in New Melones Reservoir under Alternative 1 as compared to the No Action Alternative are summarized in Tables 5.37 and 5.38. Changes in flows in the Stanislaus River downstream of Goodwin Dam are shown on Figures 5.68 through 5.70. The results are summarized following Table 5.38.

Table 5.37 Changes in New Melones Reservoir Storage under the Alternative 1 as Compared to the No Action Alternative

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 1												
Wet	1,443	1,446	1,502	1,606	1,709	1,794	1,833	1,962	1,994	1,917	1,803	1,731
Above Normal	1,092	1,116	1,175	1,261	1,360	1,455	1,481	1,543	1,516	1,419	1,321	1,274
Below Normal	1,364	1,366	1,378	1,397	1,453	1,479	1,461	1,447	1,415	1,322	1,228	1,183
Dry	1,149	1,143	1,149	1,161	1,191	1,221	1,210	1,176	1,131	1,039	956	912
Critical Dry	667	663	674	680	696	690	646	585	557	498	449	426
No Action Alternative												
Wet	1,379	1,390	1,454	1,562	1,666	1,724	1,758	1,878	1,968	1,890	1,773	1,703
Above Normal	1,029	1,060	1,125	1,214	1,317	1,406	1,413	1,484	1,467	1,372	1,277	1,232
Below Normal	1,294	1,305	1,326	1,351	1,413	1,438	1,390	1,383	1,359	1,268	1,175	1,133
Dry	1,094	1,094	1,106	1,121	1,156	1,188	1,154	1,132	1,087	997	914	871
Critical Dry	624	623	638	645	661	656	602	554	526	476	431	408
Alternative 1 as Compared to No Action Alternative												
Wet	64	56	49	44	43	70	75	84	25	27	30	28
Above Normal	62	56	50	46	43	48	68	59	49	46	44	42
Below Normal	69	61	52	46	40	41	71	63	55	54	52	51
Dry	55	49	43	40	35	33	56	45	44	43	42	42
Critical Dry	44	40	37	36	35	34	45	31	31	23	18	18
Alternative 1 as Compared to No Action Alternative (percent change)												
Wet	4.7	4.0	3.3	2.8	2.6	4.1	4.3	4.5	1.3	1.4	1.7	1.6
Above Normal	6.0	5.3	4.4	3.8	3.3	3.4	4.8	4.0	3.4	3.4	3.5	3.4
Below Normal	5.4	4.7	4.0	3.4	2.8	2.9	5.1	4.6	4.1	4.2	4.5	4.5
Dry	5.0	4.5	3.9	3.5	3.1	2.7	4.8	3.9	4.0	4.3	4.6	4.8
Critical Dry	7.0	6.4	5.8	5.5	5.2	5.2	7.5	5.6	5.9	4.8	4.2	4.4

Table 5.38 Changes in New Melones Reservoir Elevation under the Alternative 1 as Compared to the No Action Alternative

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 1												
Wet	989	990	997	1,009	1,021	1,030	1,034	1,047	1,050	1,043	1,032	1,025
Above Normal	941	944	951	966	979	992	995	1,003	1,001	990	978	901
Below Normal	977	977	979	982	991	994	994	993	991	980	968	962
Dry	951	950	950	953	957	962	963	960	954	941	929	922
Critical Dry	866	866	870	872	878	879	871	856	850	835	823	817
No Action Alternative												
Wet	980	982	990	1,004	1,016	1,023	1,026	1,039	1,047	1,040	1,029	1,022
Above Normal	932	937	945	960	974	986	988	997	996	985	973	897
Below Normal	968	969	972	975	985	988	985	985	983	972	960	955
Dry	943	943	944	947	951	957	955	953	948	934	922	915
Critical Dry	856	856	862	864	870	871	860	848	840	828	818	812
Alternative 1 as Compared to No Action Alternative												
Wet	9	8	7	6	5	8	8	8	3	3	3	3
Above Normal	9	7	6	6	6	6	8	7	5	5	5	5
Below Normal	9	8	7	7	6	6	9	8	7	8	8	8
Dry	8	7	6	6	5	5	8	7	7	7	7	7
Critical Dry	10	10	9	8	8	8	11	8	10	6	5	6
Alternative 1 as Compared to No Action Alternative (percent change)												
Wet	0.9	0.8	0.7	0.6	0.5	0.8	0.8	0.8	0.3	0.3	0.3	0.3
Above Normal	1.0	0.8	0.7	0.6	0.6	0.6	0.8	0.7	0.5	0.6	0.5	0.5
Below Normal	1.0	0.9	0.7	0.7	0.6	0.6	0.9	0.8	0.7	0.8	0.8	0.8
Dry	0.9	0.8	0.7	0.7	0.6	0.5	0.9	0.7	0.7	0.7	0.8	0.8
Critical Dry	1.2	1.1	1.0	1.0	0.9	0.9	1.3	1.0	1.2	0.8	0.6	0.7

The following changes in New Melones Reservoir storage would occur under Alternative 1 as compared to the No Action Alternative.

- In wet years, storage would be similar in all months.
- In above-normal years, storage would be similar in December through September and increased in October and November (up to 6.0 percent).
- In below-normal years, storage would be similar in November through September and increased in October (5.4 percent).
- In dry years, storage would be similar in all months.

- In critical dry years, storage would be similar in July through September and increased in October through June (up to 7.5 percent).
- In all months, in all water year types, surface water elevations would be similar.

Flows in the Stanislaus River downstream of Goodwin Dam are shown on Figures 5.68 to 5.70. Changes in flows in these rivers are summarized below.

- Over long-term conditions, similar flows would occur in July through September; reduced flows in October, March, and April (up to 59.8 percent); and increased flows in November through February and June (up to 51.1 percent).
- In wet years, similar flows would occur in February and April; reduced flows in October, March, May, July, and August (up to 53.9 percent); and increased flows in September, November through January, and June (up to 103.2 percent).
- In dry years, similar flows would occur in July through September; reduced flows in October and April (up to 60.7 percent); and increased flows in November through March, May, and June (up to 55.5 percent).

San Joaquin River at Vernalis

Flows in the San Joaquin River at Vernalis are summarized below, as shown on Figures 5.71 through 5.73.

- Over long-term conditions, similar flows would occur in July through September and November through May; reduced flows in October (16.1 percent); and increased flows in June (8.4 percent).
- In wet years, similar flows would occur in July through September and November through May; reduced flows in October (14.4 percent); and increased flows in June (10.4 percent).
- In dry years, similar flows would occur in November through March and May through September; and reduced flows in October and April (up to 15.3 percent).

San Luis Reservoir

Storage levels and surface water elevations in San Luis Reservoir under Alternative 1 as compared to the No Action Alternative are summarized in Tables 5.39 and 5.40. The results are summarized following Table 5.40.

Table 5.39 Changes in San Luis Reservoir Storage under the Alternative 1 as Compared to the No Action Alternative

Water Year	**End of Month Storage (TAF)**											
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Alternative 1												
Wet	790	1,017	1,365	1,748	1,965	2,033	2,031	1,852	1,487	1,167	889	925
Above Normal	658	883	1,213	1,671	1,913	2,001	1,995	1,717	1,263	861	612	631
Below Normal	854	1,064	1,334	1,742	1,908	1,980	1,908	1,628	1,251	964	635	591
Dry	617	764	998	1,427	1,728	1,925	1,870	1,665	1,341	1,007	660	596
Critical Dry	622	709	910	1,257	1,556	1,664	1,623	1,451	1,168	808	545	472
No Action Alternative												
Wet	555	681	931	1,236	1,526	1,788	1,598	1,251	946	741	628	679
Above Normal	490	649	957	1,223	1,441	1,661	1,444	1,048	666	466	433	513
Below Normal	525	624	907	1,141	1,314	1,473	1,312	967	555	500	426	467
Dry	476	590	867	1,150	1,339	1,494	1,413	1,167	840	763	476	469
Critical Dry	478	556	752	1,040	1,204	1,252	1,192	1,028	739	544	343	323
Alternative 1 as Compared to No Action Alternative												
Wet	234	336	433	513	439	245	433	601	541	426	261	245
Above Normal	168	234	257	448	471	341	551	669	598	395	179	117
Below Normal	329	439	427	601	594	507	596	660	696	465	209	124
Dry	141	174	130	277	390	431	457	498	501	244	185	127
Critical Dry	144	153	158	217	352	412	431	423	429	263	202	149
Alternative 1 as Compared to No Action Alternative (percent change)												
Wet	59.8	81.8	84.4	64.5	40.1	18.2	35.5	74.9	108.8	88.0	53.1	41.5
Above Normal	38.9	62.8	46.6	55.6	43.8	26.0	45.6	90.9	151.4	110.8	53.6	20.2
Below Normal	91.6	125.0	85.3	85.6	66.4	45.6	56.5	93.5	203.1	136.2	61.6	35.9
Dry	29.4	34.9	15.4	31.1	38.5	35.4	37.2	52.7	70.3	26.1	33.5	18.8
Critical Dry	38.7	39.5	25.0	24.4	37.8	39.5	40.3	43.8	57.1	38.6	46.2	20.1

Table 5.40 Changes in San Luis Reservoir Elevation under the Alternative 1 as Compared to the No Action Alternative

Water Year	End of Month Elevation (Feet)											
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Alternative 1												
Wet	426	451	485	520	538	543	543	529	497	468	440	443
Above Normal	412	437	470	513	534	541	540	518	477	437	409	411
Below Normal	435	457	483	519	533	539	533	510	476	448	412	406
Dry	407	425	450	492	518	535	530	513	484	453	415	406
Critical Dry	409	419	441	475	502	512	509	494	468	432	400	389
No Action Alternative												
Wet	399	414	443	473	500	523	507	475	444	422	409	416
Above Normal	391	411	445	472	492	512	493	456	415	389	386	398
Below Normal	397	410	442	465	481	496	481	448	400	393	383	389
Dry	391	406	437	466	484	498	490	468	434	426	390	389
Critical Dry	390	400	423	454	470	475	469	453	422	399	369	366
Alternative 1 as Compared to No Action Alternative												
Wet	26	37	42	46	38	20	36	53	53	46	30	27
Above Normal	21	26	25	41	41	29	47	61	62	48	23	14
Below Normal	38	47	42	54	52	43	52	62	76	56	30	17
Dry	17	19	12	25	34	37	40	45	51	27	25	18
Critical Dry	19	20	18	21	32	38	40	41	45	32	32	24
Alternative 1 as Compared to No Action Alternative (percent change)												
Wet	6.6	8.9	9.6	9.8	7.5	3.9	7.2	11.2	12.0	10.9	7.4	6.6
Above Normal	5.4	6.4	5.7	8.8	8.4	5.6	9.5	13.4	15.0	12.3	6.0	3.4
Below Normal	9.5	11.4	9.4	11.6	10.8	8.7	10.8	13.8	19.0	14.2	7.8	4.3
Dry	4.2	4.6	2.8	5.4	7.1	7.4	8.1	9.7	11.6	6.3	6.3	4.5
Critical Dry	4.9	4.9	4.2	4.7	6.8	7.9	8.4	9.0	10.8	8.0	8.6	6.6

The following changes in San Luis Reservoir storage would occur under Alternative 1 as compared to the No Action Alternative.

- In wet years, storage would be increased in all months (up to 108.8 percent). Water storage elevations would be increased in all months (up to 12.0 percent).
- In above-normal years, storage would be increased in all months (up to 151.4 percent). Water storage elevations would be increased in all months (up to 15.0 percent).
- In below-normal years, storage would be increased in all months (up to 203.1 percent). Water storage elevations would be increased in all months (up to 19.0 percent).
- In dry years, storage would be increased in all months (up to 70.3 percent). Water storage elevations would be increased in all months (up to 11.6 percent).
- In critical dry years, storage would be increased in all months (up to 57.1 percent). Water storage elevations would be increased in all months (up to 10.8 percent).

Changes in Flows into the Yolo Bypass

Flows from the Sacramento River into the Yolo Bypass at Fremont Weir under Alternative 1 as compared to the No Action Alternative are summarized in Table 5.41. The results are summarized following Table 5.41.

Table 5.41 Changes in Flows into the Yolo Bypass at Fremont Weir under the Alternative 1 as Compared to the No Action Alternative

Water Year	Average Monthly Flow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 1												
Wet	147	996	9,888	25,442	30,547	18,997	5,602	289	113	0	0	100
Above Normal	100	100	2,659	6,349	15,114	8,566	1,765	100	100	0	0	100
Below Normal	100	100	262	1,256	4,057	1,166	292	100	100	0	0	100
Dry	100	100	342	932	2,032	1,411	411	100	100	0	0	100
Critical Dry	100	100	149	542	533	408	106	100	100	0	0	100
No Action Alternative												
Wet	183	910	8,420	24,291	29,547	18,493	5,627	289	113	0	0	100
Above Normal	100	100	2,765	5,997	13,013	7,928	1,688	100	100	0	0	100
Below Normal	100	100	242	1,004	3,031	883	293	100	100	0	0	100
Dry	100	100	322	902	2,024	1,393	407	100	100	0	0	100
Critical Dry	100	100	149	528	534	396	106	100	100	0	0	100
Alternative 1 as Compared to No Action Alternative												
Wet	-37	86	1,468	1,151	1,000	504	-25	0	0	0	0	0
Above Normal	0	0	-106	352	2,102	638	77	0	0	0	0	0
Below Normal	0	0	20	253	1,026	283	-1	0	0	0	0	0
Dry	0	0	20	30	7	17	4	0	0	0	0	0
Critical Dry	0	0	1	15	-1	12	0	0	0	0	0	0
Alternative 1 as Compared to No Action Alternative (percent change)												
Wet	-20.0	9.5	17.4	4.7	3.4	2.7	-0.4	0.1	0.1	0.0	0.0	0.0
Above Normal	0.0	0.0	-3.8	5.9	16.2	8.0	4.5	0.0	0.0	0.0	0.0	0.0
Below Normal	0.0	0.0	8.1	25.2	33.9	32.1	-0.3	0.0	0.0	0.0	0.0	0.0
Dry	0.0	0.0	6.2	3.3	0.4	1.2	1.0	0.0	0.0	0.0	0.0	0.0
Critical Dry	0.0	0.0	0.5	2.8	-0.2	3.0	0.0	0.0	0.0	0.0	0.0	0.0

The following changes in flows from the Sacramento River into Yolo Bypass at Fremont Weir would occur under Alternative 1 as compared to the No Action Alternative.

- In wet years, flows into Yolo Bypass would be similar in January through September; reduced in October (20 percent); and increased in November and December (up to 17.4 percent).
- In above-normal years, flows into Yolo Bypass would be similar in April through December; and increased in January through March (up to 16.2 percent).

- In below-normal years, flows into Yolo Bypass would be similar in April through November; and increased in December through March (up to 33.9 percent).
- In dry years, flows into Yolo Bypass would be similar in January through November; and increased in December (6.2 percent).
- In critical dry years, flows into Yolo Bypass would be similar in all months.

Changes in Delta Conditions

Delta outflow under Alternative 1 as compared to the No Action Alternative are summarized below and shown on Figures 5.74 through 5.76.

- In wet years, average monthly Delta outflow would increase in December, February, March, and June (up to 1,492 cfs) and decrease in July through November, January, April, and May (up to 13,683 cfs).
- In dry years, average monthly Delta outflow would be similar in September; decrease in July, August, and October through May (up to 3,114 cfs); and increase in June (385 cfs).

The OMR conditions under Alternative 1 are shown on Figures 5.77 through 5.79.

- In all water years, average monthly OMR flows would be negative in all months under Alternative 1. Under the No Action Alternative, OMR flows would be positive only in wet and above normal years in April and May and April in above normal years.
- In wet years, average monthly OMR flows, would be more positive in June through August and March (up to 923 cfs); and more negative in April through June and September through February (up to 10,005 cfs).
- In dry years, average monthly OMR flows would be positive in July (up to 2,073 cfs), and more negative in August through June (up to 3,489 cfs).

Changes in CVP and SWP Exports and Deliveries

Delta exports under Alternative 1 as compared to the No Action Alternative are summarized in Table 5.42.

Table 5.42 Changes in Exports at Jones and Banks Pumping Plants under the Alternative 1 as Compared to the No Action Alternative

Water Year	**Monthly Volume (TAF)**											
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Alternative 1												
Wet	549	619	716	724	609	543	476	430	456	632	655	660
Above Normal	428	521	641	716	584	570	453	363	415	572	647	651
Below Normal	548	595	623	674	497	500	337	304	414	629	517	539
Dry	435	475	546	579	518	493	259	228	274	403	325	438
Critical Dry	340	345	455	433	406	266	134	121	132	139	203	249
No Action Alternative												
Wet	410	497	564	513	537	594	204	207	445	669	717	638
Above Normal	376	450	562	406	401	496	130	105	315	587	709	628
Below Normal	386	456	590	387	354	394	134	100	209	657	622	542
Dry	374	398	510	392	315	318	153	126	194	541	296	426
Critical Dry	314	293	384	349	250	179	93	90	64	223	176	242
Alternative 1 as Compared to No Action Alternative												
Wet	139	123	152	211	72	-51	272	223	11	-37	-63	21
Above Normal	52	71	78	311	183	73	322	257	100	-15	-61	23
Below Normal	162	139	33	287	143	106	203	204	205	-28	-105	-4
Dry	61	77	36	187	202	175	105	102	80	-138	30	12
Critical Dry	26	52	71	84	156	87	41	31	67	-84	26	8
Alternative 1 as Compared to No Action Alternative (percent change)												
Wet	33.8	24.7	26.9	41.1	13.3	-8.6	133.6	107.5	2.4	-5.5	-8.7	3.4
Above Normal	13.8	15.8	13.9	76.6	45.5	14.8	247.0	244.4	31.8	-2.5	-8.7	3.6
Below Normal	42.0	30.5	5.5	74.3	40.3	26.9	150.9	203.9	98.1	-4.3	-16.9	-0.6
Dry	16.2	19.4	7.1	47.7	64.2	55.1	68.7	81.5	41.4	-25.5	10.1	2.8
Critical Dry	8.4	17.9	18.6	24.1	62.2	48.5	44.3	33.9	104.4	-37.6	14.9	3.1

The following changes would occur in CVP and SWP exports under Alternative 1 as compared to the No Action Alternative.

- Long-term average annual exports would be 1,051 TAF (22 percent) more under Alternative 1 as compared to the No Action Alternative.
- In wet years, total exports would be similar in June and September; increased in October through February, April through May (up to 133.6 percent); and reduced in March, July, and August (up to 8.7 percent).
- In above-normal years, total exports would be similar in July and September; increased in October through June (up to 244 percent); and reduced in August (8.7 percent).

- In below-normal years, total exports would be similar in July and September; increased in October through June (up to 203.9 percent); and reduced in August (16.9 percent).
- In dry years, total exports would be similar in September; increased in October through June and August (up to 81.5 percent); and reduced in July (25.5 percent).
- In critical dry years, total exports would be similar in September; increased in October through June and August (up to 104.4 percent); and reduced in July (37.6 percent).

Deliveries to CVP and SWP water users increase under Alternative 1 as compared to the No Action Alternative, as summarized in Tables 5.43 and 5.44, respectively, due to increased water supply availability and less export limitations.

Table 5.43 Changes CVP Water Deliveries under the Alternative 1 as Compared to the No Action Alternative

Annual Average Deliveries (TAF)					
				Alternative 1 as compared to the No Action Alternative	
		Alternative 1	No Action Alternative	Difference	Percent Change
North of Delta					
CVP Agricultural Water Service Contractors	Long Term	219	185	34	18
	Dry	122	86	37	43
	Critical Dry	35	24	12	50
CVPM&I (Including American Risver Contractors and Contra Costa Water District)	Long Term	392	386	7	2
	Dry	390	385	5	1
	Critical Dry	383	383	-1	0
CVP M&I American River Contractors	Long Term	120	113	7	6
	Dry	105	97	8	8
	Critical Dry	79	75	5	7
CVP Sacramento River Settlement Contractors	Long Term	1,858	1,859	-1	0
	Dry	1,905	1,906	-1	0
	Critical Dry	1,732	1,737	-5	0
CVP Refuge Level 2 Deliveries	Long Term	155	146	8	5
	Dry	151	146	5	3
	Critical Dry	105	102	3	3

Annual Average Deliveries (TAF)					
				Alternative 1 as compared to the No Action Alternative	
		Alternative 1	No Action Alternative	Difference	Percent Change
Total CVP Agricultural, M&I, Sacramento River Settlement Contractors, and Refuge Level 2 Deliveries	Long Term	2,624	2,576	48	2
	Dry	2,568	2,523	45	2
	Critical Dry	2,255	2,246	9	0
South of Delta (Does not include Eastside Contractors)					
CVP Agricultural Water Service Contractors	Long Term	1,100	847	253	30
	Dry	650	445	206	46
	Critical Dry	195	131	64	49
CVP M&I Users	Long Term	125	112	13	12
	Dry	109	99	10	10
	Critical Dry	85	80	4	5
San Joaquin River Exchange Contractors	Long Term	852	852	0	0
	Dry	875	875	0	0
	Critical Dry	741	741	0	0
CVP Refuge Level 2 Deliveries	Long Term	272	273	-1	0
	Dry	280	281	-1	0
	Critical Dry	232	234	-3	-1
Total CVP Agricultural, M&I, San Joaquin River Exchange Contractors, and Refuge Level 2 Deliveries	Long Term	2,349	2,084	265	13
	Dry	1,914	1,700	214	13
	Critical Dry	1,253	1,186	67	6
Eastside Contractors Deliveries					
Water Rights	Long Term	514	508	6	1
	Dry	524	524	0	0
	Critical Dry	486	445	42	9
CVP Water Service Contracts	Long Term	118	104	15	14
	Dry	98	84	13	15
	Critical Dry	25	4	21	525

Annual Average Deliveries (TAF)					
				Alternative 1 as compared to the No Action Alternative	
		Alternative 1	No Action Alternative	Difference	Percent Change
Total Water Rights and CVP Service Contracts Deliveries	Long Term	632	612	20	3
	Dry	622	608	14	2
	Critical Dry	511	449	62	14

The following changes in CVP water deliveries would occur under Alternative 1 as compared to the No Action Alternative.

- Deliveries to CVP North of Delta agricultural water service contractors would be increased by 18 percent over the long-term conditions, 43 percent in dry years, and 50 percent in critical dry years.
- Deliveries to CVP North of Delta M&I contractors would be similar in total, however, deliveries to the American River CVP contractors would be increased by 6 percent over the long-term conditions, 8 percent in dry years, and 7 percent in critical dry years.
- Deliveries to CVP South of Delta agricultural water service contractors would be increased by 30 percent over the long-term conditions, 46 percent in dry years, and 49 percent in critical dry years.
- Deliveries to CVP South of Delta M&I contractors would be increased by 12 percent over the long-term conditions, 10 percent in dry years, and 5 percent in critical dry years.
- Deliveries to the Eastside contractors would be similar under long-term conditions and in dry years and increase by 14 percent in critical dry years.

Table 5.44 Changes SWP Water Deliveries under the Alternative 1 as Compared to the No Action Alternative

Annual Average Deliveries (TAF)					
				Alternative 1 as compared to the No Action Alternative	
		Alternative 1	No Action Alternative	Difference	Percent Change
North of Delta					
SWP Agricultural Uses	Long Term	0	0	0	0
	Dry	0	0	0	0
	Critical Dry	0	0	0	0
SWP M&I (without Article 21)	Long Term	83	68	15	22
	Dry	62	51	11	22
	Critical Dry	53	43	11	25
SWP M&I Article 21 Deliveries	Long Term	12	13	-1	-9
	Dry	13	14	-1	-6
	Critical Dry	12	13	-1	-9
Total SWP Agricultural and M&I (without Article 21)	Long Term	83	68	15	22
	Dry	62	51	11	22
	Critical Dry	53	43	11	25
Total SWP Agricultural and M&I Article 21 Deliveries	Long Term	12	13	-1	-9
	Dry	13	14	-1	-6
	Critical Dry	12	13	-1	-9
South of Delta					
SWP Agricultural Users (without Article 21)	Long Term	750	610	139	23
	Dry	567	455	112	25
	Critical Dry	484	378	106	28
SWP Agricultural Article 21 Deliveries	Long Term	178	27	152	569
	Dry	143	5	138	2690
	Critical Dry	100	7	93	1339
SWP M&I Users (without Article 21)	Long Term	2,183	1,800	383	21
	Dry	1,732	1,406	327	23
	Critical Dry	1,494	1,173	321	27

Annual Average Deliveries (TAF)					
				Alternative 1 as compared to the No Action Alternative	
		Alternative 1	No Action Alternative	Difference	Percent Change
SWP M&I Article 21 Deliveries	Long Term	104	20	84	418
	Dry	86	5	82	1788
	Critical Dry	58	5	53	1054
Total SWP Agricultural and M&I Users (without Article 21)	Long Term	2,933	2,410	523	22
	Dry	2,299	1,861	439	24
	Critical Dry	1,978	1,551	427	28
Total SWP Agricultural and M&I Article 21 Deliveries	Long Term	282	47	236	504
	Dry	229	10	219	2265
	Critical Dry	158	12	146	1219

The following changes in SWP water deliveries would occur under Alternative 1 as compared to the No Action Alternative.

- Deliveries without Article 21 water to SWP North of Delta water contractors would be increased by 22 percent over the long-term conditions; 22 percent in dry years; and 25 percent in critical dry years.
- Deliveries without Article 21 water to SWP South of Delta water contractors would be increased by 22 percent over the long-term conditions; 24 percent in dry years; and 28 percent in critical dry years.
- Deliveries of Article 21 water to SWP North of Delta water contractors would be reduced by 9 percent over the long-term conditions; 6 percent in dry years; and 9 percent in critical dry years.
- Deliveries of Article 21 water to SWP South of Delta water contractors would be increased by 504 percent over the long-term conditions; 2,265 percent in dry years; and 1,219 percent in critical dry years.

Effects Related to Cross Delta Water Transfers

Potential effects to surface water resources could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014i). Potential effects were identified as reduced surface water storage in upstream reservoirs and changes in flow patterns in river downstream of the reservoirs if water was released from the reservoirs in patterns that were different than would have been used by the water seller's. Because all water transfers would be required to avoid adverse impacts to other water users and biological resources (see Section 3.A.6.3, Transfers), including impacts associated with changes in reservoir storage and river flow patterns; the analysis indicated that water transfers would not result in substantial changes in storage or river flows. For the purposes of this EIS, it is anticipated that similar conditions would occur due to cross Delta water transfers under Alternative 1 and the No Action Alternative.

Under Alternative 1, water could be transferred throughout the year. As indicated in Table 5.42, capacity would be available under Alternative 1 in all months of all water year types without a maximum volume of transferred water. Under the No Action Alternative, the timing of cross Delta water transfers would be limited to July through September, and the volume would be limited to 600,000 acre-feet per year in drier years and 360,000 acre-feet in all other years, in accordance with the 2008 USFWS BO and 2009 NMFS BO. As indicated in Table 5.42, capacity would be available under the No Action Alternative between July and September for water transfers in all water year types.

Overall, the potential for water transfer conveyance would be greater under Alternative 1 as compared to the No Action Alternative.

San Francisco Bay Area, Central Coast, and Southern California Regions

Potential Changes in Surface Water Resources at Reservoirs that Store CVP and SWP Water

The San Francisco Bay Area, Central Coast, and Southern California regions include numerous reservoirs that store CVP and SWP water supplies, including CVP and SWP reservoirs, that primarily provide water supplies for M&I water users. Changes in the availability CVP and SWP water supplies for storage in these reservoirs under Alternative 1 as compared to the No Action Alternative would be consistent with the following changes in water deliveries to M&I water users, as summarized in Tables 5.43 and 5.44.

- Deliveries to CVP South of Delta M&I contractors would be increased by 11 percent over the long-term conditions; 10 percent in dry years; and 7 percent in critical dry years.
- Deliveries without Article 21 water to SWP South of Delta water contractors would be increased by 22 percent over the long-term conditions; 24 percent in dry years; and 28 percent in critical dry years.
- Deliveries of Article 21 water to SWP South of Delta water contractors would be increased by 504 percent over the long-term conditions; 2,265 percent in dry years; and 1,219 percent in critical dry years.

Changes in CVP and SWP Exports and Deliveries

Deliveries to CVP and SWP water users are described above in the Central Valley Region.

5.4.3.2.2 Alternative 1 Compared to the Second Basis of Comparison

Alternative 1 is identical to the Second Basis of Comparison.

5.4.3.3 Alternative 2

Surface water resources conditions under Alternative 2 would be identical to the surface water resources conditions under the No Action Alternative; therefore, Alternative 2 is only compared to the Second Basis of Comparison.

5.4.3.3.1 Alternative 2 Compared to the Second Basis of Comparison

Changes to surface water resources conditions under Alternatives 2 as compared to the Second Basis of Comparison would be the same as the impacts described in Section 5.4.3.1, No Action Alternative.

5.4.3.4 Alternative 3

CVP and SWP operations under Alternative 3 are similar to the Second Basis of Comparison with modified OMR flow criteria and New Melones Reservoir operations. Alternative 3 would include changed water demands for American River water supplies as compared to the No Action Alternative or Second Basis of Comparison. Alternative 3 would provide water supplies of up to 17 TAF per year under a Warren Act Contract for El Dorado Irrigation District and 15 TAF per year under a CVP water service contract for El Dorado County Water Agency. These demands are not included in the analysis presented in this section of the EIS. A sensitivity analysis comparing the results of the analysis with and without these demands is presented in Appendix 5B of this EIS.

5.4.3.4.1 Alternative 3 Compared to the No Action Alternative

Trinity River Region

Changes in CVP and SWP Reservoir Storage and Downstream River Flows

Changes in Trinity Lake storage and surface water elevations under Alternative 3 as compared to the No Action Alternative are summarized in Tables 5.45 and 5.45. The results are summarized following Table 5.45.

Table 5.45 Changes in Trinity Lake Storage under Alternative 3 as Compared to the No Action Alternative

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 3												
Wet	1,502	1,537	1,643	1,766	1,928	2,053	2,224	2,248	2,192	2,067	1,936	1,805
Above Normal	1,197	1,230	1,349	1,511	1,707	1,891	2,071	2,045	1,949	1,806	1,646	1,513
Below Normal	1,434	1,457	1,477	1,542	1,629	1,717	1,858	1,786	1,680	1,509	1,334	1,199
Dry	1,173	1,179	1,206	1,226	1,318	1,450	1,585	1,537	1,468	1,301	1,152	1,056
Critical Dry	829	803	817	829	871	952	1,003	968	936	813	664	600
No Action Alternative												
Wet	1,490	1,516	1,630	1,756	1,921	2,053	2,220	2,245	2,190	2,067	1,939	1,784
Above Normal	1,159	1,178	1,286	1,455	1,658	1,847	2,025	1,999	1,907	1,773	1,619	1,495
Below Normal	1,393	1,400	1,417	1,488	1,575	1,662	1,817	1,743	1,637	1,470	1,304	1,185
Dry	1,152	1,148	1,174	1,182	1,274	1,403	1,539	1,490	1,413	1,253	1,104	1,008
Critical Dry	747	731	746	750	790	872	923	888	862	745	612	536
Alternative 3 as Compared to No Action Alternative												
Wet	11	21	13	10	7	0	3	4	3	0	-3	21
Above Normal	38	53	63	56	49	45	46	46	42	33	27	18
Below Normal	41	57	60	54	55	55	40	43	43	38	30	13
Dry	21	31	32	45	44	47	46	47	55	48	48	48
Critical Dry	82	73	71	79	81	81	80	80	73	68	53	64
Alternative 3 as Compared to No Action Alternative (percent change)												
Wet	0.7	1.4	0.8	0.6	0.4	0.0	0.1	0.2	0.1	0.0	-0.2	1.2
Above Normal	3.3	4.5	4.9	3.8	2.9	2.4	2.3	2.3	2.2	1.8	1.7	1.2
Below Normal	3.0	4.1	4.2	3.6	3.5	3.3	2.2	2.5	2.6	2.6	2.3	1.1
Dry	1.8	2.7	2.7	3.8	3.5	3.4	3.0	3.1	3.9	3.9	4.3	4.8
Critical Dry	11.0	10.0	9.5	10.5	10.2	9.3	8.7	9.0	8.5	9.1	8.6	11.9

Table 5.46 Changes in Trinity Lake Elevation under Alternative 3 as Compared to the No Action Alternative

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 3												
Wet	2,301	2,305	2,314	2,325	2,339	2,347	2,357	2,358	2,355	2,347	2,338	2,328
Above Normal	2,268	2,271	2,284	2,301	2,319	2,334	2,347	2,345	2,339	2,328	2,315	2,304
Below Normal	2,293	2,295	2,297	2,304	2,312	2,319	2,330	2,325	2,317	2,302	2,286	2,274
Dry	2,265	2,268	2,271	2,273	2,283	2,296	2,309	2,305	2,299	2,284	2,269	2,260
Critical Dry	2,226	2,220	2,222	2,225	2,231	2,244	2,252	2,248	2,244	2,229	2,204	2,193
No Action Alternative												
Wet	2,300	2,303	2,313	2,324	2,338	2,347	2,357	2,358	2,355	2,347	2,338	2,327
Above Normal	2,261	2,264	2,276	2,294	2,314	2,330	2,343	2,341	2,335	2,325	2,313	2,302
Below Normal	2,289	2,289	2,291	2,299	2,307	2,315	2,327	2,321	2,313	2,299	2,283	2,272
Dry	2,263	2,265	2,268	2,269	2,279	2,292	2,305	2,301	2,294	2,279	2,264	2,254
Critical Dry	2,210	2,207	2,210	2,213	2,220	2,235	2,242	2,238	2,235	2,220	2,196	2,182
Alternative 3 as Compared to No Action Alternative												
Wet	1	2	1	1	1	0	0	0	0	0	0	2
Above Normal	7	8	8	7	5	4	4	4	4	3	2	2
Below Normal	4	5	6	5	5	5	3	4	4	3	3	2
Dry	3	3	3	4	4	4	4	4	5	5	5	6
Critical Dry	16	13	13	12	11	10	9	9	9	9	8	11
Alternative 3 as Compared to No Action Alternative (percent change)												
Wet	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Above Normal	0.3	0.3	0.4	0.3	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1
Below Normal	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.1	0.1	0.1
Dry	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3
Critical Dry	0.7	0.6	0.6	0.6	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.5

The following changes in Trinity Lake storage would occur under Alternative 3 as compared to the No Action Alternative.

- In wet, above-normal years, below-normal, and dry years, storage would be similar in all months.
- In critical dry years, storage would be increased in all months (up to 11.9 percent).
- In all months, in all water year types, surface water elevations would be similar.

The following changes would occur on the Trinity River under Alternative 3 as compared to the No Action Alternative, as summarized in Figures 5.53 through 5.55.

- Over long-term conditions, flows would be similar in March through November and increased in December through February (up to 11.8 percent).
- In wet years, flows would be similar in April through October; reduced in November (7.0 percent) and increased in December through March (up to 15.1 percent).
- In dry years, flows would be similar in all months.

Central Valley Region

Changes in CVP and SWP Reservoir Storage and Downstream River Flows

Shasta Lake and Sacramento River

Storage levels and surface water elevations in Shasta Lake under Alternative 3 as compared to the No Action Alternative are summarized in Tables 5.47 and 5.48. Changes in flows in the Sacramento River downstream of Keswick Dam and at Freeport are shown on Figures 5.56 through 5.61. The results are summarized following Table 5.48.

Table 5.47 Changes in Shasta Lake Storage under Alternative 3 as Compared to the No Action Alternative

Water Year	End of Month Storage (TAF)											
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Alternative 3												
Wet	2,816	2,932	3,161	3,408	3,597	3,841	4,301	4,453	4,221	3,720	3,370	3,244
Above Normal	2,475	2,555	2,783	3,303	3,509	4,023	4,403	4,401	3,975	3,350	2,998	2,946
Below Normal	2,818	2,851	2,983	3,302	3,650	3,971	4,176	4,056	3,631	3,036	2,669	2,562
Dry	2,431	2,451	2,590	2,770	3,189	3,662	3,885	3,798	3,359	2,826	2,542	2,500
Critical Dry	1,833	1,793	1,877	2,024	2,184	2,424	2,354	2,237	1,836	1,406	1,129	1,066
No Action Alternative												
Wet	2,700	2,719	3,077	3,384	3,589	3,836	4,298	4,460	4,242	3,735	3,410	2,985
Above Normal	2,369	2,385	2,600	3,167	3,453	4,021	4,404	4,429	4,039	3,407	3,069	2,834
Below Normal	2,587	2,548	2,686	3,062	3,442	3,814	4,026	3,957	3,588	3,002	2,643	2,608
Dry	2,345	2,283	2,428	2,621	3,034	3,505	3,737	3,668	3,284	2,767	2,496	2,462
Critical Dry	1,702	1,633	1,717	1,871	2,031	2,274	2,202	2,088	1,719	1,253	986	937
Alternative 3 as Compared to No Action Alternative												
Wet	116	214	84	24	8	5	2	-7	-21	-16	-41	260
Above Normal	106	170	183	136	56	2	-1	-27	-64	-57	-71	112
Below Normal	231	302	296	240	208	157	150	99	42	34	26	-46
Dry	86	168	162	149	155	156	148	130	74	58	45	38
Critical Dry	131	160	160	153	152	149	152	149	117	153	143	129
Alternative 3 as Compared to No Action Alternative (percent change)												
Wet	4.3	7.9	2.7	0.7	0.2	0.1	0.1	-0.2	-0.5	-0.4	-1.2	8.7
Above Normal	4.5	7.1	7.0	4.3	1.6	0.1	0.0	-0.6	-1.6	-1.7	-2.3	4.0
Below Normal	8.9	11.9	11.0	7.9	6.0	4.1	3.7	2.5	1.2	1.1	1.0	-1.8
Dry	3.7	7.4	6.7	5.7	5.1	4.5	4.0	3.5	2.3	2.1	1.8	1.6
Critical Dry	7.7	9.8	9.3	8.2	7.5	6.6	6.9	7.1	6.8	12.2	14.5	13.8

Table 5.48 Changes in Shasta Lake Elevation under Alternative 3 as Compared to the No Action Alternative

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 3												
Wet	997	1,002	1,012	1,024	1,032	1,041	1,058	1,063	1,055	1,036	1,022	1,017
Above Normal	973	976	990	1,018	1,028	1,048	1,062	1,062	1,046	1,021	1,006	1,004
Below Normal	997	998	1,004	1,019	1,034	1,046	1,054	1,049	1,032	1,008	991	986
Dry	974	976	983	993	1,013	1,033	1,042	1,039	1,021	998	985	983
Critical Dry	935	933	939	948	960	975	972	966	941	910	888	882
No Action Alternative												
Wet	991	992	1,008	1,023	1,031	1,041	1,058	1,064	1,056	1,037	1,024	1,005
Above Normal	967	968	982	1,012	1,025	1,048	1,062	1,063	1,049	1,024	1,009	999
Below Normal	986	985	991	1,009	1,025	1,040	1,048	1,045	1,031	1,006	989	987
Dry	969	967	975	986	1,006	1,027	1,037	1,034	1,018	995	982	980
Critical Dry	927	923	929	939	951	968	965	958	935	899	876	872
Alternative 3 as Compared to No Action Alternative												
Wet	6	10	4	1	0	0	0	0	-1	-1	-2	12
Above Normal	5	8	8	6	2	0	0	-1	-2	-2	-3	5
Below Normal	11	14	13	10	9	6	6	4	2	2	2	-2
Dry	5	9	8	7	7	6	6	5	3	3	3	2
Critical Dry	8	10	10	9	8	7	8	8	7	11	11	11
Alternative 3 as Compared to No Action Alternative (percent change)												
Wet	0.6	1.0	0.4	0.1	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.2	1.2
Above Normal	0.6	0.8	0.9	0.6	0.2	0.0	0.0	-0.1	-0.2	-0.2	-0.3	0.5
Below Normal	1.1	1.4	1.3	1.0	0.9	0.6	0.5	0.4	0.2	0.2	0.2	-0.2
Dry	0.5	0.9	0.8	0.7	0.7	0.6	0.6	0.5	0.3	0.3	0.3	0.2
Critical Dry	0.9	1.1	1.0	1.0	0.9	0.8	0.8	0.8	0.7	1.2	1.3	1.2

The following changes in Shasta Lake storage and surface water elevations would occur under Alternative 3 as compared to the No Action Alternative.

- In wet years, storage would be similar in December through August and increased in September and November (up to 8.7 percent).
- In above-normal years, storage would be similar in January through October and increased in November and December (up to 7.1 percent).
- In below-normal years, storage would be similar in March through September and increased in October through February (up to 11.9 percent).

- In dry years, storage would be similar in March through October and increased in November through January (up to 7.4 percent).
- In critical dry years, storage would increase in all months (up to 12.2 percent).
- In all months, in all water year types, surface water elevations would be similar.

The following changes in Sacramento River flows would occur under Alternative 3 as compared to the No Action Alternative, as shown on Figures 5.56 through 5.61.

- Sacramento River downstream of Keswick Dam (Figures 5.56 through 5.58).
  - Over long-term conditions, similar flows would occur in October, February through May, July, and August; reduced flows in September and November (up to 20.1 percent); and increased flows in December, January, and June (up to 8.9 percent).
  - In wet years, similar flows would occur in February through August; reduced flows in September through November (up to 42.1 percent); and increased flows in December and January (up to 16.9 percent).
  - In dry years, similar flows would occur in July through September and December through May; reduced flows in November (24.6 percent); and increased flows in January and June (up to 7.3 percent).
- Sacramento River near Freeport (near the northern boundary of the Delta) (Figures 5.59 through 5.61).
  - Over long-term conditions, similar flows would occur in October, December through May, July, and August; reduced flows in September and November (up to 30.1 percent); and increased flows in June (12.1 percent).
  - In wet years, similar flows would occur in January through May, July, and October; reduced flows in August, September, and November (up to 48.1 percent); and increased flows in December and June (up to 6.6 percent).
  - In dry years, similar flows would occur in July through October and December through April; reduced flows in November (14.2 percent); and increased flows in May and June (up to 15.7 percent).

Lake Oroville and Feather River

Storage levels and surface water elevations in Lake Oroville under Alternative 3 as compared to the No Action Alternative are summarized in Tables 5.49 and 5.50. Changes in flows in the Feather River downstream of Thermalito Complex are shown on Figures 5.62 through 5.64. The results are summarized following Table 5.50.

Table 5.49 Changes in Lake Oroville Storage under Alternative 3 as Compared to the No Action Alternative

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 3												
Wet	1,893	1,931	2,315	2,608	2,854	2,942	3,300	3,473	3,375	2,902	2,630	2,499
Above Normal	1,405	1,448	1,623	2,109	2,623	2,945	3,280	3,371	3,129	2,494	2,039	1,778
Below Normal	1,839	1,801	1,846	2,054	2,370	2,636	2,879	2,883	2,610	1,971	1,520	1,354
Dry	1,332	1,288	1,322	1,454	1,733	2,088	2,329	2,319	1,980	1,548	1,343	1,198
Critical Dry	1,129	1,067	1,067	1,156	1,275	1,429	1,449	1,437	1,236	1,029	918	862
No Action Alternative												
Wet	1,691	1,732	2,189	2,554	2,832	2,942	3,300	3,488	3,445	2,964	2,626	2,109
Above Normal	1,279	1,322	1,485	1,959	2,519	2,892	3,247	3,393	3,232	2,600	2,117	1,659
Below Normal	1,542	1,497	1,507	1,719	2,122	2,397	2,653	2,714	2,530	1,923	1,513	1,307
Dry	1,206	1,158	1,177	1,305	1,582	1,938	2,178	2,210	1,951	1,478	1,287	1,144
Critical Dry	1,092	1,029	1,019	1,108	1,223	1,381	1,408	1,392	1,243	1,018	917	865
Alternative 3 as Compared to No Action Alternative												
Wet	201	199	126	54	23	0	0	-15	-70	-62	4	390
Above Normal	126	127	138	151	105	53	33	-22	-102	-106	-78	118
Below Normal	297	303	339	335	248	240	225	169	80	48	8	47
Dry	127	130	145	149	151	150	151	109	29	70	55	55
Critical Dry	37	38	48	48	52	48	41	45	-8	10	1	-3
Alternative 3 as Compared to No Action Alternative (percent change)												
Wet	11.9	11.5	5.8	2.1	0.8	0.0	0.0	-0.4	-2.0	-2.1	0.1	18.5
Above Normal	9.9	9.6	9.3	7.7	4.2	1.8	1.0	-0.7	-3.2	-4.1	-3.7	7.1
Below Normal	19.3	20.2	22.5	19.5	11.7	10.0	8.5	6.2	3.2	2.5	0.5	3.6
Dry	10.5	11.2	12.3	11.4	9.6	7.7	6.9	4.9	1.5	4.7	4.3	4.8
Critical Dry	3.4	3.7	4.7	4.3	4.2	3.5	2.9	3.2	-0.6	1.0	0.1	-0.3

Table 5.50 Changes in Lake Oroville Elevation under Alternative 3 as Compared to the No Action Alternative

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 3												
Wet	763	767	805	834	853	859	884	895	889	856	836	825
Above Normal	711	717	738	791	836	859	882	889	872	827	786	758
Below Normal	758	754	759	781	813	835	854	855	836	780	730	710
Dry	702	697	703	720	752	789	811	810	779	733	709	691
Critical Dry	679	671	671	684	699	718	719	718	693	665	648	640
No Action Alternative												
Wet	743	748	794	829	852	859	884	897	894	861	836	790
Above Normal	698	703	722	776	828	856	880	890	879	835	794	746
Below Normal	730	725	726	751	793	818	838	842	828	773	729	704
Dry	688	683	686	704	737	775	798	800	775	724	702	684
Critical Dry	674	667	664	678	693	712	715	712	693	663	648	640
Alternative 3 as Compared to No Action Alternative												
Wet	19	19	11	5	2	0	0	-1	-5	-5	0	35
Above Normal	13	14	16	15	9	4	2	-2	-7	-9	-9	13
Below Normal	28	29	32	30	21	17	16	13	8	6	1	6
Dry	14	14	16	16	15	13	13	10	3	8	7	7
Critical Dry	5	5	7	7	6	6	5	6	0	2	0	0
Alternative 3 as Compared to No Action Alternative (percent change)												
Wet	2.6	2.6	1.4	0.6	0.2	0.0	0.0	-0.1	-0.5	-0.6	0.0	4.4
Above Normal	1.9	2.0	2.2	1.9	1.0	0.4	0.3	-0.2	-0.8	-1.0	-1.1	1.7
Below Normal	3.9	4.0	4.5	4.0	2.6	2.1	1.9	1.5	1.0	0.8	0.2	0.8
Dry	2.0	2.1	2.4	2.2	2.1	1.7	1.6	1.2	0.4	1.2	1.0	1.0
Critical Dry	0.7	0.7	1.0	1.0	0.9	0.8	0.6	0.8	0.0	0.3	0.1	0.0

The following changes in Lake Oroville storage and surface water elevations would occur under Alternative 3 as compared to the No Action Alternative.

- In wet years, storage would be similar in January through August and increased in September through December (up to 18.5 percent).
- In above-normal years, storage would be similar in February through August and increased in September through January (up to 18.5 percent).
- In below-normal years, storage would be similar in June through September and increased in October through May (up to 22.5 percent).

- In dry years, storage would be similar in May through September and increased in October through April (up to 12.3 percent).
- In critical dry years, storage would be similar under all months.
- In all months, in all water year types, surface water elevations would be similar.

The following changes in Feather River flows would occur under Alternative 3 as compared to the No Action Alternative, as shown on Figures 5.62 through 5.64.

- Over long-term conditions, similar flows would occur in October, November, March, April, and July; reduced flows in August and September (up to 49.4 percent); and increased flows in December through February, May, and June (up to 33.9 percent).
- In wet years, similar flows would occur in October, November, February through May, and July; reduced flows in August and September (up to 70.0 percent) and increased flows in December, January, and June (up to 28.1 percent).
- In dry years, similar flows would occur in September and January through April; reduced flows in October through December and July (up to 14.5 percent); and increased flows in May, June, and August (36.9 percent).

Folsom Lake and American River

Storage levels and surface water elevations in Folsom Lake under Alternative 3 as compared to the No Action Alternative are summarized in Tables 5.51 and 5.52. Changes in flows in the American River downstream of Nimbus Dam are shown on Figures 5.65 through 5.67. The results are summarized following Table 5.52.

Table 5.51 Changes in Folsom Lake Storage under Alternative 3 as Compared to the No Action Alternative

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 3												
Wet	486	473	525	524	515	632	785	951	929	790	690	645
Above Normal	388	404	454	537	539	640	787	946	851	580	516	479
Below Normal	513	496	505	514	542	627	764	844	766	506	436	407
Dry	405	398	420	434	482	580	692	761	654	491	436	411
Critical Dry	331	314	322	325	370	436	474	485	431	343	291	257
No Action Alternative												
Wet	454	435	514	518	515	632	785	951	941	800	712	576
Above Normal	377	380	429	513	531	640	787	946	887	621	552	477
Below Normal	446	431	467	484	533	619	757	843	780	527	472	453
Dry	394	383	408	423	479	579	691	760	658	495	443	419
Critical Dry	324	305	315	320	366	432	475	486	415	327	267	231
Alternative 3 as Compared to No Action Alternative												
Wet	33	38	11	6	0	0	0	0	-12	-10	-22	69
Above Normal	11	24	25	25	8	0	0	0	-36	-41	-36	2
Below Normal	67	64	38	30	9	8	6	1	-14	-21	-36	-45
Dry	11	15	12	11	3	1	1	1	-4	-4	-7	-8
Critical Dry	7	8	8	5	3	3	-1	-1	16	16	25	27
Alternative 3 as Compared to No Action Alternative (percent change)												
Wet	7.2	8.8	2.1	1.2	0.0	0.0	0.0	0.0	-1.3	-1.3	-3.1	12.0
Above Normal	2.8	6.3	5.8	4.8	1.5	0.0	0.0	0.0	-4.1	-6.7	-6.6	0.5
Below Normal	15.0	14.9	8.2	6.2	1.6	1.3	0.8	0.1	-1.8	-3.9	-7.6	-10.0
Dry	2.8	3.9	2.9	2.6	0.6	0.2	0.1	0.2	-0.6	-0.8	-1.6	-1.9
Critical Dry	2.1	2.7	2.5	1.6	0.9	0.7	-0.2	-0.1	3.9	4.9	9.2	11.6

Table 5.52 Changes in Folsom Lake Elevation under Alternative 3 as Compared to the No Action Alternative

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 3												
Wet	413	412	419	419	418	432	448	465	463	448	438	433
Above Normal	395	397	408	421	421	433	448	465	455	425	418	413
Below Normal	416	415	416	417	421	432	446	454	446	415	404	401
Dry	401	401	405	407	414	426	438	445	434	414	407	404
Critical Dry	388	386	390	390	396	406	411	411	403	389	379	372
No Action Alternative												
Wet	409	407	418	418	418	432	448	464	464	449	440	425
Above Normal	394	395	405	418	420	433	449	464	458	430	422	413
Below Normal	408	406	411	414	420	431	445	454	447	418	411	409
Dry	400	399	403	405	413	426	438	445	434	414	408	405
Critical Dry	386	384	389	390	396	406	411	412	401	386	374	366
Alternative 3 as Compared to No Action Alternative												
Wet	4	5	1	1	0	0	0	1	-1	-1	-3	8
Above Normal	0	2	3	3	1	0	0	1	-3	-5	-4	0
Below Normal	8	8	5	4	1	1	1	1	-1	-3	-7	-8
Dry	1	2	1	1	0	0	0	0	0	-1	-1	-1
Critical Dry	2	2	1	1	0	0	0	0	2	3	5	6
Alternative 3 as Compared to No Action Alternative (percent change)												
Wet	1.0	1.2	0.3	0.2	0.0	0.0	0.0	0.2	-0.1	-0.3	-0.6	1.9
Above Normal	0.1	0.6	0.6	0.7	0.2	0.0	0.0	0.1	-0.7	-1.2	-1.0	0.1
Below Normal	2.1	2.0	1.2	0.9	0.3	0.2	0.2	0.1	-0.3	-0.7	-1.6	-1.9
Dry	0.3	0.5	0.3	0.3	0.1	0.0	0.0	0.1	-0.1	-0.1	-0.2	-0.3
Critical Dry	0.4	0.5	0.4	0.2	0.1	0.0	-0.1	-0.1	0.5	0.7	1.5	1.7

The following changes in Folsom Lake storage would occur under Alternative 3 as compared to the No Action Alternative.

- In wet years, storage would be similar in December through August and increased in September through December (up to 12.1 percent).
- In above-normal years, storage would be similar in January through June, September, and October; and increased in November and December (up to 6.3 percent); and reduced in July and August (up to 6.7 percent).
- In below-normal years, storage would be similar in February through July; reduced in August and September (up to 10.0 percent); and increased in October through January (up to 15.0 percent).

- In dry years, storage would be similar in all months.
- In critical dry years, storage would be similar in October through July and increased in August and September (up to 11.6 percent).
- In all months, in all water year types, surface water elevations would be similar.

The following changes in American River flows would occur under Alternative 3 as compared to the No Action Alternative, as shown on Figures 5.65 through 5.67.

- Over long-term conditions, similar flows would occur in November, January through May, July, and August; reduced flows in September and October (up to 28.7 percent); and increased flows in June (5.8 percent).
- In wet years, similar flows would occur in October, November, and January through July; reduced flows in September (45.9 percent); and increased flows in August and December (up to 8.5 percent).
- In dry years, similar flows would occur in November through January and March through September; reduced flows in October (11.2 percent); and increased flows in February (6.1 percent).

Clear Creek

Changes in flows in Clear Creek downstream of Whiskeytown Dam are summarized in Table 5.53.

Monthly Clear Creek flows under Alternative 3 as compared to the No Action Alternative are identical except in May. In May, under Alternative 3, flows are up to 28.9 percent lower than under the No Action Alternative.

Table 5.53 Changes in Clear Creek Flows below Whiskeytown Dam under Alternative 3 as Compared to the No Action Alternative

Water Year	Average Monthly Flow (cfs)											
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Alternative 3												
Wet	200	200	200	309	356	272	200	200	200	85	85	150
Above Normal	181	182	188	192	196	196	196	200	200	85	85	150
Below Normal	195	195	195	195	195	195	195	195	191	85	85	150
Dry	178	184	188	190	190	190	190	190	183	85	85	150
Critical Dry	163	167	167	167	167	167	167	167	111	85	85	133
No Action Alternative												
Wet	200	200	200	309	356	272	200	277	200	85	85	150
Above Normal	181	182	188	192	196	196	196	277	200	85	85	150
Below Normal	195	195	195	195	195	195	195	274	191	85	85	150
Dry	175	184	188	190	190	190	190	267	183	85	85	150
Critical Dry	163	167	167	167	167	167	167	214	111	85	85	133
Alternative 3 as Compared to No Action Alternative												
Wet	0	0	0	0	0	0	0	-77	0	0	0	0
Above Normal	0	0	0	0	0	0	0	-77	0	0	0	0
Below Normal	0	0	0	0	0	0	0	-78	0	0	0	0
Dry	3	0	0	0	0	0	0	-77	0	0	0	0
Critical Dry	0	0	0	0	0	0	0	-47	0	0	0	0
Alternative 3 as Compared to No Action Alternative (percent change)												
Wet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-27.9	0.0	0.0	0.0	0.0
Above Normal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-27.9	0.0	0.0	0.0	0.0
Below Normal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-28.6	0.0	0.0	0.0	0.0
Dry	1.6	0.0	0.0	0.0	0.0	0.0	0.0	-28.9	0.0	0.0	0.0	0.0
Critical Dry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-22.1	0.0	0.0	0.0	0.0

New Melones Reservoir and Stanislaus River

Storage levels and surface water elevations in New Melones Reservoir under Alternative 3 as compared to the No Action Alternative are summarized in Tables 5.54 and 5.55. Changes in flows in the Stanislaus River downstream of Goodwin Dam are shown on Figures 5.68 through 5.70. The results are summarized following Table 5.55.

Table 5.54 Changes in New Melones Reservoir Storage under Alternative 3 as Compared to the No Action Alternative

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 3												
Wet	1,562	1,567	1,618	1,720	1,792	1,871	1,906	2,049	2,146	2,057	1,934	1,855
Above Normal	1,269	1,295	1,356	1,442	1,530	1,620	1,634	1,713	1,720	1,627	1,529	1,481
Below Normal	1,530	1,536	1,550	1,570	1,620	1,650	1,614	1,617	1,599	1,501	1,403	1,357
Dry	1,327	1,320	1,326	1,342	1,378	1,409	1,380	1,360	1,319	1,224	1,137	1,091
Critical Dry	828	824	836	846	866	860	803	751	719	653	593	563
No Action Alternative												
Wet	1,379	1,390	1,454	1,562	1,666	1,724	1,758	1,878	1,968	1,890	1,773	1,703
Above Normal	1,029	1,060	1,125	1,214	1,317	1,406	1,413	1,484	1,467	1,372	1,277	1,232
Below Normal	1,294	1,305	1,326	1,351	1,413	1,438	1,390	1,383	1,359	1,268	1,175	1,133
Dry	1,094	1,094	1,106	1,121	1,156	1,188	1,154	1,132	1,087	997	914	871
Critical Dry	624	623	638	645	661	656	602	554	526	476	431	408
Alternative 3 as Compared to No Action Alternative												
Wet	183	177	165	158	126	147	149	172	178	168	161	152
Above Normal	239	235	231	228	213	213	220	229	253	255	252	250
Below Normal	236	231	224	219	207	212	224	234	239	233	228	224
Dry	232	226	220	220	222	221	226	228	232	228	223	221
Critical Dry	205	201	198	201	204	204	202	197	193	177	162	154
Alternative 3 as Compared to No Action Alternative (percent change)												
Wet	13.3	12.7	11.3	10.1	7.6	8.5	8.4	9.1	9.0	8.9	9.1	8.9
Above Normal	23.3	22.1	20.5	18.7	16.2	15.2	15.6	15.4	17.2	18.6	19.7	20.3
Below Normal	18.2	17.7	16.9	16.2	14.7	14.7	16.1	16.9	17.6	18.4	19.4	19.8
Dry	21.2	20.7	19.9	19.7	19.2	18.6	19.5	20.1	21.3	22.8	24.4	25.3
Critical Dry	32.8	32.3	31.1	31.1	30.9	31.1	33.6	35.5	36.7	37.3	37.6	37.8

Table 5.55 Changes in New Melones Reservoir Elevation under Alternative 3 as Compared to the No Action Alternative

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 3												
Wet	1,003	1,004	1,010	1,022	1,030	1,038	1,042	1,055	1,064	1,056	1,045	1,037
Above Normal	964	967	974	987	999	1,009	1,012	1,021	1,022	1,013	1,002	924
Below Normal	998	998	1,000	1,002	1,011	1,014	1,011	1,012	1,010	1,000	989	983
Dry	974	973	974	977	981	985	983	982	978	966	954	948
Critical Dry	899	899	902	904	909	909	899	889	883	870	858	852
No Action Alternative												
Wet	980	982	990	1,004	1,016	1,023	1,026	1,039	1,047	1,040	1,029	1,022
Above Normal	932	937	945	960	974	986	988	997	996	985	973	897
Below Normal	968	969	972	975	985	988	985	985	983	972	960	955
Dry	943	943	944	947	951	957	955	953	948	934	922	915
Critical Dry	856	856	862	864	870	871	860	848	840	828	818	812
Alternative 3 as Compared to No Action Alternative												
Wet	23	22	20	18	14	16	15	16	17	16	16	16
Above Normal	32	30	29	28	25	23	24	24	27	28	29	27
Below Normal	30	29	28	27	26	26	26	27	27	28	28	28
Dry	32	31	30	30	30	29	29	29	31	31	32	33
Critical Dry	43	43	40	40	38	38	39	41	43	41	40	40
Alternative 3 as Compared to No Action Alternative (percent change)												
Wet	2.3	2.2	2.0	1.8	1.4	1.5	1.5	1.6	1.6	1.5	1.6	1.5
Above Normal	3.4	3.2	3.1	2.9	2.6	2.4	2.4	2.4	2.7	2.9	3.0	3.0
Below Normal	3.1	3.0	2.9	2.8	2.6	2.6	2.7	2.7	2.8	2.9	3.0	3.0
Dry	3.3	3.3	3.2	3.2	3.2	3.0	3.0	3.1	3.2	3.4	3.5	3.6
Critical Dry	5.1	5.0	4.7	4.6	4.4	4.3	4.5	4.9	5.1	5.0	4.9	4.9

The following changes in New Melones Reservoir storage would occur under Alternative 3 as compared to the No Action Alternative.

- In wet years, storage would be increased in all months (up to 13.3 percent).
- In above-normal years, storage would be increased in all months (up to 23.3 percent).
- In below-normal years, storage would be increased in all months (up to 19.8 percent).
- In dry years, storage would be increased in all months (up to 25.3 percent).
- In critical dry years, storage would be increased in all months (up to 37.8 percent).
- In all months, in all water year types, surface water elevations would be similar.

Flows in the Stanislaus River downstream of Goodwin Dam are shown on Figures 5.68 to 5.70. Changes in flows in these rivers are summarized below.

- Over long-term conditions, reduced flows would occur in October and March through June (up to 58.3 percent); and increased flows in November through February and July through September (up to 36.81 percent).
- In wet years, similar flows would occur in April; reduced flows in October, March, and May (up to 52.9 percent); and increased flows in June through September and November through February (up to 67.8 percent).
- In dry years, similar flows would occur in March and July through September; reduced flows in October and April through June (up to 59.6 percent); and increased flows in November through February (up to 37.0 percent).

San Joaquin River at Vernalis

Flows in the San Joaquin River at Vernalis under Alternative 3 as compared to the No Action Alternative are summarized below, as shown on Figures 5.71 through 5.73.

- Over long-term conditions, similar flows would occur in November through September and reduced flows in October (15.7 percent).
- In wet years, similar flows would occur in November through August; reduced flows in October (14.1 percent); and increased flows in September (5.7 percent).
- In dry years, similar flows would occur in November through March and July through September and reduced flows in October and April through June (up to 15.2 percent).

San Luis Reservoir

Storage levels and surface water elevations in San Luis Reservoir under Alternative 3 as compared to the No Action Alternative are summarized in Tables 5.56 and 5.57. The results are summarized following Table 5.57.

Table 5.56 Changes in San Luis Reservoir Storage under Alternative 3 as Compared to the No Action Alternative

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 3												
Wet	810	1,033	1,276	1,555	1,810	1,957	1,975	1,851	1,540	1,228	961	980
Above Normal	619	844	1,109	1,342	1,571	1,756	1,763	1,575	1,155	830	674	703
Below Normal	834	1,043	1,305	1,489	1,623	1,736	1,651	1,338	899	737	585	561
Dry	634	804	1,052	1,302	1,455	1,608	1,593	1,413	1,128	926	590	535
Critical Dry	548	632	804	1,076	1,216	1,256	1,227	1,069	838	572	380	351
No Action Alternative												
Wet	555	681	931	1,236	1,526	1,788	1,598	1,251	946	741	628	679
Above Normal	490	649	957	1,223	1,441	1,661	1,444	1,048	666	466	433	513
Below Normal	525	624	907	1,141	1,314	1,473	1,312	967	555	500	426	467
Dry	476	590	867	1,150	1,339	1,494	1,413	1,167	840	763	476	469
Critical Dry	478	556	752	1,040	1,204	1,252	1,192	1,028	739	544	343	323
Alternative 3 as Compared to No Action Alternative												
Wet	255	351	345	320	284	170	377	599	593	487	334	300
Above Normal	130	194	153	119	129	95	319	526	489	363	241	190
Below Normal	309	419	399	348	309	263	339	371	344	237	160	94
Dry	158	214	185	152	117	114	180	246	288	163	114	66
Critical Dry	70	76	53	37	12	4	35	40	99	28	38	28
Alternative 3 as Compared to No Action Alternative (percent change)												
Wet	55.3	76.6	58.4	38.6	25.4	12.5	31.2	68.0	96.3	84.6	58.6	43.5
Above Normal	30.9	56.4	31.9	21.8	20.6	11.1	31.0	71.0	111.4	93.4	63.4	34.8
Below Normal	73.2	106.9	71.2	45.4	32.8	23.5	31.7	45.1	81.6	69.1	59.6	30.0
Dry	39.1	52.1	30.6	18.3	11.8	10.0	14.5	24.2	38.5	19.4	18.5	4.4
Critical Dry	28.6	28.3	10.8	5.5	1.9	0.8	2.5	2.9	16.3	10.1	25.1	29.2

Table 5.57 Changes in San Luis Reservoir Elevation under Alternative 3 as Compared to the No Action Alternative

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 3												
Wet	427	452	477	503	525	537	539	529	502	473	447	449
Above Normal	406	431	459	482	504	520	521	505	467	433	417	420
Below Normal	431	454	480	497	509	519	512	484	440	423	405	401
Dry	410	430	456	480	494	508	506	490	464	444	405	397
Critical Dry	399	409	430	458	472	475	473	457	434	403	375	371
No Action Alternative												
Wet	399	414	443	473	500	523	507	475	444	422	409	416
Above Normal	391	411	445	472	492	512	493	456	415	389	386	398
Below Normal	397	410	442	465	481	496	481	448	400	393	383	389
Dry	391	406	437	466	484	498	490	468	434	426	390	389
Critical Dry	390	400	423	454	470	475	469	453	422	399	369	366
Alternative 3 as Compared to No Action Alternative												
Wet	28	38	34	29	24	14	32	53	58	52	38	33
Above Normal	14	21	15	11	11	8	28	49	51	44	31	23
Below Normal	33	44	39	32	28	23	30	36	40	30	23	12
Dry	19	24	18	14	10	10	16	23	30	18	15	9
Critical Dry	9	10	6	4	2	1	4	4	12	4	6	5
Alternative 3 as Compared to No Action Alternative (percent change)												
Wet	6.9	9.1	7.6	6.2	4.9	2.7	6.2	11.2	13.0	12.2	9.3	7.9
Above Normal	3.7	5.0	3.3	2.3	2.3	1.6	5.6	10.6	12.4	11.3	8.1	5.7
Below Normal	8.4	10.7	8.8	6.9	5.8	4.6	6.3	8.0	10.1	7.6	5.9	3.2
Dry	4.9	5.8	4.2	3.0	2.2	2.0	3.2	4.8	6.8	4.2	3.9	2.2
Critical Dry	2.3	2.4	1.5	0.9	0.4	0.2	0.8	1.0	2.8	0.9	1.7	1.4

The following changes in San Luis Reservoir storage would occur under Alternative 3 as compared to the No Action Alternative.

- In wet years, storage would be increased in all months (up to 96.3 percent). Water storage elevations would be increased in all months (up to 13.0 percent).
- In above-normal years, storage would be increased in all months (up to 111.4 percent). Water storage elevations would be similar in October through March and increased in April through September (up to 11.3 percent).
- In below-normal years, storage would be increased in all months (up to 106.9 percent). Water storage elevations would be similar in September and increased in October through August (up to 10.7 percent).
- In dry years, storage would be similar in September and increased in October through August (up to 52.1 percent). Water storage elevations would be similar December through May and July through October and increased in November and June (up to 6.8 percent).
- In critical dry years, storage would be similar in February through May and increased in June through January (up to 29.2 percent). Water storage elevations would be similar in all months.

Changes in Flows into the Yolo Bypass

Flows from the Sacramento River into the Yolo Bypass at Fremont Weir under Alternative 3 as compared to the No Action Alternative are summarized in Table 5.58. The results are summarized following Table 5.58.

Table 5.58 Changes in Flows into the Yolo Bypass at Fremont Weir under Alternative 3 as Compared to the No Action Alternative

Water Year	Average Monthly Flow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 3												
Wet	139	973	9,693	25,241	30,361	18,837	5,617	289	113	0	0	100
Above Normal	100	100	2,686	6,188	14,531	8,490	1,768	100	100	0	0	100
Below Normal	100	100	262	1,250	4,001	1,153	293	100	100	0	0	100
Dry	100	100	342	923	2,007	1,406	410	100	100	0	0	100
Critical Dry	100	100	150	534	545	397	106	100	100	0	0	100
No Action Alternative												
Wet	183	910	8,420	24,291	29,547	18,493	5,627	289	113	0	0	100
Above Normal	100	100	2,765	5,997	13,013	7,928	1,688	100	100	0	0	100
Below Normal	100	100	242	1,004	3,031	883	293	100	100	0	0	100
Dry	100	100	322	902	2,024	1,393	407	100	100	0	0	100
Critical Dry	100	100	149	528	534	396	106	100	100	0	0	100
Alternative 3 as Compared to No Action Alternative												
Wet	-45	64	1,273	950	813	344	-10	1	0	0	0	0
Above Normal	0	0	-78	192	1,519	562	80	0	0	0	0	0
Below Normal	0	0	20	247	970	271	-1	0	0	0	0	0
Dry	0	0	19	22	-17	13	3	0	0	0	0	0
Critical Dry	0	0	1	7	11	1	0	0	0	0	0	0
Alternative 3 as Compared to No Action Alternative (percent change)												
Wet	-24.5	7.0	15.1	3.9	2.8	1.9	-0.2	0.2	0.1	0.0	0.0	0.0
Above Normal	0.0	0.0	-2.8	3.2	11.7	7.1	4.8	0.0	0.0	0.0	0.0	0.0
Below Normal	0.0	0.0	8.3	24.6	32.0	30.7	-0.3	0.0	0.0	0.0	0.0	0.0
Dry	0.0	0.0	6.0	2.4	-0.8	0.9	0.6	0.0	0.0	0.0	0.0	0.0
Critical Dry	0.0	0.0	0.8	1.2	2.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0

The following changes in flows from the Sacramento River into Yolo Bypass at Fremont Weir would occur under Alternative 3 as compared to the No Action Alternative.

- In wet years, flows into Yolo Bypass would be similar in January through September; reduced in October (24.5 percent) and increased in November and December (up to 15.1 percent).
- In above-normal years, storage would be similar in April through January and increased in February and March (up to 11.7 percent).
- In below-normal years, flows into Yolo Bypass would be similar in April through November and increased in December through March (up to 32.0 percent).
- In dry years, flows into Yolo Bypass would be similar in January through November and increased in December (6.0 percent).
- In critical dry years, flows into Yolo Bypass would be similar in all months.

Changes in Delta Conditions

Delta outflow under Alternative 3 as compared to the No Action Alternative are summarized below and shown on Figures 5.74 through 5.76.

- In wet years, average monthly Delta outflow would increase in December through March (up to 3,307 cfs) and decrease in April through November (up to 13,678 cfs).
- In dry years, average monthly Delta outflow would increase January, February, June, and July (up to 277 cfs) and decrease in August through December and March through May (up to 2,902 cfs).

The OMR conditions under Alternative 3 as compared to the No Action Alternative are shown on Figures 5.77 through 5.79.

- Under Alternative 3, OMR flows are negative in all months of all water year types except in April in a wet year (405 cfs). Under the No Action Alternative, OMR flows are negative except in April and May of wet and above-normal years and April of below-normal years.
- In wet years, average monthly OMR flows would be more positive in July and August (up to 800 cfs) and more negative in September through June (up to 4,477 cfs).
- In dry years, average monthly OMR flows would be more positive in July and January (up to 728 cfs) and more negative in August through December and February through June (up to 1,847 cfs).

Changes in CVP and SWP Exports and Deliveries

Delta exports under Alternative 3 as compared to the No Action Alternative are summarized in Table 5.59.

Table 5.59 Changes in Exports at Jones and Banks Pumping Plants under Alternative 3 as Compared to the No Action Alternative

Water Year	Monthly Volume (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 3												
Wet	544	615	601	559	594	589	494	490	519	648	667	654
Above Normal	430	533	574	414	469	566	441	413	397	586	680	647
Below Normal	524	587	607	394	373	448	312	266	330	683	650	588
Dry	440	471	523	389	314	337	270	242	292	492	318	426
Critical Dry	321	319	401	355	251	180	127	100	131	158	196	245
No Action Alternative												
Wet	410	497	564	513	537	594	204	207	445	669	717	638
Above Normal	376	450	562	406	401	496	130	105	315	587	709	628
Below Normal	386	456	590	387	354	394	134	100	209	657	622	542
Dry	374	398	510	392	315	318	153	126	194	541	296	426
Critical Dry	314	293	384	349	250	179	93	90	64	223	176	242
Alternative 3 as Compared to No Action Alternative												
Wet	134	118	37	45	57	-4	290	283	74	-21	-51	16
Above Normal	54	83	12	8	68	69	311	308	81	-2	-28	19
Below Normal	138	132	17	8	19	54	178	166	121	26	27	45
Dry	66	74	14	-3	-1	19	117	116	98	-49	22	0
Critical Dry	7	27	18	6	0	1	35	10	67	-64	19	3
Alternative 3 as Compared to No Action Alternative (percent change)												
Wet	32.7	23.8	6.6	8.8	10.6	-0.7	142.4	136.5	16.7	-3.1	-7.1	2.5
Above Normal	14.4	18.4	2.2	2.0	16.9	13.9	238.3	292.1	25.9	-0.3	-4.0	3.0
Below Normal	35.8	28.9	2.9	2.0	5.3	13.7	132.2	166.5	58.2	3.9	4.4	8.4
Dry	17.7	18.5	2.7	-0.7	-0.3	6.1	76.2	92.5	50.5	-9.0	7.6	0.1
Critical Dry	2.2	9.2	4.6	1.7	0.1	0.4	37.3	11.0	104.1	-28.9	10.9	1.4

The following changes would occur in CVP and SWP exports under Alternative 3 as compared to the No Action Alternative.

- Long-term average annual exports would be 726 TAF (15 percent) more under Alternative 3 as compared to the No Action Alternative.
- In wet years, total exports would be similar in March, July, and September; increased in October, February and April through June (up to 142.4 percent); and reduced in August (7.1 percent).
- In above-normal years, total exports would be similar in December, January, and July through September and increased in October, November, and February through June (up to 292 percent).
- In below-normal years, total exports would be similar in December, January, July, and August and increased in September through November and February through June (up to 166.5 percent).
- In dry years, total exports would be similar in September and December, and July; increased in October, November, March through June, and August (up to 92.5 percent); and reduced in July (7.6 percent).
- In critical dry years, total exports would be similar in September, October, and December through March; increased in November, April through June and August (up to 104.1 percent); and reduced in July (28.9 percent).

Deliveries to CVP and SWP water users increase under Alternative 3 as compared to the No Action Alternative, as summarized in Tables 5.60 and 5.61, respectively, due to increased water supply availability and export limitations.

Table 5.60 Changes CVP Water Deliveries under Alternative 3 as Compared to the No Action Alternative

Annual Average Deliveries (TAF)					
				Alternative 3 as compared to the No Action Alternative	
		Alternative 3	No Action Alternative	Difference	Percent Change
North of Delta					
CVP Agricultural Water Service Contractors	Long Term	209	185	24	13
	Dry	111	86	25	29
	Critical Dry	31	24	7	29
CVP M&I (Including American River Contractors and Contra Costa Water District)	Long Term	392	386	6	2
	Dry	390	385	6	2
	Critical Dry	384	383	1	0
CVP M&I American River Contractors	Long Term	118	113	6	5
	Dry	104	97	7	7
	Critical Dry	78	75	3	4
CVP Sacramento River Settlement Contractors	Long Term	1,860	1,859	1	0
	Dry	1,906	1,906	0	0
	Critical Dry	1,742	1,737	5	0
CVP Refuge Level 2 Deliveries	Long Term	153	146	7	5
	Dry	149	146	4	3
	Critical Dry	103	102	1	1
Total CVP Agricultural, M&I, Sacramento River Settlement Contractors, and Refuge Level 2 Deliveries	Long Term	2,614	2,576	38	1
	Dry	2,556	2,523	33	1
	Critical Dry	2,260	2,246	14	1
South of Delta (Does not include Eastside Contractors)					
CVP Agricultural Water Service Contractors	Long Term	1,079	847	233	28
	Dry	596	445	151	34
	Critical Dry	168	131	36	27

Annual Average Deliveries (TAF)					
		Alternative 3	No Action Alternative	Alternative 3 as compared to the No Action Alternative	
				Difference	Percent Change
CVP M&I Users	Long Term	122	112	11	10
	Dry	108	99	8	8
	Critical Dry	83	80	2	3
San Joaquin River Exchange Contractors	Long Term	852	852	0	0
	Dry	875	875	0	0
	Critical Dry	741	741	0	0
CVP Refuge Level 2 Deliveries	Long Term	273	273	0	0
	Dry	281	281	0	0
	Critical Dry	234	234	0	0
Total CVP Agricultural, M&I, San Joaquin River Exchange Contractors, and Refuge Level 2 Deliveries	Long Term	2,326	2,084	242	12
	Dry	1,860	1,700	160	9
	Critical Dry	1,226	1,186	40	3
Eastside Contractors Deliveries					
Water Rights	Long Term	513	508	5	1
	Dry	524	524	0	0
	Critical Dry	478	445	33	7
CVP Water Service Contracts	Long Term	123	104	20	19
	Dry	109	84	25	30
	Critical Dry	36	4	32	800
Total Water Rights and CVP Service Contracts Deliveries	Long Term	636	612	24	4
	Dry	633	608	25	4
	Critical Dry	514	449	65	14

The following changes in CVP water deliveries would occur under Alternative 3 as compared to the No Action Alternative.

- Deliveries to CVP North of Delta agricultural water service contractors would be increased by 13 percent over the long-term conditions and 29 percent in dry and critical dry years.
- Deliveries to CVP North of Delta M&I contractors would be similar in total; however, deliveries to the American River CVP contractors would increase by 5 percent over the long-term conditions and 7 percent in dry years, and remain similar in critical dry years.
- Deliveries to CVP South of Delta agricultural water service contractors would be increased by 28 percent over the long-term conditions, 34 percent in dry years, and 27 percent in critical dry years.
- Deliveries to CVP South of Delta M&I contractors would be similar in critical dry years and increased by 10 percent over the long-term conditions and 8 percent in dry years.
- Deliveries to the Eastside contractors would be similar under long-term conditions and dry years and increased by 14 percent in critical dry years.

Table 5.61 Changes SWP Water Deliveries under Alternative 3 as Compared to the No Action Alternative

Annual Average Deliveries (TAF)					
		Alternative 3	No Action Alternative	Alternative 3 as compared to the No Action Alternative	
				Difference	Percent Change
North of Delta					
SWP Agricultural Uses	Long Term	0	0	0	0
	Dry	0	0	0	0
	Critical Dry	0	0	0	0
SWP M&I (without Article 21)	Long Term	80	68	11	17
	Dry	60	51	8	17
	Critical Dry	48	43	5	13
SWP M&I Article 21 Deliveries	Long Term	12	13	-1	-4
	Dry	13	14	-1	-5
	Critical Dry	12	13	-1	-5
Total SWP Agricultural and M&I (without Article 21)	Long Term	80	68	11	17
	Dry	60	51	8	17
	Critical Dry	48	43	5	13

Annual Average Deliveries (TAF)					
				Alternative 3 as compared to the No Action Alternative	
		Alternative 3	No Action Alternative	Difference	Percent Change
Total SWP Agricultural and M&I Article 21 Deliveries	Long Term	12	13	-1	-4
	Dry	13	14	-1	-5
	Critical Dry	12	13	-1	-5
South of Delta					
SWP Agricultural Users (without Article 21)	Long Term	716	610	106	17
	Dry	533	455	78	17
	Critical Dry	430	378	52	14
SWP Agricultural Article 21 Deliveries	Long Term	73	27	47	175
	Dry	36	5	31	604
	Critical Dry	27	7	21	296
SWP M&I Users (without Article 21)	Long Term	2,106	1,800	306	17
	Dry	1,649	1,406	243	17
	Critical Dry	1,340	1,173	167	14
SWP M&I Article 21 Deliveries	Long Term	33	20	13	65
	Dry	11	5	6	137
	Critical Dry	10	5	5	101
Total SWP Agricultural and M&I Users (without Article 21)	Long Term	2,822	2,410	412	17
	Dry	2,182	1,861	321	17
	Critical Dry	1,770	1,551	219	14
Total SWP Agricultural and M&I Article 21 Deliveries	Long Term	106	47	60	128
	Dry	47	10	37	384
	Critical Dry	38	12	26	214

The following changes in SWP water deliveries would occur under Alternative 3 as compared to the No Action Alternative.

- Deliveries without Article 21 water to SWP North of Delta water contractors would be increased by 17 percent over the long-term conditions and in dry years and 13 percent in critical dry years.
- Deliveries without Article 21 water to SWP South of Delta water contractors would be increased by 17 percent over the long-term conditions and in dry years and 14 percent in critical dry years.
- Deliveries of Article 21 water to SWP North of Delta water contractors would be similar over the long-term conditions and in dry and critical dry years.
- Deliveries of Article 21 water to SWP South of Delta water contractors would be increased by 128 percent over the long-term conditions, 384 percent in dry years, and 214 percent in critical dry years.

Effects Related to Cross Delta Water Transfers

Potential effects to surface water resources could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014i). Potential effects were identified as reduced surface water storage in upstream reservoirs and changes in flow patterns in river downstream of the reservoirs if water was released from the reservoirs in patterns that were different than would have been used by the water seller's. Because all water transfers would be required to avoid adverse impacts to other water users and biological resources (see Section 3.A.6.3, Transfers), including impacts associated with changes in reservoir storage and river flow patterns, the analysis indicated that water transfers would not result in substantial changes in storage or river flows. For the purposes of this EIS, it is anticipated that similar conditions would occur due to cross Delta water transfers under Alternative 3 and the No Action Alternative.

Under Alternative 3, water could be transferred throughout the year. As indicated in Table 5.59, capacity would be available under Alternative 3 in all months of all water year types without a maximum volume of transferred water. Under the No Action Alternative, the timing of cross Delta water transfers would be limited to July through September, and the volume would be limited to 600,000 acre-feet per year in drier years and 360,000 acre-feet in all other years, in accordance with the 2008 USFWS BO and 2009 NMFS BO. As indicated in Table 5.59, capacity would be available under the No Action Alternative between July and September for water transfers in all water year types.

Overall, the potential for water transfer conveyance would be greater under Alternative 3 as compared to the No Action Alternative.

San Francisco Bay Area, Central Coast, and Southern California Regions

Potential Changes in Surface Water Resources at Reservoirs that Store CVP and SWP Water

The San Francisco Bay Area, Central Coast, and Southern California regions include numerous reservoirs that store CVP and SWP water supplies, including CVP and SWP reservoirs, that primarily provide water supplies for M&I water users. Changes in the availability CVP and SWP water supplies for storage in these reservoirs under Alternative 3 as compared to the No Action Alternative would be consistent with the following changes in water deliveries to M&I water users, as summarized in Tables 5.60 and 5.61.

- Deliveries to CVP South of Delta M&I contractors would be similar in critical dry years; and increased by 9 percent over the long-term conditions and 8 percent in dry years.
- Deliveries without Article 21 water to SWP South of Delta water contractors would be increased by 17 percent over the long-term conditions and in dry years and 14 percent in critical dry years.
- Deliveries of Article 21 water to SWP South of Delta water contractors would be increased by 128 percent over the long-term conditions, 384 percent in dry years, and 214 percent in critical dry years.

Changes in CVP and SWP Exports and Deliveries

Deliveries to CVP and SWP water users are described above in the Central Valley Region.

5.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison

Trinity River Region

Changes in CVP and SWP Reservoir Storage and Downstream River Flows

Changes in Trinity Lake storage and surface water elevations under Alternative 3 as compared to the Second Basis of Comparison are summarized in Tables 5.62 and 5.63. The results are summarized following Table 5.63.

Table 5.62 Changes in Trinity Lake Storage under Alternative 3 as Compared to the Second Basis of Comparison

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 3												
Wet	1,502	1,537	1,643	1,766	1,928	2,053	2,224	2,248	2,192	2,067	1,936	1,805
Above Normal	1,197	1,230	1,349	1,511	1,707	1,891	2,071	2,045	1,949	1,806	1,646	1,513
Below Normal	1,434	1,457	1,477	1,542	1,629	1,717	1,858	1,786	1,680	1,509	1,334	1,199
Dry	1,173	1,179	1,206	1,226	1,318	1,450	1,585	1,537	1,468	1,301	1,152	1,056
Critical Dry	829	803	817	829	871	952	1,003	968	936	813	664	600
Second Basis of Comparison												
Wet	1,501	1,535	1,644	1,767	1,931	2,055	2,224	2,250	2,194	2,068	1,939	1,805
Above Normal	1,208	1,245	1,363	1,524	1,718	1,901	2,079	2,053	1,955	1,815	1,647	1,513
Below Normal	1,451	1,472	1,492	1,554	1,641	1,729	1,872	1,799	1,696	1,515	1,337	1,204
Dry	1,178	1,184	1,210	1,230	1,322	1,453	1,586	1,536	1,466	1,302	1,152	1,055
Critical Dry	819	803	813	825	868	949	999	962	929	811	667	598
Alternative 3 as Compared to Second Basis of Comparison												
Wet	0	1	-1	-1	-2	-1	-1	-2	-1	0	-3	0
Above Normal	-11	-15	-14	-13	-11	-10	-8	-8	-7	-9	0	0
Below Normal	-17	-15	-15	-12	-12	-12	-14	-13	-16	-6	-3	-5
Dry	-5	-5	-4	-4	-4	-2	-1	0	2	0	0	1
Critical Dry	10	1	3	3	3	3	4	6	7	2	-3	2
Alternative 3 as Compared to Second Basis of Comparison (percent change)												
Wet	0.0	0.1	-0.1	0.0	-0.1	-0.1	0.0	-0.1	-0.1	0.0	-0.2	0.0
Above Normal	-0.9	-1.2	-1.1	-0.8	-0.7	-0.5	-0.4	-0.4	-0.3	-0.5	0.0	0.0
Below Normal	-1.2	-1.0	-1.0	-0.8	-0.7	-0.7	-0.8	-0.7	-1.0	-0.4	-0.2	-0.4
Dry	-0.4	-0.4	-0.4	-0.3	-0.3	-0.1	0.0	0.0	0.1	0.0	0.0	0.1
Critical Dry	1.2	0.1	0.4	0.4	0.3	0.3	0.4	0.6	0.7	0.3	-0.5	0.4

Table 5.63 Changes in Trinity Lake Elevation under Alternative 3 as Compared to the Second Basis of Comparison

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 3												
Wet	2,301	2,305	2,314	2,325	2,339	2,347	2,357	2,358	2,355	2,347	2,338	2,328
Above Normal	2,268	2,271	2,284	2,301	2,319	2,334	2,347	2,345	2,339	2,328	2,315	2,304
Below Normal	2,293	2,295	2,297	2,304	2,312	2,319	2,330	2,325	2,317	2,302	2,286	2,274
Dry	2,265	2,268	2,271	2,273	2,283	2,296	2,309	2,305	2,299	2,284	2,269	2,260
Critical Dry	2,226	2,220	2,222	2,225	2,231	2,244	2,252	2,248	2,244	2,229	2,204	2,193
Second Basis of Comparison												
Wet	2,301	2,305	2,314	2,325	2,339	2,347	2,357	2,358	2,355	2,347	2,338	2,328
Above Normal	2,270	2,273	2,286	2,303	2,320	2,335	2,347	2,346	2,339	2,329	2,315	2,304
Below Normal	2,295	2,296	2,298	2,305	2,313	2,320	2,331	2,326	2,318	2,303	2,287	2,274
Dry	2,266	2,269	2,272	2,274	2,284	2,296	2,309	2,304	2,298	2,284	2,269	2,259
Critical Dry	2,218	2,216	2,217	2,222	2,229	2,243	2,250	2,246	2,243	2,227	2,204	2,191
Alternative 3 as Compared to Second Basis of Comparison												
Wet	0	0	0	0	0	0	0	0	0	0	0	0
Above Normal	-2	-2	-2	-2	-1	-1	-1	-1	0	-1	0	0
Below Normal	-2	-2	-1	-1	-1	-1	-1	-1	-1	-1	0	-1
Dry	0	0	0	0	0	0	0	0	0	0	0	0
Critical Dry	8	5	5	4	3	2	1	2	2	1	0	2
Alternative 3 as Compared to Second Basis of Comparison (percent change)												
Wet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Above Normal	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Below Normal	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0
Dry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Critical Dry	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1

In all months, in all water year types, Trinity Lake storage and surface water elevations would be similar under Alternative 3 as compared to the Second Basis of Comparison. Trinity River flows would be similar in all months under long-term conditions and wet and dry years, as shown on Figures 5.53 through 5.55.

Central Valley Region

Changes in CVP and SWP Reservoir Storage and Downstream River Flows

Shasta Lake and Sacramento River

Storage levels and surface water elevations in Shasta Lake under Alternative 3 as compared to the Second Basis of Comparison are summarized in Tables 5.64 and 5.65. Changes in flows in the Sacramento River downstream of Keswick

Dam and at Freeport are shown on Figures 5.56 through 5.61. The results are summarized following Table 5.65.

Table 5.64 Changes in Shasta Lake Storage under Alternative 3 as Compared to the Second Basis of Comparison

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 3												
Wet	2,816	2,932	3,161	3,408	3,597	3,841	4,301	4,453	4,221	3,720	3,370	3,244
Above Normal	2,475	2,555	2,783	3,303	3,509	4,023	4,403	4,401	3,975	3,350	2,998	2,946
Below Normal	2,818	2,851	2,983	3,302	3,650	3,971	4,176	4,056	3,631	3,036	2,669	2,562
Dry	2,431	2,451	2,590	2,770	3,189	3,662	3,885	3,798	3,359	2,826	2,542	2,500
Critical Dry	1,833	1,793	1,877	2,024	2,184	2,424	2,354	2,237	1,836	1,406	1,129	1,066
Second Basis of Comparison												
Wet	2,817	2,926	3,154	3,406	3,597	3,841	4,301	4,453	4,228	3,733	3,362	3,252
Above Normal	2,499	2,578	2,808	3,313	3,515	4,038	4,416	4,417	3,979	3,347	2,975	2,921
Below Normal	2,826	2,846	2,977	3,299	3,646	3,966	4,164	4,042	3,599	3,010	2,601	2,574
Dry	2,409	2,431	2,578	2,755	3,168	3,644	3,861	3,774	3,333	2,800	2,539	2,496
Critical Dry	1,873	1,826	1,911	2,050	2,222	2,460	2,386	2,270	1,861	1,409	1,151	1,086
Alternative 3 as Compared to Second Basis of Comparison												
Wet	-1	6	7	2	0	0	0	0	-7	-13	8	-8
Above Normal	-24	-23	-25	-11	-6	-15	-13	-16	-4	3	23	25
Below Normal	-9	5	5	3	4	5	12	13	32	26	68	-13
Dry	22	21	12	15	22	17	24	24	26	25	3	4
Critical Dry	-40	-33	-34	-26	-38	-36	-32	-33	-25	-2	-22	-20
Alternative 3 as Compared to Second Basis of Comparison (percent change)												
Wet	0.0	0.2	0.2	0.1	0.0	0.0	0.0	0.0	-0.2	-0.4	0.2	-0.2
Above Normal	-1.0	-0.9	-0.9	-0.3	-0.2	-0.4	-0.3	-0.4	-0.1	0.1	0.8	0.9
Below Normal	-0.3	0.2	0.2	0.1	0.1	0.1	0.3	0.3	0.9	0.9	2.6	-0.5
Dry	0.9	0.9	0.5	0.5	0.7	0.5	0.6	0.6	0.8	0.9	0.1	0.1
Critical Dry	-2.1	-1.8	-1.8	-1.3	-1.7	-1.5	-1.3	-1.5	-1.3	-0.2	-1.9	-1.9

Table 5.65 Changes in Shasta Lake Elevation under Alternative 3 as Compared to the Second Basis of Comparison

Water Year	End of Month Elevation (Feet)											
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Alternative 3												
Wet	997	1,002	1,012	1,024	1,032	1,041	1,058	1,063	1,055	1,036	1,022	1,017
Above Normal	973	976	990	1,018	1,028	1,048	1,062	1,062	1,046	1,021	1,006	1,004
Below Normal	997	998	1,004	1,019	1,034	1,046	1,054	1,049	1,032	1,008	991	986
Dry	974	976	983	993	1,013	1,033	1,042	1,039	1,021	998	985	983
Critical Dry	935	933	939	948	960	975	972	966	941	910	888	882
Second Basis of Comparison												
Wet	997	1,002	1,012	1,024	1,032	1,041	1,058	1,063	1,055	1,037	1,022	1,017
Above Normal	974	978	992	1,019	1,028	1,048	1,062	1,062	1,046	1,021	1,005	1,003
Below Normal	997	998	1,004	1,019	1,034	1,046	1,053	1,049	1,031	1,006	987	986
Dry	972	974	982	992	1,012	1,032	1,041	1,038	1,020	997	984	982
Critical Dry	938	935	941	950	961	977	974	967	943	910	889	884
Alternative 3 as Compared to Second Basis of Comparison												
Wet	0	0	0	0	0	0	0	0	0	-1	0	0
Above Normal	-2	-2	-2	-1	0	-1	0	-1	0	0	1	1
Below Normal	0	0	0	0	0	0	0	1	1	1	4	0
Dry	2	2	1	1	1	1	1	1	1	1	0	0
Critical Dry	-3	-2	-2	-2	-2	-2	-1	-1	-1	0	-1	-1
Alternative 3 as Compared to Second Basis of Comparison (percent change)												
Wet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0
Above Normal	-0.2	-0.2	-0.2	-0.1	0.0	-0.1	0.0	-0.1	0.0	0.0	0.1	0.1
Below Normal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.4	0.0
Dry	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0
Critical Dry	-0.3	-0.3	-0.3	-0.2	-0.2	-0.2	-0.2	-0.1	-0.1	0.0	-0.2	-0.1

Shasta Lake storage and surface water elevation would be similar under Alternative 3 as compared to the Second Basis of Comparison in all months and all water years.

The following changes in Sacramento River flows would occur under Alternative 3 as compared to the Second Basis of Comparison, as shown on Figures 5.56 through 5.61.

- Sacramento River downstream of Keswick Dam (Figures 5.56 through 5.58) would be similar in all months over the long-term conditions and in wet and dry years.

- Sacramento River near Freeport (near the northern boundary of the Delta) (Figures 5.59 through 5.61).
  - Over long-term conditions and in wet years, flows would be similar in all months.
  - In dry years, similar flows would occur in July through May; and increased flows in June (11 percent).

Lake Oroville and Feather River

Storage levels and surface water elevations in Lake Oroville under Alternative 3 as compared to the Second Basis of Comparison are summarized in Tables 5.66 and 5.67. Changes in flows in the Feather River downstream of Thermalito Complex are shown on Figures 5.62 through 5.64. The results are summarized following Table 5.67.

Table 5.66 Changes in Lake Oroville Storage under Alternative 3 as Compared to the Second Basis of Comparison

Water Year	End of Month Storage (TAF)											
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Alternative 3												
Wet	1,893	1,931	2,315	2,608	2,854	2,942	3,300	3,473	3,375	2,902	2,630	2,499
Above Normal	1,405	1,448	1,623	2,109	2,623	2,945	3,280	3,371	3,129	2,494	2,039	1,778
Below Normal	1,839	1,801	1,846	2,054	2,370	2,636	2,879	2,883	2,610	1,971	1,520	1,354
Dry	1,332	1,288	1,322	1,454	1,733	2,088	2,329	2,319	1,980	1,548	1,343	1,198
Critical Dry	1,129	1,067	1,067	1,156	1,275	1,429	1,449	1,437	1,236	1,029	918	862
Second Basis of Comparison												
Wet	1,936	1,984	2,354	2,636	2,871	2,942	3,300	3,477	3,402	2,976	2,728	2,569
Above Normal	1,465	1,523	1,702	2,173	2,648	2,937	3,271	3,357	3,081	2,493	2,087	1,827
Below Normal	1,823	1,783	1,831	2,037	2,361	2,627	2,875	2,836	2,461	1,930	1,637	1,424
Dry	1,371	1,324	1,344	1,473	1,764	2,120	2,363	2,357	2,031	1,688	1,427	1,261
Critical Dry	1,117	1,044	1,041	1,125	1,235	1,406	1,423	1,407	1,219	1,027	911	839
Alternative 3 as Compared to Second Basis of Comparison												
Wet	-43	-53	-39	-28	-17	0	0	-5	-27	-73	-98	-70
Above Normal	-61	-75	-78	-64	-24	8	8	14	48	1	-49	-49
Below Normal	16	18	15	17	9	9	3	47	150	41	-117	-70
Dry	-38	-35	-22	-19	-31	-32	-34	-38	-51	-140	-84	-62
Critical Dry	12	23	25	31	39	23	25	30	17	2	7	23
Alternative 3 as Compared to Second Basis of Comparison (percent change)												
Wet	-2.2	-2.7	-1.7	-1.1	-0.6	0.0	0.0	-0.1	-0.8	-2.5	-3.6	-2.7
Above Normal	-4.1	-4.9	-4.6	-2.9	-0.9	0.3	0.3	0.4	1.6	0.0	-2.3	-2.7
Below Normal	0.9	1.0	0.8	0.8	0.4	0.4	0.1	1.7	6.1	2.1	-7.2	-4.9
Dry	-2.8	-2.7	-1.6	-1.3	-1.8	-1.5	-1.4	-1.6	-2.5	-8.3	-5.9	-5.0
Critical Dry	1.1	2.2	2.4	2.8	3.2	1.6	1.8	2.1	1.4	0.2	0.8	2.8

Table 5.67 Changes in Lake Oroville Elevation under Alternative 3 as Compared to the Second Basis of Comparison

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 3												
Wet	763	767	805	834	853	859	884	895	889	856	836	825
Above Normal	711	717	738	791	836	859	882	889	872	827	786	758
Below Normal	758	754	759	781	813	835	854	855	836	780	730	710
Dry	702	697	703	720	752	789	811	810	779	733	709	691
Critical Dry	679	671	671	684	699	718	719	718	693	665	648	640
Second Basis of Comparison												
Wet	768	773	810	837	854	859	884	896	891	861	844	831
Above Normal	717	723	745	796	838	859	882	888	869	826	790	763
Below Normal	757	752	757	779	812	834	854	852	823	775	743	719
Dry	706	701	705	721	755	791	814	813	784	748	718	698
Critical Dry	677	668	668	680	694	715	716	714	691	664	647	636
Alternative 3 as Compared to Second Basis of Comparison												
Wet	-5	-6	-4	-2	-1	0	0	0	-2	-5	-8	-6
Above Normal	-6	-7	-8	-5	-2	1	1	1	3	1	-5	-5
Below Normal	1	2	2	2	1	1	0	3	13	5	-13	-8
Dry	-4	-4	-2	-2	-3	-3	-3	-4	-6	-16	-10	-7
Critical Dry	2	3	3	4	5	3	3	4	2	1	1	4
Alternative 3 as Compared to Second Basis of Comparison (percent change)												
Wet	-0.6	-0.7	-0.5	-0.3	-0.1	0.0	0.0	0.0	-0.2	-0.6	-0.9	-0.8
Above Normal	-0.8	-1.0	-1.0	-0.7	-0.2	0.1	0.1	0.1	0.4	0.1	-0.6	-0.6
Below Normal	0.2	0.3	0.2	0.3	0.1	0.1	0.0	0.4	1.6	0.6	-1.8	-1.2
Dry	-0.6	-0.5	-0.3	-0.2	-0.4	-0.4	-0.3	-0.5	-0.7	-2.1	-1.4	-1.1
Critical Dry	0.3	0.5	0.5	0.6	0.7	0.4	0.4	0.5	0.3	0.2	0.2	0.6

Lake Oroville storage and surface water elevation would be similar under Alternative 3 as compared to the Second Basis of Comparison in all months and all water years.

The following changes in Feather River flows would occur under Alternative 3 as compared to the Second Basis of Comparison, as shown on Figures 5.62 through 5.64.

- Over long-term conditions, similar flows would occur in November and January through June; reduced flows in October, December, and September (up to 12.5 percent); and increased flows in July and August (up to 17.0 percent).
- In wet years, similar flows would occur in November and January through May; reduced flows in October, December, and September (up to 14.6 percent); and increased flows in June through August (up to 10.9 percent).
- In dry years, similar flows would occur in November and January through June; reduced flows in August through October (up to 21.2 percent); and increased flows in July (37.1 percent).

Folsom Lake and American River

Storage levels and surface water elevations in Folsom Lake under Alternative 3 as compared to the Second Basis of Comparison are summarized in Tables 5.68 and 5.69. Changes in flows in the American River downstream of Nimbus Dam are shown on Figures 5.65 through 5.67. The results are summarized following Table 5.69.

Table 5.68 Changes in Folsom Lake Storage under Alternative 3 as Compared to the Second Basis of Comparison

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 3												
Wet	486	473	525	524	515	632	785	951	929	790	690	645
Above Normal	388	404	454	537	539	640	787	946	851	580	516	479
Below Normal	513	496	505	514	542	627	764	844	766	506	436	407
Dry	405	398	420	434	482	580	692	761	654	491	436	411
Critical Dry	331	314	322	325	370	436	474	485	431	343	291	257
Second Basis of Comparison												
Wet	483	470	522	524	515	632	785	951	937	793	688	646
Above Normal	390	412	467	537	538	640	787	946	857	591	522	485
Below Normal	506	489	502	514	541	626	761	847	739	475	408	387
Dry	405	399	423	437	486	585	698	769	664	486	432	408
Critical Dry	339	317	323	325	369	436	469	482	430	352	288	258
Alternative 3 as Compared to Second Basis of Comparison												
Wet	3	4	3	0	0	0	0	0	-8	-3	2	-1
Above Normal	-3	-9	-13	1	1	0	0	0	-6	-10	-7	-6
Below Normal	8	6	3	0	1	1	3	-3	27	31	28	21
Dry	-1	-1	-3	-3	-4	-4	-6	-7	-9	5	4	3
Critical Dry	-7	-3	-1	0	1	0	5	3	1	-9	4	-1
Alternative 3 as Compared to Second Basis of Comparison (percent change)												
Wet	0.7	0.8	0.6	0.0	0.0	0.0	0.0	0.0	-0.8	-0.4	0.3	-0.1
Above Normal	-0.7	-2.1	-2.8	0.1	0.2	0.0	0.0	0.0	-0.8	-1.8	-1.3	-1.2
Below Normal	1.5	1.3	0.6	0.1	0.2	0.1	0.3	-0.4	3.6	6.6	6.7	5.3
Dry	-0.1	-0.2	-0.8	-0.7	-0.8	-0.7	-0.9	-1.0	-1.4	1.1	0.8	0.8
Critical Dry	-2.2	-1.0	-0.3	0.0	0.2	0.0	1.0	0.6	0.2	-2.6	1.3	-0.4

Table 5.69 Changes in Folsom Lake Elevation under Alternative 3 as Compared to the Second Basis of Comparison

Water Year	End of Month Elevation (Feet)											
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Alternative 3												
Wet	413	412	419	419	418	432	448	465	463	448	438	433
Above Normal	395	397	408	421	421	433	448	465	455	425	418	413
Below Normal	416	415	416	417	421	432	446	454	446	415	404	401
Dry	401	401	405	407	414	426	438	445	434	414	407	404
Critical Dry	388	386	390	390	396	406	411	411	403	389	379	372
Second Basis of Comparison												
Wet	412	412	419	419	418	432	448	465	464	449	438	433
Above Normal	397	400	410	421	421	433	448	465	456	427	419	414
Below Normal	415	414	416	417	421	432	446	455	443	410	401	398
Dry	401	401	405	407	414	427	439	446	435	413	406	403
Critical Dry	389	386	390	391	397	406	410	411	404	391	378	372
Alternative 3 as Compared to Second Basis of Comparison												
Wet	1	1	0	0	0	0	0	0	-1	0	0	0
Above Normal	-2	-3	-3	0	0	0	0	0	-1	-1	-1	-1
Below Normal	1	1	0	0	0	0	0	0	3	5	3	3
Dry	0	0	0	0	-1	-1	-1	-1	-1	1	0	0
Critical Dry	-1	0	0	0	0	0	0	0	0	-2	1	0
Alternative 3 as Compared to Second Basis of Comparison (percent change)												
Wet	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	-0.2	-0.1	0.0	0.0
Above Normal	-0.5	-0.8	-0.6	0.0	0.0	0.0	0.0	0.0	-0.1	-0.3	-0.2	-0.2
Below Normal	0.3	0.2	0.1	0.0	0.0	0.0	0.1	-0.1	0.7	1.2	0.9	0.6
Dry	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.2	-0.2	-0.3	0.2	0.1	0.1
Critical Dry	-0.2	-0.1	-0.1	0.0	0.0	-0.1	0.1	0.0	-0.1	-0.5	0.4	-0.1

Folsom Lake storage and surface water elevation would be similar under Alternative 3 as compared to the Second Basis of Comparison in all months and all water years.

The American River flows would be similar in all months over long-term conditions, wet years, and dry years under Alternative 3 as compared to the Second Basis of Comparison, as shown on Figures 5.65 through 5.67.

Clear Creek

Flows in Clear Creek downstream of Whiskeytown Dam would be identical under Alternative 3 as compared to the Second Basis of Comparison, as summarized in Table 5.70.

Table 5.70 Changes in Clear Creek Flows below Whiskeytown Dam under Alternative 3 as Compared to the Second Basis of Comparison

Water Year	Average Monthly Flow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 3												
Wet	200	200	200	309	356	272	200	200	200	85	85	150
Above Normal	181	182	188	192	196	196	196	200	200	85	85	150
Below Normal	195	195	195	195	195	195	195	195	191	85	85	150
Dry	178	184	188	190	190	190	190	190	183	85	85	150
Critical Dry	163	167	167	167	167	167	167	167	111	85	85	133
Second Basis of Comparison												
Wet	200	200	200	309	356	272	200	200	200	85	85	150
Above Normal	181	182	188	192	196	196	196	200	200	85	85	150
Below Normal	195	195	195	195	195	195	195	195	191	85	85	150
Dry	178	184	188	190	190	190	190	190	183	85	85	150
Critical Dry	163	167	167	167	167	167	167	167	111	85	85	133
Alternative 3 as Compared to Second Basis of Comparison												
Wet	0	0	0	0	0	0	0	0	0	0	0	0
Above Normal	0	0	0	0	0	0	0	0	0	0	0	0
Below Normal	0	0	0	0	0	0	0	0	0	0	0	0
Dry	0	0	0	0	0	0	0	0	0	0	0	0
Critical Dry	0	0	0	0	0	0	0	0	0	0	0	0
Alternative 3 as Compared to Second Basis of Comparison (percent change)												
Wet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Above Normal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Below Normal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Critical Dry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

New Melones Reservoir and Stanislaus River

Storage levels and surface water elevations in New Melones Reservoir under Alternative 3 as compared to the Second Basis of Comparison are summarized in Tables 5.71 and 5.72. Changes in flows in the Stanislaus River downstream of Goodwin Dam are shown on Figures 5.68 through 5.70. The results are summarized following Table 5.72.

Table 5.71 Changes in New Melones Reservoir Storage under Alternative 3 as Compared to the Second Basis of Comparison

Water Year	End of Month Storage (TAF)											
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Alternative 3												
Wet	1,562	1,567	1,618	1,720	1,792	1,871	1,906	2,049	2,146	2,057	1,934	1,855
Above Normal	1,269	1,295	1,356	1,442	1,530	1,620	1,634	1,713	1,720	1,627	1,529	1,481
Below Normal	1,530	1,536	1,550	1,570	1,620	1,650	1,614	1,617	1,599	1,501	1,403	1,357
Dry	1,327	1,320	1,326	1,342	1,378	1,409	1,380	1,360	1,319	1,224	1,137	1,091
Critical Dry	828	824	836	846	866	860	803	751	719	653	593	563
Second Basis of Comparison												
Wet	1,443	1,446	1,502	1,606	1,709	1,794	1,833	1,962	1,994	1,917	1,803	1,731
Above Normal	1,092	1,116	1,175	1,261	1,360	1,455	1,481	1,543	1,516	1,419	1,321	1,274
Below Normal	1,364	1,366	1,378	1,397	1,453	1,479	1,461	1,447	1,415	1,322	1,228	1,183
Dry	1,149	1,143	1,149	1,161	1,191	1,221	1,210	1,176	1,131	1,039	956	912
Critical Dry	667	663	674	680	696	690	646	585	557	498	449	426
Alternative 3 as Compared to Second Basis of Comparison												
Wet	119	121	116	114	83	77	73	88	153	141	131	124
Above Normal	177	179	181	181	170	165	153	170	204	208	207	208
Below Normal	167	170	172	173	167	170	153	170	184	179	175	174
Dry	177	177	177	181	187	188	170	183	188	185	181	179
Critical Dry	161	161	162	165	170	170	157	166	162	155	144	137
Alternative 3 as Compared to Second Basis of Comparison (percent change)												
Wet	8.2	8.4	7.7	7.1	4.8	4.3	4.0	4.5	7.7	7.3	7.3	7.2
Above Normal	16.3	16.0	15.4	14.4	12.5	11.3	10.3	11.0	13.4	14.7	15.7	16.3
Below Normal	12.2	12.5	12.5	12.4	11.5	11.5	10.5	11.8	13.0	13.6	14.3	14.7
Dry	15.4	15.5	15.4	15.6	15.7	15.4	14.0	15.6	16.6	17.8	19.0	19.6
Critical Dry	24.1	24.3	24.0	24.3	24.4	24.6	24.3	28.3	29.1	31.1	32.0	32.1

Table 5.72 Changes in New Melones Reservoir Elevation under Alternative 3 as Compared to the Second Basis of Comparison

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 3												
Wet	1,003	1,004	1,010	1,022	1,030	1,038	1,042	1,055	1,064	1,056	1,045	1,037
Above Normal	964	967	974	987	999	1,009	1,012	1,021	1,022	1,013	1,002	924
Below Normal	998	998	1,000	1,002	1,011	1,014	1,011	1,012	1,010	1,000	989	983
Dry	974	973	974	977	981	985	983	982	978	966	954	948
Critical Dry	899	899	902	904	909	909	899	889	883	870	858	852
Second Basis of Comparison												
Wet	989	990	997	1,009	1,021	1,030	1,034	1,047	1,050	1,043	1,032	1,025
Above Normal	941	944	951	966	979	992	995	1,003	1,001	990	978	901
Below Normal	977	977	979	982	991	994	994	993	991	980	968	962
Dry	951	950	950	953	957	962	963	960	954	941	929	922
Critical Dry	866	866	870	872	878	879	871	856	850	835	823	817
Alternative 3 as Compared to Second Basis of Comparison												
Wet	14	14	13	12	9	8	7	8	14	13	13	12
Above Normal	23	23	23	21	19	18	16	18	21	23	24	23
Below Normal	20	21	21	21	20	20	17	19	20	20	21	21
Dry	24	24	24	24	25	23	20	23	24	24	25	26
Critical Dry	33	33	31	32	31	30	28	33	33	35	35	34
Alternative 3 as Compared to Second Basis of Comparison (percent change)												
Wet	1.4	1.4	1.3	1.2	0.9	0.8	0.7	0.8	1.3	1.3	1.2	1.2
Above Normal	2.4	2.4	2.4	2.2	2.0	1.8	1.6	1.7	2.1	2.3	2.4	2.5
Below Normal	2.1	2.1	2.1	2.1	2.0	2.0	1.7	1.9	2.0	2.1	2.1	2.2
Dry	2.5	2.5	2.5	2.5	2.6	2.4	2.1	2.3	2.5	2.6	2.7	2.8
Critical Dry	3.8	3.8	3.6	3.6	3.5	3.4	3.2	3.9	3.9	4.2	4.3	4.2

The following changes in New Melones Reservoir storage and surface water elevations would occur under Alternative 3 as compared to the Second Basis of Comparison.

- In wet years, storage would be similar in March through May and increased in June through February (up to 8.4 percent).
- In above normal years, storage would be increased in all months (up to 16.3 percent).
- In below normal years, storage would be increased in all months (up to 14.7 percent).
- In dry years, storage would be increased in all months (up to 19.6 percent).
- In critical dry years, storage would be increased in all months (up to 32.1 percent).
- In all months, in all water year types, surface water elevations would be similar.

Flows in the Stanislaus River downstream of Goodwin Dam are shown on Figures 5.68 to 5.70. Changes in flows in the river are summarized below.

- Over long-term conditions, similar flows would occur in October, December, January, and March; reduced flows would occur in November, May, and June (up to 52.3 percent); and increased flows in February, April, July, and August through September (up to 26.8 percent).
- In wet years, similar flows would occur in October, November, January, and April; reduced flows in May and June (up to 44.8 percent); and increased flows in December, February, March, and July through September (up to 68.6 percent).
- In dry years, similar flows would occur in July through October; reduced flows in November through March and May through June (up to 36.0 percent); and increased flows in April (40.2 percent).

San Joaquin River at Vernalis

Flows in the San Joaquin River at Vernalis under Alternative 3 as compared to the Second Basis of Comparison are summarized below, as shown on Figures 5.71 through 5.73.

- Over long-term conditions, similar flows would occur in July through May and reduced flows in June (11.8 percent).
- In wet years, similar flows would occur in September through January, March through May, and July; reduced flows in June (8.3 percent); and increased flows in August and February (6.2 percent).
- In dry years, similar flows would occur in July through March; reduced flows in May and June (up to 12.3 percent); and increased flows in April (6.6 percent).

San Luis Reservoir

Storage levels and surface water elevations in San Luis Reservoir under Alternative 3 as compared to the Second Basis of Comparison are summarized in Tables 5.73 and 5.74. The results are summarized following Table 5.74.

Table 5.73 Changes in San Luis Reservoir Storage under Alternative 3 as Compared to the Second Basis of Comparison

Water Year	End of Month Storage (TAF)											
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Alternative 3												
Wet	810	1,033	1,276	1,555	1,810	1,957	1,975	1,851	1,540	1,228	961	980
Above Normal	619	844	1,109	1,342	1,571	1,756	1,763	1,575	1,155	830	674	703
Below Normal	834	1,043	1,305	1,489	1,623	1,736	1,651	1,338	899	737	585	561
Dry	634	804	1,052	1,302	1,455	1,608	1,593	1,413	1,128	926	590	535
Critical Dry	548	632	804	1,076	1,216	1,256	1,227	1,069	838	572	380	351
Second Basis of Comparison												
Wet	790	1,017	1,365	1,748	1,965	2,033	2,031	1,852	1,487	1,167	889	925
Above Normal	658	883	1,213	1,671	1,913	2,001	1,995	1,717	1,263	861	612	631
Below Normal	854	1,064	1,334	1,742	1,908	1,980	1,908	1,628	1,251	964	635	591
Dry	617	764	998	1,427	1,728	1,925	1,870	1,665	1,341	1,007	660	596
Critical Dry	622	709	910	1,257	1,556	1,664	1,623	1,451	1,168	808	545	472
Alternative 3 as Compared to Second Basis of Comparison												
Wet	21	16	-88	-193	-155	-76	-56	-2	53	61	72	55
Above Normal	-38	-40	-104	-329	-342	-245	-233	-143	-108	-32	63	73
Below Normal	-20	-20	-29	-253	-285	-244	-257	-290	-352	-227	-50	-30
Dry	17	40	55	-125	-273	-317	-277	-252	-214	-81	-70	-61
Critical Dry	-74	-77	-106	-180	-340	-408	-396	-383	-330	-235	-164	-121
Alternative 3 as Compared to Second Basis of Comparison (percent change)												
Wet	-2.8	-2.9	-14.1	-15.7	-10.5	-4.9	-3.2	-3.9	-6.0	-1.8	3.6	1.4
Above Normal	-5.8	-3.9	-10.0	-21.7	-16.1	-11.8	-10.0	-10.4	-15.9	-8.3	6.4	12.1
Below Normal	-9.6	-8.0	-7.6	-21.7	-20.2	-15.1	-15.9	-25.0	-40.1	-28.4	-1.3	-4.4
Dry	7.5	12.7	13.2	-9.8	-19.2	-18.7	-16.5	-18.7	-18.6	-5.3	-11.2	-12.1
Critical Dry	-7.3	-8.0	-11.4	-15.2	-26.1	-27.7	-27.0	-28.5	-26.0	-20.6	-14.5	7.6

Table 5.74 Changes in San Luis Reservoir Elevation under Alternative 3 as Compared to the Second Basis of Comparison

Water Year	**End of Month Elevation (Feet)**											
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Alternative 3												
Wet	427	452	477	503	525	537	539	529	502	473	447	449
Above Normal	406	431	459	482	504	520	521	505	467	433	417	420
Below Normal	431	454	480	497	509	519	512	484	440	423	405	401
Dry	410	430	456	480	494	508	506	490	464	444	405	397
Critical Dry	399	409	430	458	472	475	473	457	434	403	375	371
Second Basis of Comparison												
Wet	426	451	485	520	538	543	543	529	497	468	440	443
Above Normal	412	437	470	513	534	541	540	518	477	437	409	411
Below Normal	435	457	483	519	533	539	533	510	476	448	412	406
Dry	407	425	450	492	518	535	530	513	484	453	415	406
Critical Dry	409	419	441	475	502	512	509	494	468	432	400	389
Alternative 3 as Compared to Second Basis of Comparison												
Wet	1	1	**-8**	**-17**	**-13**	**-6**	**-5**	**0**	5	6	8	6
Above Normal	**-7**	**-6**	**-11**	**-31**	**-30**	**-21**	**-20**	**-13**	**-11**	**-4**	8	9
Below Normal	**-4**	**-3**	**-3**	**-22**	**-24**	**-20**	**-22**	**-26**	**-36**	**-26**	**-7**	**-4**
Dry	3	5	6	**-11**	**-24**	**-27**	**-24**	**-23**	**-21**	**-9**	**-9**	**-9**
Critical Dry	**-10**	**-10**	**-12**	**-17**	**-30**	**-37**	**-36**	**-36**	**-34**	**-28**	**-25**	**-19**
Alternative 3 as Compared to Second Basis of Comparison (percent change)												
Wet	0.3	0.2	-1.7	-3.3	-2.4	-1.1	-0.8	0.0	0.9	1.2	1.7	1.3
Above Normal	-1.6	-1.3	-2.3	-6.0	-5.6	-3.8	-3.6	-2.5	-2.2	-0.9	1.9	2.3
Below Normal	-0.9	-0.6	-0.6	-4.2	-4.5	-3.7	-4.1	-5.1	-7.5	-5.7	-1.7	-1.1
Dry	0.7	1.1	1.3	-2.2	-4.6	-5.0	-4.5	-4.4	-4.3	-2.0	-2.3	-2.2
Critical Dry	-2.5	-2.3	-2.6	-3.6	-6.1	-7.2	-7.1	-7.4	-7.2	-6.6	-6.4	-4.9

The following changes in San Luis Reservoir storage would occur under Alternative 3 as compared to the Second Basis of Comparison.

- In wet years, storage would be similar in July through November and March through May and reduced in December through February and June (up to 15.7 percent). Surface water elevations would be similar in all months.
- In above-normal years, storage would be similar in November; increased in August and September (up to 12.1 percent); and reduced in October and December through July (up to 21.7 percent). Surface water elevations would be similar in March through December and reduced in January and February (up to 6.0 percent).
- In below-normal years, storage would be similar in August and September and reduced in October through July (up to 40.1 percent). Surface water elevations would be similar in all months.
- In dry years, storage would be reduced in January through September (up to 19.2 percent) and increased in October through December (up to 13.2 percent). Surface water elevations would be similar in all months.
- In critical dry years, storage would be reduced in October through August (up to 28.5 percent) and increased in September (7.6 percent). Surface water elevations would be similar September through January and reduced in February through August (up to 7.4 percent).

Changes in Flows into the Yolo Bypass

Flows from the Sacramento River into the Yolo Bypass at Fremont Weir under Alternative 3 as compared to the Second Basis of Comparison are summarized in Table 5.75. The results are summarized following Table 5.75.

Table 5.75 Changes in Flows into the Yolo Bypass at Fremont Weir under Alternative 3 as Compared to the Second Basis of Comparison

Water Year	Average Monthly Flow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 3												
Wet	139	973	9,693	25,241	30,361	18,837	5,617	289	113	0	0	100
Above Normal	100	100	2,686	6,188	14,531	8,490	1,768	100	100	0	0	100
Below Normal	100	100	262	1,250	4,001	1,153	293	100	100	0	0	100
Dry	100	100	342	923	2,007	1,406	410	100	100	0	0	100
Critical Dry	100	100	150	534	545	397	106	100	100	0	0	100
Second Basis of Comparison												
Wet	147	996	9,888	25,442	30,547	18,997	5,602	289	113	0	0	100
Above Normal	100	100	2,659	6,349	15,114	8,566	1,765	100	100	0	0	100
Below Normal	100	100	262	1,256	4,057	1,166	292	100	100	0	0	100
Dry	100	100	342	932	2,032	1,411	411	100	100	0	0	100
Critical Dry	100	100	149	542	533	408	106	100	100	0	0	100
Alternative 3 as Compared to Second Basis of Comparison												
Wet	-8	-23	-195	-201	-187	-160	15	0	0	0	0	0
Above Normal	0	0	28	-161	-583	-76	4	0	0	0	0	0
Below Normal	0	0	0	-6	-56	-13	0	0	0	0	0	0
Dry	0	0	-1	-9	-24	-4	-2	0	0	0	0	0
Critical Dry	0	0	0	-8	12	-11	0	0	0	0	0	0
Alternative 3 as Compared to Second Basis of Comparison (percent change)												
Wet	-5.6	-2.3	-2.0	-0.8	-0.6	-0.8	0.3	0.1	0.0	0.0	0.0	0.0
Above Normal	0.0	0.0	1.0	-2.5	-3.9	-0.9	0.2	0.0	0.0	0.0	0.0	0.0
Below Normal	0.0	0.0	0.2	-0.5	-1.4	-1.1	0.1	0.0	0.0	0.0	0.0	0.0
Dry	0.0	0.0	-0.2	-0.9	-1.2	-0.3	-0.4	0.0	0.0	0.0	0.0	0.0
Critical Dry	0.0	0.0	0.2	-1.5	2.2	-2.6	0.0	0.0	0.0	0.0	0.0	0.0

The following changes in flows from the Sacramento River into the Yolo Bypass at Fremont Weir would occur under Alternative 3 as compared to the Second Basis of Comparison.

- In wet years, flows into the Yolo Bypass would be similar in November through September and reduced in October (5.6 percent).
- In above-normal, below-normal, dry, and critical dry years, flows into the Yolo Bypass would be similar in all months.

Changes in Delta Conditions

Delta outflow under Alternative 3 as compared to the Second Basis of Comparison are summarized below and shown on Figures 5.74 through 5.76.

- In wet years, average monthly Delta outflow would increase in November through February and July through September (up to 2,546 cfs) and decrease in October and March through June (up to 1,127 cfs).
- In dry years, average monthly Delta outflow would increase in November through April, July and August (up to 3,391 cfs) and decrease in October, May, and June (up to 373 cfs).

The OMR conditions under Alternative 3 as compared to the Second Basis of Comparison are shown on Figures 5.77 through 5.79.

- Under Alternative 3, OMR flows are negative in all months of all water year types except in April in wet year (405 cfs). Under Second Basis of Comparison, OMR flows are negative in all months of all water year types.
- In wet years, flows would be more positive in September through February, April, and May (up to 5,528 cfs) and more negative in March and June through August (up to 1,453 cfs).
- In dry years, flows would be more positive in August through May (up to 3,249 cfs); and more negative flows in June and July (up to 1,345 cfs).

Changes in CVP and SWP Exports and Deliveries

Delta exports under Alternative 3 as compared to the Second Basis of Comparison are summarized in Table 5.76.

Table 5.76 Changes in Exports at Jones and Banks Pumping Plants under Alternative 3 as Compared to the Second Basis of Comparison

Water Year	Monthly Volume (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 3												
Wet	544	615	601	559	594	589	494	490	519	648	667	654
Above Normal	430	533	574	414	469	566	441	413	397	586	680	647
Below Normal	524	587	607	394	373	448	312	266	330	683	650	588
Dry	440	471	523	389	314	337	270	242	292	492	318	426
Critical Dry	321	319	401	355	251	180	127	100	131	158	196	245
Second Basis of Comparison												
Wet	549	619	716	724	609	543	476	430	456	632	655	660
Above Normal	428	521	641	716	584	570	453	363	415	572	647	651
Below Normal	548	595	623	674	497	500	337	304	414	629	517	539
Dry	435	475	546	579	518	493	259	228	274	403	325	438
Critical Dry	340	345	455	433	406	266	134	121	132	139	203	249
Alternative 3 as Compared to Second Basis of Comparison												
Wet	-5	-5	-115	-165	-15	46	18	60	64	16	12	-5
Above Normal	2	12	-66	-303	-115	-4	-11	50	-19	13	33	-3
Below Normal	-24	-7	-16	-280	-124	-52	-25	-37	-83	54	133	49
Dry	5	-4	-23	-190	-203	-156	12	14	18	89	-7	-12
Critical Dry	-19	-26	-54	-78	-156	-86	-6	-21	0	19	-7	-4
Alternative 3 as Compared to Second Basis of Comparison (percent change)												
Wet	-0.8	-0.7	-16.0	-22.8	-2.4	8.6	3.7	14.0	14.0	2.5	1.8	-0.8
Above Normal	0.5	2.2	-10.3	-42.2	-19.7	-0.7	-2.5	13.8	-4.5	2.3	5.1	-0.5
Below Normal	-4.4	-1.3	-2.5	-41.5	-24.9	-10.4	-7.5	-12.3	-20.2	8.6	25.7	9.1
Dry	1.3	-0.8	-4.1	-32.8	-39.3	-31.6	4.5	6.1	6.5	22.1	-2.3	-2.7
Critical Dry	-5.7	-7.4	-11.8	-18.0	-38.3	-32.4	-4.8	-17.1	-0.2	14.0	-3.5	-1.7

The following changes would occur in CVP and SWP exports under Alternative 3 as compared to the Second Basis of Comparison.

- Long-term average annual exports would be 326 TAF (6 percent) less under Alternative 3 as compared to the Second Basis of Comparison.
- In wet years, total exports would be similar in July through November, February, and April; increased exports in March, May, and June (up to 14.0 percent); and reduced in December and January (up to 22.8 percent).
- In above-normal years, total exports would be similar in June through November, March, and April; reduced exports in December through February (up to 42.2 percent); and increased in May (up to 13.8 percent).
- In below-normal years, total exports would be similar in October through December; reduced exports in January through June (up to 41.5 percent); and increased in July through September (up to 25.7 percent).
- In dry years, total exports would be similar in August through December and April; reduced exports in January through March (up to 39.3 percent); and increased exports in May through July (up to 22.1 percent).
- In critical dry years, total exports would be similar in April, June, August, and September; reduced exports in October through March and May (up to 38.3 percent); and increased exports in July (14.0 percent).

Deliveries to CVP and SWP water users would be similar under Alternative 3 as compared to the Second Basis of Comparison, as summarized in Tables 5.77 and 5.78.

Table 5.77 Changes CVP Water Deliveries under Alternative 3 as Compared to the Second Basis of Comparison

Annual Average Deliveries (TAF)					
				Alternative 3 as Compared to the Second Basis of Comparison	
		Alternative 3	Second Basis of Comparison	Difference	Percent Change
North of Delta					
CVP Agricultural Water Service Contractors	Long Term	209	219	-10	-5
	Dry	111	122	-11	-9
	Critical Dry	31	35	-4	-11

Annual Average Deliveries (TAF)					
				Alternative 3 as Compared to the Second Basis of Comparison	
		Alternative 3	**Second Basis of Comparison**	**Difference**	**Percent Change**
CVP M&I (Including American River Contractors and Contra Costa Water District)	Long Term	392	392	0	0
	Dry	390	390	0	0
	Critical Dry	384	383	2	1
CVP M&I American River Contractors	Long Term	118	120	-2	-2
	Dry	104	105	-1	-1
	Critical Dry	78	79	-2	-3
CVP Sacramento River Settlement Contractors	Long Term	1,860	1,858	2	0
	Dry	1,906	1,905	1	0
	Critical Dry	1,742	1,732	10	1
CVP Refuge Level 2 Deliveries	Long Term	153	155	-1	-1
	Dry	149	151	-2	-1
	Critical Dry	103	105	-2	-2
Total CVP Agricultural, M&I, Sacramento River Settlement Contractors, and Refuge Level 2 Deliveries	Long Term	602	612	-10	0
	Dry	501	512	-12	0
	Critical Dry	415	418	5	0
South of Delta (Does not include Eastside Contractors)					
CVP Agricultural Water Service Contractors	Long Term	1,079	1,100	-20	-2
	Dry	596	650	-55	-8
	Critical Dry	168	195	-28	-14

Annual Average Deliveries (TAF)					
		Alternative 3	Second Basis of Comparison	Alternative 3 as Compared to the Second Basis of Comparison	
				Difference	Percent Change
CVP M&I Users	Long Term	122	125	-2	-2
	Dry	108	109	-1	-1
	Critical Dry	83	85	-2	-2
San Joaquin River Exchange Contractors	Long Term	852	852	0	0
	Dry	875	875	0	0
	Critical Dry	741	741	0	0
CVP Refuge Level 2 Deliveries	Long Term	273	272	1	0
	Dry	281	280	1	0
	Critical Dry	234	232	3	1
Total CVP Agricultural, M&I, San Joaquin River Exchange Contractors, and Refuge Level 2 Deliveries	Long Term	1,202	1,225	-23	-1
	Dry	703	759	-54	-3
	Critical Dry	250	280	-27	-2
Eastside Contractors Deliveries					
Water Rights	Long Term	513	514	-1	0
	Dry	524	524	0	0
	Critical Dry	478	486	-8	-2
CVP Water Service Contracts	Long Term	123	118	5	4
	Dry	109	98	12	12
	Critical Dry	36	25	11	44
Total Water Rights and CVP Service Contracts Deliveries	Long Term	636	632	4	1
	Dry	633	621	11	2
	Critical Dry	514	511	3	1

The following changes in CVP water deliveries would occur under Alternative 3 as compared to the Second Basis of Comparison.

- Deliveries to CVP North of Delta agricultural water service contractors would be reduced by 5 percent over the long-term conditions, 9 percent in dry years, and 11 percent in critical dry years.
- Deliveries to CVP North of Delta M&I contractors (including American River CVP contractors) would be similar in long-term conditions and dry and critical dry years.
- Deliveries to CVP South of Delta agricultural water service contractors would be similar over the long-term conditions and reduced by 8 percent in dry years and 14 percent in critical dry years.
- Deliveries to CVP South of Delta M&I contractors would be similar in long-term conditions and dry and critical dry years.
- Deliveries to the Eastside contractors would be similar under long-term conditions, dry years, and in critical dry years.

Table 5.78 Changes SWP Water Deliveries under Alternative 3 as Compared to the Second Basis of Comparison

Annual Average Deliveries (TAF)					
				Alternative 3 as Compared to the Second Basis of Comparison	
		Alternative 3	Second Basis of Comparison	Difference	Percent Change
North of Delta					
SWP Agricultural Uses	Long Term	0	0	0	0
	Dry	0	0	0	0
	Critical Dry	0	0	0	0
SWP M&I (without Article 21)	Long Term	80	83	-3	-4
	Dry	60	62	-2	-4
	Critical Dry	48	53	-5	-10
SWP M&I Article 21 Deliveries	Long Term	12	12	0	5
	Dry	13	13	0	1
	Critical Dry	12	12	0	3

Annual Average Deliveries (TAF)					
				Alternative 3 as Compared to the Second Basis of Comparison	
		Alternative 3	Second Basis of Comparison	Difference	Percent Change
Total SWP Agricultural and M&I (without Article 21)	Long Term	80	83	-3	-4
	Dry	60	62	-2	-4
	Critical Dry	48	53	-5	-10
Total SWP Agricultural and M&I Article 21 Deliveries	Long Term	12	12	0	5
	Dry	13	13	0	1
	Critical Dry	12	12	0	3
South of Delta					
SWP Agricultural Users (without Article 21)	Long Term	716	750	-34	-4
	Dry	533	567	-34	-6
	Critical Dry	430	484	-54	-11
SWP Agricultural Article 21 Deliveries	Long Term	73	178	-105	-59
	Dry	36	143	-107	-75
	Critical Dry	27	100	-73	-72
SWP M&I Users (without Article 21)	Long Term	2,106	2,183	-77	-4
	Dry	1,649	1,732	-83	-5
	Critical Dry	1,340	1,494	-154	-10
SWP M&I Article 21 Deliveries	Long Term	33	104	-71	-68
	Dry	11	86	-75	-87
	Critical Dry	10	58	-48	-83

Annual Average Deliveries (TAF)					
				Alternative 3 as Compared to the Second Basis of Comparison	
		Alternative 3	**Second Basis of Comparison**	**Difference**	**Percent Change**
Total SWP Agricultural and M&I Users (without Article 21)	Long Term	2,822	2,933	-111	-4
	Dry	2,182	2,299	-117	-5
	Critical Dry	1,770	1,978	-208	-11
Total SWP Agricultural and M&I Article 21 Deliveries	Long Term	106	282	-176	-62
	Dry	47	229	-182	-80
	Critical Dry	38	158	-120	-76

The following changes in SWP water deliveries would occur under Alternative 3 as compared to the Second Basis of Comparison.

- Deliveries without Article 21 water to SWP North of Delta water contractors would be similar over the long-term conditions and in dry years and reduced by 10 percent in critical dry years.
- Deliveries without Article 21 water to SWP South of Delta water contractors would be similar over the long-term conditions and in dry years and reduced by 11 percent in critical dry years.
- Deliveries of Article 21 water to SWP North of Delta water contractors would be similar over the long-term conditions and in dry and critical dry years.
- Deliveries of Article 21 water to SWP South of Delta water contractors would be reduced by 62 percent over the long-term conditions; 80 percent in dry years; and 76 percent in critical dry years.

Effects Related to Cross Delta Water Transfers

Potential effects to surface water resources could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014i). Potential effects were identified as reduced surface water storage in upstream reservoirs and changes in flow patterns in river downstream of the reservoirs if water was released from the reservoirs in patterns that were different than would have been used by the water seller's. Because all water transfers would be required to avoid adverse impacts to other water users and biological resources (see Section 3.A.6.3, Transfers), including impacts associated with changes in reservoir storage and river flow patterns, the analysis indicated that water transfers would not result in substantial changes in storage or river flows. For the purposes of this EIS, it is anticipated that similar conditions would occur due to cross Delta water transfers under Alternative 3 and the Second Basis of Comparison.

Under Alternative 3 and the Second Basis of Comparison, water could be transferred throughout the year. As indicated in Table 5.76, capacity would be available under Alternative 3 and the Second Basis of Comparison in a similar manner in all months of all water year types.

San Francisco Bay Area, Central Coast, and Southern California Regions

Potential Changes in Surface Water Resources at Reservoirs that Store CVP and SWP Water

The San Francisco Bay Area, Central Coast, and Southern California regions include numerous reservoirs that store CVP and SWP water supplies, including CVP and SWP reservoirs, that primarily provide water supplies for M&I water users. Changes in the availability CVP and SWP water supplies for storage in these reservoirs under Alternative 3 as compared to the Second Basis of Comparison would be consistent with the following changes in water deliveries to M&I water users, as summarized in Tables 5.77 and 5.78.

- Deliveries to CVP South of Delta M&I contractors would be similar in long-term conditions and dry and critical dry years.
- Deliveries without Article 21 water to SWP South of Delta water contractors would be similar over the long-term conditions and in dry years and reduced by 11 percent in critical dry years.
- Deliveries of Article 21 water to SWP South of Delta water contractors would be reduced by 62 percent over the long-term conditions, 80 percent in dry years, and 76 percent in critical dry years.

Changes in CVP and SWP Exports and Deliveries

Deliveries to CVP and SWP water users are described above in the Central Valley Region.

5.4.3.5 Alternative 4

Surface water resources conditions under Alternative 4 would be identical to the surface water resources conditions under the Second Basis of Comparison; therefore, Alternative 4 is only compared to the No Action Alternative.

5.4.3.5.1 Alternative 4 Compared to the No Action Alternative

Changes in surface water resources under Alternative 4 as compared to the No Action Alternative would be the same as the impacts described in Section 5.4.3.2.1, Alternative 1 Compared to the No Action Alternative.

5.4.3.6 Alternative 5

CVP and SWP operations under Alternative 5 are similar to the No Action Alternative with modified Old and Middle River flow criteria and New Melones Reservoir operations. Alternative 5 would include changed water demands for American River water supplies as compared to the No Action Alternative or Second Basis of Comparison. Alternative 5 would provide water supplies of up to 17 TAF per year under a Warren Act Contract for El Dorado Irrigation District and 15 TAF per year under a CVP water service contract for El Dorado County Water Agency. These demands are not included in the analysis presented in this section of the EIS. A sensitivity analysis comparing the results of the analysis with and without these demands is presented in Appendix 5B of this EIS.

5.4.3.6.1 Alternative 5 Compared to the No Action Alternative

Trinity River Region

Changes in CVP and SWP Reservoir Storage and Downstream River Flows

Changes in Trinity Lake storage and surface water elevations under Alternative 5 as compared to the No Action Alternative are summarized in Tables 5.79 and 5.80. The results are summarized following Table 5.80.

Table 5.79 Changes in Trinity Lake Storage under Alternative 5 as Compared to the No Action Alternative

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 5												
Wet	1,494	1,520	1,635	1,759	1,926	2,056	2,222	2,246	2,191	2,068	1,940	1,781
Above Normal	1,155	1,180	1,290	1,459	1,662	1,850	2,030	2,004	1,912	1,778	1,627	1,503
Below Normal	1,398	1,405	1,422	1,493	1,580	1,667	1,813	1,741	1,637	1,474	1,311	1,190
Dry	1,155	1,150	1,175	1,183	1,275	1,404	1,540	1,492	1,415	1,259	1,110	1,012
Critical Dry	744	726	741	743	784	866	913	878	856	755	622	539
No Action Alternative												
Wet	1,490	1,516	1,630	1,756	1,921	2,053	2,220	2,245	2,190	2,067	1,939	1,784
Above Normal	1,159	1,178	1,286	1,455	1,658	1,847	2,025	1,999	1,907	1,773	1,619	1,495
Below Normal	1,393	1,400	1,417	1,488	1,575	1,662	1,817	1,743	1,637	1,470	1,304	1,185
Dry	1,152	1,148	1,174	1,182	1,274	1,403	1,539	1,490	1,413	1,253	1,104	1,008
Critical Dry	747	731	746	750	790	872	923	888	862	745	612	536
Alternative 5 as Compared to No Action Alternative												
Wet	4	3	5	4	4	2	2	2	2	0	0	-2
Above Normal	-4	2	4	4	4	4	6	6	5	5	8	8
Below Normal	5	5	5	5	5	5	-5	-2	0	4	7	4
Dry	3	1	1	1	1	1	1	1	2	6	6	4
Critical Dry	-2	-5	-4	-7	-6	-6	-10	-10	-7	10	11	3
Alternative 5 as Compared to No Action Alternative (percent change)												
Wet	0.2	0.2	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.0	0.0	-0.1
Above Normal	-0.4	0.2	0.3	0.3	0.2	0.2	0.3	0.3	0.3	0.3	0.5	0.5
Below Normal	0.4	0.4	0.4	0.3	0.3	0.3	-0.3	-0.1	0.0	0.3	0.5	0.4
Dry	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.5	0.5	0.4
Critical Dry	-0.3	-0.6	-0.6	-0.9	-0.7	-0.7	-1.1	-1.1	-0.8	1.3	1.8	0.5

Table 5.80 Changes in Trinity Lake Elevation under Alternative 5 as Compared to the No Action Alternative

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 5												
Wet	2,300	2,303	2,313	2,325	2,338	2,347	2,357	2,358	2,355	2,347	2,338	2,326
Above Normal	2,259	2,262	2,276	2,294	2,314	2,330	2,343	2,342	2,335	2,326	2,313	2,303
Below Normal	2,289	2,290	2,292	2,299	2,308	2,315	2,326	2,321	2,313	2,299	2,284	2,272
Dry	2,263	2,265	2,268	2,269	2,279	2,292	2,305	2,301	2,294	2,279	2,265	2,254
Critical Dry	2,209	2,206	2,209	2,212	2,220	2,234	2,241	2,237	2,235	2,221	2,199	2,183
No Action Alternative												
Wet	2,300	2,303	2,313	2,324	2,338	2,347	2,357	2,358	2,355	2,347	2,338	2,327
Above Normal	2,261	2,264	2,276	2,294	2,314	2,330	2,343	2,341	2,335	2,325	2,313	2,302
Below Normal	2,289	2,289	2,291	2,299	2,307	2,315	2,327	2,321	2,313	2,299	2,283	2,272
Dry	2,263	2,265	2,268	2,269	2,279	2,292	2,305	2,301	2,294	2,279	2,264	2,254
Critical Dry	2,210	2,207	2,210	2,213	2,220	2,235	2,242	2,238	2,235	2,220	2,196	2,182
Alternative 5 as Compared to No Action Alternative												
Wet	0	0	0	0	0	0	0	0	0	0	0	0
Above Normal	-2	-2	0	0	0	0	0	0	0	0	1	1
Below Normal	1	1	1	1	1	0	0	0	0	0	1	0
Dry	1	0	0	0	0	0	0	0	0	0	1	1
Critical Dry	0	-1	-1	-1	-1	-1	-1	-1	-1	2	3	1
Alternative 5 as Compared to No Action Alternative (percent change)												
Wet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Above Normal	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Below Normal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Critical Dry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1

Trinity Lake storage and surface water elevations would be similar in all months and all water year types under Alternative 5 as compared to the No Action Alternative.

Trinity River flows would be similar in all months under long-term conditions and wet and dry years, as shown on Figures 5.53 through 5.55.Central Valley Region

Changes in CVP and SWP Reservoir Storage and Downstream River Flows

Shasta Lake and Sacramento River

Storage levels and surface water elevations in Shasta Lake under Alternative 5 as compared to the No Action Alternative are summarized in Tables 5.81 and 5.82. Changes in flows in the Sacramento River downstream of Keswick Dam and at Freeport are shown on Figures 5.56 through 5.61. The results are summarized following Table 5.82.

Table 5.81 Changes in Shasta Lake Storage under Alternative 5 as Compared to the No Action Alternative

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 5												
Wet	2,704	2,716	3,078	3,385	3,590	3,836	4,299	4,461	4,243	3,736	3,410	2,989
Above Normal	2,369	2,388	2,598	3,164	3,454	4,019	4,401	4,430	4,042	3,409	3,071	2,842
Below Normal	2,603	2,565	2,704	3,077	3,450	3,820	4,039	3,970	3,602	3,012	2,663	2,620
Dry	2,344	2,287	2,433	2,627	3,039	3,509	3,745	3,699	3,315	2,787	2,497	2,459
Critical Dry	1,676	1,611	1,700	1,856	2,015	2,258	2,203	2,104	1,749	1,246	958	910
No Action Alternative												
Wet	2,700	2,719	3,077	3,384	3,589	3,836	4,298	4,460	4,242	3,735	3,410	2,985
Above Normal	2,369	2,385	2,600	3,167	3,453	4,021	4,404	4,429	4,039	3,407	3,069	2,834
Below Normal	2,587	2,548	2,686	3,062	3,442	3,814	4,026	3,957	3,588	3,002	2,643	2,608
Dry	2,345	2,283	2,428	2,621	3,034	3,505	3,737	3,668	3,284	2,767	2,496	2,462
Critical Dry	1,702	1,633	1,717	1,871	2,031	2,274	2,202	2,088	1,719	1,253	986	937
Alternative 5 as Compared to No Action Alternative												
Wet	4	-3	1	1	0	0	1	1	1	0	0	4
Above Normal	0	4	-2	-3	0	-1	-3	2	3	2	2	8
Below Normal	16	16	18	16	8	6	13	13	14	10	20	12
Dry	-1	4	5	6	5	4	8	31	31	20	1	-3
Critical Dry	-25	-22	-17	-15	-16	-16	1	16	31	-7	-28	-26
Alternative 5 as Compared to No Action Alternative (percent change)												
Wet	0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Above Normal	0.0	0.2	-0.1	-0.1	0.0	0.0	-0.1	0.0	0.1	0.1	0.1	0.3
Below Normal	0.6	0.6	0.7	0.5	0.2	0.2	0.3	0.3	0.4	0.3	0.8	0.5
Dry	0.0	0.2	0.2	0.2	0.2	0.1	0.2	0.8	0.9	0.7	0.0	-0.1
Critical Dry	-1.5	-1.3	-1.0	-0.8	-0.8	-0.7	0.0	0.8	1.8	-0.6	-2.8	-2.8

Table 5.82 Changes in Shasta Lake Elevation under Alternative 5 as Compared to the No Action Alternative

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 5												
Wet	991	992	1,008	1,023	1,031	1,041	1,058	1,064	1,056	1,037	1,024	1,005
Above Normal	967	968	982	1,012	1,025	1,048	1,062	1,063	1,049	1,024	1,009	999
Below Normal	987	985	992	1,009	1,025	1,040	1,048	1,045	1,031	1,006	990	988
Dry	969	967	975	986	1,006	1,027	1,037	1,035	1,019	996	982	980
Critical Dry	925	921	928	938	950	967	965	959	937	899	874	869
No Action Alternative												
Wet	991	992	1,008	1,023	1,031	1,041	1,058	1,064	1,056	1,037	1,024	1,005
Above Normal	967	968	982	1,012	1,025	1,048	1,062	1,063	1,049	1,024	1,009	999
Below Normal	986	985	991	1,009	1,025	1,040	1,048	1,045	1,031	1,006	989	987
Dry	969	967	975	986	1,006	1,027	1,037	1,034	1,018	995	982	980
Critical Dry	927	923	929	939	951	968	965	958	935	899	876	872
Alternative 5 as Compared to No Action Alternative												
Wet	0	0	0	0	0	0	0	0	0	0	0	0
Above Normal	0	0	0	0	0	0	0	0	0	0	0	0
Below Normal	1	1	1	1	0	0	1	1	1	0	1	1
Dry	0	0	0	0	0	0	0	1	1	1	0	0
Critical Dry	-2	-2	-1	-1	-1	-1	0	1	3	-1	-2	-2
Alternative 5 as Compared to No Action Alternative (percent change)												
Wet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Above Normal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Below Normal	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.0	0.1	0.1
Dry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0
Critical Dry	-0.2	-0.2	-0.2	-0.1	-0.1	-0.1	0.0	0.1	0.3	-0.1	-0.3	-0.3

Shasta Lake storage and surface water elevations would be similar in all months and all water year types under Alternative 5 as compared to the No Action Alternative.

The following changes in Sacramento River flows would occur under Alternative 5 as compared to the No Action Alternative, as shown on Figures 5.56 through 5.61.

- Sacramento River flows downstream of Keswick Dam (Figures 5.56 through 5.58) would be similar over the long-term conditions and in wet and dry years.
- Sacramento River near Freeport (near the northern boundary of the Delta) (Figures 5.59 through 5.61) would be similar over the long-term conditions and in wet and dry years.

Lake Oroville and Feather River

Storage levels and surface water elevations in Lake Oroville under Alternative 5 as compared to the No Action Alternative are summarized in Tables 5.83 and 5.84. Changes in flows in the Feather River downstream of Thermalito Complex are shown on Figures 5.62 through 5.64. The results are summarized following Table 5.84.

Table 5.83 Changes in Lake Oroville Storage under Alternative 5 as Compared to the No Action Alternative

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 5												
Wet	1,681	1,723	2,179	2,556	2,833	2,942	3,300	3,488	3,447	2,961	2,613	2,103
Above Normal	1,275	1,310	1,471	1,948	2,512	2,892	3,247	3,401	3,241	2,608	2,125	1,668
Below Normal	1,552	1,507	1,517	1,728	2,132	2,406	2,663	2,746	2,569	1,959	1,521	1,305
Dry	1,223	1,173	1,190	1,319	1,595	1,952	2,193	2,255	1,992	1,502	1,295	1,150
Critical Dry	1,102	1,037	1,025	1,114	1,229	1,383	1,415	1,411	1,266	1,045	929	873
No Action Alternative												
Wet	1,691	1,732	2,189	2,554	2,832	2,942	3,300	3,488	3,445	2,964	2,626	2,109
Above Normal	1,279	1,322	1,485	1,959	2,519	2,892	3,247	3,393	3,232	2,600	2,117	1,659
Below Normal	1,542	1,497	1,507	1,719	2,122	2,397	2,653	2,714	2,530	1,923	1,513	1,307
Dry	1,206	1,158	1,177	1,305	1,582	1,938	2,178	2,210	1,951	1,478	1,287	1,144
Critical Dry	1,092	1,029	1,019	1,108	1,223	1,381	1,408	1,392	1,243	1,018	917	865
Alternative 5 as Compared to No Action Alternative												
Wet	-10	-9	-10	1	1	0	0	0	2	-3	-13	-7
Above Normal	-3	-12	-14	-11	-7	0	0	8	9	8	8	9
Below Normal	10	10	10	9	10	10	10	32	39	36	8	-1
Dry	17	15	13	13	13	13	15	45	41	23	8	6
Critical Dry	10	9	6	6	6	3	7	19	22	27	12	8
Alternative 5 as Compared to No Action Alternative (percent change)												
Wet	-0.6	-0.5	-0.4	0.0	0.0	0.0	0.0	0.0	0.1	-0.1	-0.5	-0.3
Above Normal	-0.3	-0.9	-0.9	-0.6	-0.3	0.0	0.0	0.2	0.3	0.3	0.4	0.5
Below Normal	0.6	0.7	0.7	0.5	0.5	0.4	0.4	1.2	1.6	1.9	0.6	-0.1
Dry	1.4	1.3	1.1	1.0	0.8	0.7	0.7	2.0	2.1	1.6	0.6	0.5
Critical Dry	0.9	0.8	0.6	0.6	0.5	0.2	0.5	1.3	1.8	2.6	1.3	1.0

Table 5.84 Changes in Lake Oroville Elevation under Alternative 5 as Compared to the No Action Alternative

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 5												
Wet	742	746	793	829	852	859	884	897	894	860	835	789
Above Normal	698	701	720	775	827	856	880	891	880	836	795	747
Below Normal	731	726	728	752	794	818	839	845	831	777	730	704
Dry	691	685	688	706	738	777	799	804	779	727	703	685
Critical Dry	676	668	665	679	694	712	716	715	696	667	650	642
No Action Alternative												
Wet	743	748	794	829	852	859	884	897	894	861	836	790
Above Normal	698	703	722	776	828	856	880	890	879	835	794	746
Below Normal	730	725	726	751	793	818	838	842	828	773	729	704
Dry	688	683	686	704	737	775	798	800	775	724	702	684
Critical Dry	674	667	664	678	693	712	715	712	693	663	648	640
Alternative 5 as Compared to No Action Alternative												
Wet	-1	-1	-1	0	0	0	0	0	0	0	-1	-1
Above Normal	0	-1	-2	-1	-1	0	0	1	1	1	1	1
Below Normal	1	1	2	1	1	1	1	2	3	4	1	0
Dry	3	2	2	2	1	1	1	4	4	3	1	1
Critical Dry	2	1	1	1	1	0	1	2	3	4	2	2
Alternative 5 as Compared to No Action Alternative (percent change)												
Wet	-0.2	-0.2	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1
Above Normal	0.0	-0.2	-0.2	-0.1	-0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1
Below Normal	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.3	0.4	0.5	0.1	0.0
Dry	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.5	0.5	0.4	0.2	0.2
Critical Dry	0.2	0.2	0.2	0.2	0.1	0.0	0.1	0.3	0.4	0.6	0.4	0.3

Lake Oroville storage and surface water elevations would be similar in all months and all water year types under Alternative 5 as compared to the No Action Alternative.

The following changes in Feather River flows would occur under Alternative 5 as compared to the No Action Alternative, as shown on Figures 5.62 through 5.64.

- Over long-term conditions, similar flows would occur in June through April and reduced flows in May (6.6 percent).
- In wet years, similar flows would occur in all months.
- In dry years, similar flows would occur in September through April and June; reduced flows in May (27.1 percent) and increased flows in July and August (up to 8.9 percent).

Folsom Lake and American River

Storage levels and surface water elevations in Folsom Lake under Alternative 5 as compared to the No Action Alternative are summarized in Tables 5.85 and 5.86. Changes in flows in the American River downstream of Nimbus Dam are shown on Figures 5.65 through 5.67. The results are summarized following Table 5.86.

Table 5.85 Changes in Folsom Lake Storage under Alternative 5 as Compared to the No Action Alternative

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 5												
Wet	454	435	515	518	515	632	785	952	941	794	710	577
Above Normal	375	379	428	513	532	640	787	946	888	622	554	478
Below Normal	440	425	461	483	534	620	758	845	783	523	469	450
Dry	397	386	411	426	479	579	691	766	664	489	435	410
Critical Dry	325	304	314	320	367	433	483	499	411	324	257	231
No Action Alternative												
Wet	454	435	514	518	515	632	785	951	941	800	712	576
Above Normal	377	380	429	513	531	640	787	946	887	621	552	477
Below Normal	446	431	467	484	533	619	757	843	780	527	472	453
Dry	394	383	408	423	479	579	691	760	658	495	443	419
Critical Dry	324	305	315	320	366	432	475	486	415	327	267	231
Alternative 5 as Compared to No Action Alternative												
Wet	0	0	0	0	0	0	0	1	0	-6	-2	1
Above Normal	-2	-1	-1	1	1	0	0	0	1	1	2	1
Below Normal	-6	-7	-6	-2	0	0	0	2	3	-4	-3	-3
Dry	3	3	3	2	0	0	0	6	6	-5	-8	-9
Critical Dry	1	-1	0	0	0	0	8	13	-4	-3	-10	0
Alternative 5 as Compared to No Action Alternative (percent change)												
Wet	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	-0.8	-0.2	0.2
Above Normal	-0.7	-0.4	-0.2	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.4	0.3
Below Normal	-1.4	-1.5	-1.3	-0.3	0.0	0.1	0.1	0.3	0.4	-0.7	-0.6	-0.7
Dry	0.7	0.8	0.6	0.5	0.0	0.0	0.0	0.8	0.8	-1.1	-1.9	-2.1
Critical Dry	0.2	-0.2	-0.1	0.0	0.1	0.1	1.7	2.8	-0.9	-0.9	-3.9	0.2

Table 5.86 Changes in Folsom Lake Elevation under Alternative 5 as Compared to the No Action Alternative

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 5												
Wet	409	407	418	418	418	432	448	465	464	449	440	425
Above Normal	394	395	405	418	420	433	449	464	458	431	423	413
Below Normal	406	405	410	413	420	431	445	454	447	417	411	408
Dry	400	400	404	406	413	426	438	446	435	413	406	403
Critical Dry	386	384	389	390	396	406	412	414	400	385	370	365
No Action Alternative												
Wet	409	407	418	418	418	432	448	464	464	449	440	425
Above Normal	394	395	405	418	420	433	449	464	458	430	422	413
Below Normal	408	406	411	414	420	431	445	454	447	418	411	409
Dry	400	399	403	405	413	426	438	445	434	414	408	405
Critical Dry	386	384	389	390	396	406	411	412	401	386	374	366
Alternative 5 as Compared to No Action Alternative												
Wet	0	0	0	0	0	0	0	0	0	-1	0	0
Above Normal	-1	0	0	0	0	0	0	0	0	0	0	0
Below Normal	-2	-2	-1	0	0	0	0	0	0	-1	0	0
Dry	0	0	0	0	0	0	0	1	1	-1	-2	-2
Critical Dry	0	0	0	0	0	0	1	2	-1	-2	-3	0
Alternative 5 as Compared to No Action Alternative (percent change)												
Wet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0
Above Normal	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Below Normal	-0.5	-0.4	-0.3	-0.1	0.0	0.0	0.0	0.0	0.1	-0.1	-0.1	-0.1
Dry	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.1	0.1	-0.3	-0.5	-0.5
Critical Dry	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	-0.2	-0.4	-0.9	-0.1

Folsom Lake storage and surface water elevations would be similar in all months and all water year types under Alternative 5 as compared to the No Action Alternative.

American River flows would be similar over long-term conditions and in wet and dry years in all months under Alternative 5 as compared to the No Action Alternative, as shown on Figures 5.65 through 5.67.

Clear Creek

Monthly Clear Creek flows under Alternative 5 are identical to flows under the No Action Alternative, as summarized in Table 5.87.

Table 5.87 Changes in Clear Creek Flows below Whiskeytown Dam under Alternative 5 as Compared to the No Action Alternative

Water Year	Average Monthly Flow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 5												
Wet	200	200	200	309	356	272	200	277	200	85	85	150
Above Normal	181	182	188	192	196	196	196	277	200	85	85	150
Below Normal	195	195	195	195	195	195	195	274	191	85	85	150
Dry	175	184	188	190	190	190	190	267	183	85	85	150
Critical Dry	163	167	167	167	167	167	167	214	111	85	85	133
No Action Alternative												
Wet	200	200	200	309	356	272	200	277	200	85	85	150
Above Normal	181	182	188	192	196	196	196	277	200	85	85	150
Below Normal	195	195	195	195	195	195	195	274	191	85	85	150
Dry	177	184	188	190	190	190	190	267	183	85	85	150
Critical Dry	163	167	167	167	167	167	167	214	111	85	85	133
Alternative 5 as Compared to No Action Alternative												
Wet	0	0	0	0	0	0	0	0	0	0	0	0
Above Normal	0	0	0	0	0	0	0	0	0	0	0	0
Below Normal	0	0	0	0	0	0	0	0	0	0	0	0
Dry	2	0	0	0	0	0	0	0	0	0	0	0
Critical Dry	0	0	0	0	0	0	0	0	0	0	0	0
Alternative 5 as Compared to No Action Alternative (percent change)												
Wet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Above Normal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Below Normal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dry	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Critical Dry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0

New Melones Reservoir and Stanislaus River

Storage levels and surface water elevations in New Melones Reservoir under Alternative 5 as compared to the No Action Alternative are summarized in Tables 5.88 and 5.89. Changes in flows in the Stanislaus River downstream of Goodwin Dam are shown on Figures 5.68 through 5.70. The results are summarized following Table 5.89.

Table 5.88 Changes in New Melones Reservoir Storage under Alternative 5 as Compared to the No Action Alternative

Water Year	End of Month Storage (TAF)											
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Alternative 5												
Wet	1,309	1,321	1,388	1,496	1,602	1,668	1,704	1,812	1,906	1,833	1,722	1,653
Above Normal	983	1,014	1,079	1,168	1,271	1,361	1,363	1,413	1,396	1,302	1,207	1,162
Below Normal	1,210	1,220	1,242	1,267	1,329	1,354	1,298	1,276	1,254	1,163	1,071	1,028
Dry	1,018	1,018	1,030	1,045	1,081	1,114	1,066	1,031	990	903	823	781
Critical Dry	558	559	570	578	597	591	506	449	433	391	355	336
No Action Alternative												
Wet	1,379	1,390	1,454	1,562	1,666	1,724	1,758	1,878	1,968	1,890	1,773	1,703
Above Normal	1,029	1,060	1,125	1,214	1,317	1,406	1,413	1,484	1,467	1,372	1,277	1,232
Below Normal	1,294	1,305	1,326	1,351	1,413	1,438	1,390	1,383	1,359	1,268	1,175	1,133
Dry	1,094	1,094	1,106	1,121	1,156	1,188	1,154	1,132	1,087	997	914	871
Critical Dry	624	623	638	645	661	656	602	554	526	476	431	408
Alternative 5 as Compared to No Action Alternative												
Wet	-70	-69	-65	-66	-64	-56	-54	-65	-62	-57	-51	-49
Above Normal	-46	-46	-46	-46	-46	-46	-51	-71	-71	-70	-70	-70
Below Normal	-84	-84	-84	-84	-84	-84	-93	-107	-106	-105	-105	-104
Dry	-77	-76	-76	-76	-75	-74	-88	-100	-97	-94	-91	-89
Critical Dry	-66	-64	-68	-66	-64	-65	-95	-105	-93	-84	-76	-73
Alternative 5 as Compared to No Action Alternative (percent change)												
Wet	-5.1	-5.0	-4.5	-4.2	-3.9	-3.2	-3.1	-3.5	-3.2	-3.0	-2.9	-2.9
Above Normal	-4.5	-4.4	-4.1	-3.8	-3.5	-3.3	-3.6	-4.8	-4.8	-5.1	-5.5	-5.7
Below Normal	-6.5	-6.5	-6.4	-6.2	-5.9	-5.8	-6.7	-7.7	-7.8	-8.3	-8.9	-9.2
Dry	-7.0	-7.0	-6.9	-6.8	-6.5	-6.2	-7.6	-8.9	-8.9	-9.4	-10.0	-10.2
Critical Dry	-10.5	-10.3	-10.6	-10.3	-9.8	-9.9	-15.8	-18.9	-17.6	-17.7	-17.7	-17.8

Table 5.89 Changes in New Melones Reservoir Elevation under Alternative 5 as Compared to the No Action Alternative

Water Year	End of Month Elevation (Feet)											
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Alternative 5												
Wet	969	971	980	995	1,007	1,016	1,020	1,031	1,040	1,033	1,022	1,015
Above Normal	924	930	939	954	968	980	982	988	987	975	963	890
Below Normal	954	956	959	962	973	977	972	970	968	957	944	938
Dry	930	930	932	934	939	945	940	936	931	918	905	898
Critical Dry	837	838	842	845	853	855	834	818	815	804	796	791
No Action Alternative												
Wet	980	982	990	1,004	1,016	1,023	1,026	1,039	1,047	1,040	1,029	1,022
Above Normal	932	937	945	960	974	986	988	997	996	985	973	897
Below Normal	968	969	972	975	985	988	985	985	983	972	960	955
Dry	943	943	944	947	951	957	955	953	948	934	922	915
Critical Dry	856	856	862	864	870	871	860	848	840	828	818	812
Alternative 5 as Compared to No Action Alternative												
Wet	-11	-11	-10	-9	-8	-7	-7	-7	-7	-7	-6	-6
Above Normal	-8	-7	-6	-6	-6	-6	-6	-8	-8	-9	-10	-7
Below Normal	-13	-13	-13	-13	-12	-12	-13	-15	-15	-15	-16	-16
Dry	-13	-13	-12	-13	-12	-12	-15	-17	-17	-17	-17	-17
Critical Dry	-19	-18	-20	-19	-17	-16	-26	-30	-25	-24	-22	-21
Alternative 5 as Compared to No Action Alternative (percent change)												
Wet	-1.2	-1.2	-1.0	-0.9	-0.8	-0.7	-0.7	-0.7	-0.7	-0.6	-0.6	-0.6
Above Normal	-0.8	-0.7	-0.7	-0.6	-0.6	-0.6	-0.6	-0.8	-0.8	-0.9	-1.0	-0.7
Below Normal	-1.4	-1.4	-1.4	-1.3	-1.2	-1.2	-1.3	-1.5	-1.5	-1.6	-1.7	-1.7
Dry	-1.3	-1.3	-1.3	-1.3	-1.3	-1.2	-1.5	-1.8	-1.8	-1.8	-1.9	-1.9
Critical Dry	-2.2	-2.1	-2.3	-2.2	-2.0	-1.9	-3.0	-3.5	-3.0	-2.9	-2.7	-2.6

The following changes in New Melones Reservoir storage and elevation would occur under Alternative 5 as compared to the No Action Alternative.

- In wet years, storage would be similar in all months.
- In above normal years, storage would be similar in October through June and reduced in July through September (up to 5.7 percent).
- In below normal years, storage would be reduced in all months (up to 9.2 percent).
- In dry years, storage would be reduced in all months (up to 10.2 percent).
- In critical dry years, storage would be reduced in all months (up to 18.9 percent).
- In all months, in all water year types, surface water elevations would be similar.

Flows in the Stanislaus River downstream of Goodwin Dam are shown on Figures 5.68 to 5.70. Changes in flows in these rivers are summarized below.

- Over long-term conditions, flows would be similar in September through February and June; reduced flows would occur in March, July, and August (up to 8.0 percent); and increased flows in April and May (up to 22.4 percent).
- In wet years, similar flows would occur in October, November, January, February, and April through June and reduced flows in December, March, and July through September (up to 18.0 percent).
- In dry years, similar flows would occur in June through March and increased flows in April and May (up to 47.3 percent).

San Joaquin River at Vernalis

Flows in the San Joaquin River at Vernalis under Alternative 5 as compared to the No Action Alternative are summarized below, as shown on Figures 5.71 through 5.73.

- Over long-term conditions and wet years, similar flows would occur in all months.
- In dry years, similar flows would occur in June through March and increased flows in April and May (up to 15.7 percent).San Luis Reservoir.

Storage levels and surface water elevations in San Luis Reservoir under Alternative 5 as compared to the No Action Alternative are summarized in Tables 5.90 and 5.91. The results are summarized following Table 5.91.

Table 5.90 Changes in San Luis Reservoir Storage under Alternative 5 as Compared to the No Action Alternative

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 5												
Wet	576	706	958	1,251	1,539	1,804	1,624	1,279	984	787	680	726
Above Normal	488	622	932	1,213	1,440	1,660	1,447	1,046	672	477	442	520
Below Normal	541	628	923	1,157	1,335	1,496	1,305	928	524	476	414	463
Dry	464	572	856	1,139	1,327	1,481	1,324	1,002	691	655	412	418
Critical Dry	429	505	698	994	1,166	1,216	1,103	875	600	428	284	270
No Action Alternative												
Wet	555	681	931	1,236	1,526	1,788	1,598	1,251	946	741	628	679
Above Normal	490	649	957	1,223	1,441	1,661	1,444	1,048	666	466	433	513
Below Normal	525	624	907	1,141	1,314	1,473	1,312	967	555	500	426	467
Dry	476	590	867	1,150	1,339	1,494	1,413	1,167	840	763	476	469
Critical Dry	478	556	752	1,040	1,204	1,252	1,192	1,028	739	544	343	323
Alternative 5 as Compared to No Action Alternative												
Wet	20	25	27	15	13	16	26	28	38	46	52	47
Above Normal	-2	-27	-24	-10	-2	-1	3	-2	6	10	8	7
Below Normal	16	4	16	17	21	23	-7	-39	-31	-24	-12	-4
Dry	-12	-18	-11	-11	-12	-13	-89	-165	-149	-107	-64	-51
Critical Dry	-50	-51	-53	-46	-38	-36	-89	-154	-140	-116	-59	-53
Alternative 5 as Compared to No Action Alternative (percent change)												
Wet	7.4	6.9	5.8	1.8	1.2	1.2	2.3	3.5	6.7	8.4	10.0	9.1
Above Normal	1.2	-3.0	-1.4	0.3	1.4	1.1	1.6	0.7	2.3	2.5	2.3	2.0
Below Normal	8.3	4.4	6.8	5.1	3.3	2.9	-0.6	-5.1	-9.2	-9.0	-3.1	-1.3
Dry	-0.4	-1.0	0.6	0.4	0.2	-0.1	-6.5	-14.6	-17.3	-12.7	-13.5	-12.3
Critical Dry	-12.6	-13.9	-10.4	-6.3	-4.3	-3.5	-7.1	-13.0	-15.6	-18.2	-17.6	-16.9

Table 5.91 Changes in San Luis Reservoir Elevation under Alternative 5 as Compared to the No Action Alternative

Water Year	**End of Month Storage (TAF)**											
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Alternative 5												
Wet	402	417	446	475	501	525	509	478	448	427	416	422
Above Normal	391	408	443	471	492	512	494	456	416	390	386	398
Below Normal	399	411	443	467	483	498	481	444	397	390	381	388
Dry	389	404	436	465	483	497	482	451	417	413	381	381
Critical Dry	383	393	417	450	467	471	460	437	405	383	359	357
No Action Alternative												
Wet	399	414	443	473	500	523	507	475	444	422	409	416
Above Normal	391	411	445	472	492	512	493	456	415	389	386	398
Below Normal	397	410	442	465	481	496	481	448	400	393	383	389
Dry	391	406	437	466	484	498	490	468	434	426	390	389
Critical Dry	390	400	423	454	470	475	469	453	422	399	369	366
Alternative 5 as Compared to No Action Alternative												
Wet	3	3	3	1	1	1	2	3	4	5	6	6
Above Normal	**0**	**-3**	**-2**	**-1**	**0**	**0**	0	**0**	1	1	1	1
Below Normal	2	1	2	2	2	2	**-1**	**-4**	**-3**	**-3**	**-2**	**-1**
Dry	**-2**	**-2**	**-1**	**-1**	**-1**	**-1**	**-8**	**-16**	**-17**	**-13**	**-9**	**-7**
Critical Dry	**-7**	**-7**	**-6**	**-4**	**-3**	**-3**	**-9**	**-16**	**-18**	**-16**	**-10**	**-9**
Alternative 5 as Compared to No Action Alternative (percent change)												
Wet	0.6	0.7	0.6	0.3	0.2	0.3	0.4	0.6	0.9	1.2	1.5	1.3
Above Normal	-0.1	-0.7	-0.5	-0.2	0.0	0.0	0.1	0.0	0.2	0.3	0.2	0.2
Below Normal	0.4	0.2	0.4	0.3	0.4	0.4	-0.1	-0.9	-0.9	-0.7	-0.4	-0.1
Dry	-0.4	-0.5	-0.3	-0.2	-0.2	-0.2	-1.6	-3.5	-3.9	-2.9	-2.3	-1.9
Critical Dry	-1.8	-1.6	-1.4	-0.9	-0.7	-0.7	-1.9	-3.6	-4.2	-4.1	-2.7	-2.4

The following changes in San Luis Reservoir storage would occur under Alternative 5 as compared to the No Action Alternative.

- In wet years, storage would be similar in January through May and increased in June through December (up to 10.0 percent).
- In above-normal years, storage would be similar in all months.
- In below-normal years, storage would be similar in November, February through April, August, and September; reduced in June and July (up to 9.2 percent); and increased in October, December, January, and May (up to 8.3 percent).
- In dry years, storage would be similar in October through March and reduced in April through September (up to 17.3 percent).
- In critical dry years, storage would be similar in February and March; and reduced in April through January (up to 18.2 percent).
- Surface water elevations would be similar in all months, in all water years.

Changes in Flows into the Yolo Bypass

Flows from the Sacramento River into the Yolo Bypass at Fremont Weir under Alternative 5 as compared to the No Action Alternative are summarized in Table 5.92. The results are summarized following Table 5.92.

Table 5.92 Changes in Flows into the Yolo Bypass at Fremont Weir under Alternative 5 as Compared to the No Action Alternative

Water Year	Average Monthly Flow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 5												
Wet	170	933	8,400	24,048	29,507	18,512	5,627	289	113	0	0	100
Above Normal	100	100	2,786	6,000	12,885	7,895	1,688	100	100	0	0	100
Below Normal	100	100	242	1,004	3,115	886	293	100	100	0	0	100
Dry	100	100	317	896	2,015	1,398	407	100	100	0	0	100
Critical Dry	100	100	151	525	531	393	106	100	100	0	0	100
No Action Alternative												
Wet	183	910	8,420	24,291	29,547	18,493	5,627	289	113	0	0	100
Above Normal	100	100	2,765	5,997	13,013	7,928	1,688	100	100	0	0	100
Below Normal	100	100	242	1,004	3,031	883	293	100	100	0	0	100
Dry	100	100	322	902	2,024	1,393	407	100	100	0	0	100
Critical Dry	100	100	149	528	534	396	106	100	100	0	0	100
Alternative 5 as Compared to No Action Alternative												
Wet	-13	23	-20	-243	-40	18	0	0	0	0	0	0
Above Normal	0	0	22	4	-128	-34	0	0	0	0	0	0
Below Normal	0	0	-1	0	84	3	0	0	0	0	0	0
Dry	0	0	-5	-6	-10	4	0	0	0	0	0	0
Critical Dry	0	0	2	-3	-3	-3	0	0	0	0	0	0
Alternative 5 as Compared to No Action Alternative (percent change)												
Wet	-7.3	2.6	-0.2	-1.0	-0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Above Normal	0.0	0.0	0.8	0.1	-1.0	-0.4	0.0	0.0	0.0	0.0	0.0	0.0
Below Normal	0.0	0.0	-0.2	0.0	2.8	0.4	0.0	0.0	0.0	0.0	0.0	0.0
Dry	0.0	0.0	-1.6	-0.6	-0.5	0.3	0.1	0.0	0.0	0.0	0.0	0.0
Critical Dry	0.0	0.0	1.6	-0.5	-0.6	-0.7	0.0	0.0	0.0	0.0	0.0	0.0

Flows from the Sacramento River into Yolo Bypass at Fremont Weir would be similar under Alternative 5 and the No Action Alternative.

Changes in Delta Conditions

Delta outflow under Alternative 5 as compared to the No Action Alternative are summarized below and shown on Figures 5.74 through 5.76.

- In wet years, average monthly Delta outflow would be similar.
- In dry years, average monthly Delta outflow would be similar in July through April and increased in May and June (up to 1,377 cfs).

The OMR conditions under Alternative 5 as compared to the No Action Alternative are shown on Figures 5.77 through 5.79.

- Under Alternative 5, OMR flows would be negative except in April and May of all water year types. Under the No Action Alternative, OMR flows would be negative except in April and May of wet and above normal years and April of below normal years.
- In wet years, OMR flows would be more positive or no change in September, October, January, and April through June (up to 171 cfs) and more negative in November, December, March, and August (up to 124 cfs).
- In dry years, OMR flows would be more positive or no change in October through March (up to 1,359 cfs) and more negative in June through September (up to 568 cfs).

Changes in CVP and SWP Exports and Deliveries

Delta exports under Alternative 5 as compared to the No Action Alternative are summarized in Table 5.93.

Table 5.93 Changes in Exports at Jones and Banks Pumping Plants under Alternative 5 as Compared to the No Action Alternative

Water Year	Monthly Volume (TAF)											
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Alternative 5												
Wet	408	505	564	514	532	592	202	202	444	667	718	627
Above Normal	376	423	561	407	405	496	127	92	315	590	705	625
Below Normal	381	456	588	387	359	397	103	55	208	663	632	561
Dry	370	394	513	392	315	318	80	41	205	577	333	433
Critical Dry	313	293	382	355	249	179	34	20	69	239	222	243
No Action Alternative												
Wet	410	497	564	513	537	594	204	207	445	669	717	638
Above Normal	376	450	562	406	401	496	130	105	315	587	709	628
Below Normal	386	456	590	387	354	394	134	100	209	657	622	542
Dry	374	398	510	392	315	318	153	126	194	541	296	426
Critical Dry	314	293	384	349	250	179	93	90	64	223	176	242
Alternative 5 as Compared to No Action Alternative												
Wet	-2	8	0	0	-5	-2	-2	-5	-1	-1	0	-11
Above Normal	1	-28	-1	1	4	0	-4	-14	0	2	-4	-3
Below Normal	-5	0	-2	0	5	4	-31	-45	-1	6	10	18
Dry	-4	-4	4	0	0	0	-73	-84	11	36	38	8
Critical Dry	-1	0	-2	6	-1	-1	-59	-70	4	17	46	1
Alternative 5 as Compared to No Action Alternative (percent change)												
Wet	-0.6	1.6	0.0	0.1	-0.9	-0.3	-1.0	-2.6	-0.2	-0.2	0.1	-1.8
Above Normal	0.2	-6.1	-0.1	0.3	0.9	0.0	-2.9	-13.0	-0.1	0.4	-0.5	-0.5
Below Normal	-1.3	0.0	-0.4	0.0	1.4	0.9	-23.4	-45.4	-0.3	0.8	1.6	3.4
Dry	-1.1	-1.0	0.7	-0.1	-0.1	0.0	-47.6	-67.0	5.7	6.7	12.8	1.8
Critical Dry	-0.2	0.1	-0.4	1.8	-0.4	-0.4	-63.8	-77.5	6.9	7.6	25.9	0.6

The following changes would occur in CVP and SWP exports under Alternative 5 as compared to the No Action Alternative.

- Long-term average annual exports would be 45 TAF (1 percent) less under Alternative 5 as compared to the No Action Alternative.
- In wet years, total exports would be similar in all months.
- In above-normal years, total exports would be similar in June through April and reduced in May (13.0 percent).
- In below-normal years, total exports would be similar in June through March and reduced in April and May (up to 45.4 percent).
- In dry years, total exports would be similar in June, July, and September through March; reduced in April and May (up to 67.0 percent); and increased in August (12.8 percent).
- In critical dry years, total exports would be similar in June, July, and September through March; reduced in April and May (up to 77.5 percent); and increased August (25.9 percent).

Deliveries to CVP and SWP water users would be similar under Alternative 5 as compared to the No Action Alternative, as summarized in Tables 5.94 and 5.95, respectively.

Table 5.94 Changes CVP Water Deliveries under Alternative 5 as Compared to the No Action Alternative

Annual Average Deliveries (TAF)					
				Alternative 5 as compared to the No Action Alternative	
		Alternative 5	No Action Alternative	Difference	Percent Change
North of Delta					
CVP Agricultural Water Service Contractors	Long Term	185	185	0	0
	Dry	85	86	0	0
	Critical Dry	24	24	0	0
CVP M&I (Including American River Contractors and Contra Costa Water District)	Long Term	386	386	0	0
	Dry	384	385	0	0
	Critical Dry	384	383	1	0

Annual Average Deliveries (TAF)					
				Alternative 5 as compared to the No Action Alternative	
		Alternative 5	**No Action Alternative**	**Difference**	**Percent Change**
CVP M&I American River Contractors	Long Term	112	113	0	0
	Dry	96	97	0	0
	Critical Dry	74	75	-1	-1
CVP Sacramento River Settlement Contractors	Long Term	1,861	1,859	2	0
	Dry	1,906	1,906	0	0
	Critical Dry	1,747	1,737	10	1
CVP Refuge Level 2 Deliveries	Long Term	146	146	0	0
	Dry	145	146	0	0
	Critical Dry	103	102	1	1
Total CVP Agricultural, M&I, Sacramento River Settlement Contractors, and Refuge Level 2 Deliveries	Long Term	2,578	2,576	2	0
	Dry	2,520	2,523	-3	0
	Critical Dry	2,258	2,246	12	1
South of Delta (Does not include Eastside Contractors)					
CVP Agricultural Water Service Contractors	Long Term	834	847	-13	-2
	Dry	433	445	-12	-3
	Critical Dry	130	131	-1	-1
CVP M&I Users	Long Term	112	112	0	0
	Dry	100	99	1	1
	Critical Dry	80	80	0	0
San Joaquin River Exchange Contractors	Long Term	852	852	0	0
	Dry	875	875	0	0
	Critical Dry	741	741	0	0

Annual Average Deliveries (TAF)					
				Alternative 5 as compared to the No Action Alternative	
		Alternative 5	No Action Alternative	Difference	Percent Change
CVP Refuge Level 2 Deliveries	Long Term	273	273	0	0
	Dry	281	281	0	0
	Critical Dry	232	234	-2	-1
Total CVP Agricultural, M&I, San Joaquin River Exchange Contractors, and Refuge Level 2 Deliveries	Long Term	2,071	2,084	-13	-1
	Dry	1,689	1,700	-11	-1
	Critical Dry	1,183	1,186	-3	0
Eastside Contractors Deliveries					
Water Rights	Long Term	502	508	-6	-1
	Dry	524	524	0	0
	Critical Dry	406	445	-39	-9
CVP Water Service Contracts	Long Term	100	104	-4	-4
	Dry	69	84	-16	-19
	Critical Dry	8	4	4	100
Total Water Rights and CVP Service Contracts Deliveries	Long Term	602	612	-10	-2
	Dry	593	608	-15	-2
	Critical Dry	414	449	-35	-8

The following changes in CVP water deliveries would occur under Alternative 5 as compared to the No Action Alternative.

- Deliveries to CVP North of Delta agricultural water service contractors would be similar over the long-term conditions and in dry and critical dry years.
- Deliveries to CVP North of Delta M&I contractors would be similar over the long-term conditions and in dry and critical dry years in total and for the American River CVP contractors.
- Deliveries to CVP South of Delta agricultural water service contractors would be similar over the long-term conditions and in dry and critical dry years.

- Deliveries to CVP South of Delta M&I contractors would be similar over the long-term conditions and in dry and critical dry years.
- Deliveries to the Eastside contractors would be similar under long-term conditions and dry years; and reduced by 8 percent in critical dry years.

Table 5.95 Changes SWP Water Deliveries under the Alternative 5 as Compared to the No Action Alternative

Annual Average Deliveries (TAF)					
				Alternative 5 as compared to the No Action Alternative	
		Alternative 5	No Action Alternative	Difference	Percent Change
North of Delta					
SWP Agricultural Uses	Long Term	0	0	0	0
	Dry	0	0	0	0
	Critical Dry	0	0	0	0
SWP M&I (without Article 21)	Long Term	67	68	-1	-2
	Dry	51	51	0	-1
	Critical Dry	42	43	-1	-1
SWP M&I Article 21 Deliveries	Long Term	13	13	0	3
	Dry	14	14	1	4
	Critical Dry	13	13	1	5
Total SWP Agricultural and M&I (without Article 21)	Long Term	67	68	-1	-2
	Dry	51	51	0	-1
	Critical Dry	42	43	-1	-1
Total SWP Agricultural and M&I Article 21 Deliveries	Long Term	13	13	0	3
	Dry	14	14	1	4
	Critical Dry	13	13	1	5

Annual Average Deliveries (TAF)					
				Alternative 5 as compared to the No Action Alternative	
		Alternative 5	No Action Alternative	Difference	Percent Change
South of Delta					
SWP Agricultural Users (without Article 21)	Long Term	598	610	-12	-2
	Dry	449	455	-7	-1
	Critical Dry	369	378	-9	-2
SWP Agricultural Article 21 Deliveries	Long Term	24	27	-2	-9
	Dry	6	5	1	20
	Critical Dry	4	7	-3	-43
SWP M&I Users (without Article 21)	Long Term	1,784	1,800	-15	-1
	Dry	1,397	1,406	-9	-1
	Critical Dry	1,157	1,173	-16	-1
SWP M&I Article 21 Deliveries	Long Term	19	20	-1	-7
	Dry	5	5	0	4
	Critical Dry	3	5	-2	-37
Total SWP Agricultural and M&I Users (without Article 21)	Long Term	2,383	2,410	-27	-1
	Dry	1,845	1,861	-15	-1
	Critical Dry	1,526	1,551	-25	-2
Total SWP Agricultural and M&I Article 21 Deliveries	Long Term	43	47	-4	-8
	Dry	11	10	1	12
	Critical Dry	7	12	-5	-41

The following changes in SWP water deliveries would occur under Alternative 5 as compared to the No Action Alternative.

- Deliveries without Article 21 water to SWP North of Delta water contractors would be similar over the long-term conditions and in dry and critical dry years.
- Deliveries without Article 21 water to SWP South of Delta water contractors would be similar over the long-term conditions and in dry and critical dry years.
- Deliveries of Article 21 water to SWP North of Delta water contractors would be similar over the long-term conditions and in dry and critical dry years.
- Deliveries of Article 21 water to SWP South of Delta water contractors would be reduced by 8 percent over the long-term conditions and 41 percent in critical dry years; and increased by 12 percent in dry years.

Effects Related to Cross Delta Water Transfers

Potential effects to surface water resources could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014i). Potential effects were identified as reduced surface water storage in upstream reservoirs and changes in flow patterns in river downstream of the reservoirs if water was released from the reservoirs in patterns that were different than would have been used by the water seller's. Because all water transfers would be required to avoid adverse impacts to other water users and biological resources (see Section 3.A.6.3, Transfers), including impacts associated with changes in reservoir storage and river flow patterns, the analysis indicated that water transfers would not result in substantial changes in storage or river flows. For the purposes of this EIS, it is anticipated that similar conditions would occur due to cross Delta water transfers under Alternative 5 and the No Action Alternative.

Under Alternative 5 and the No Action Alternative, the timing of cross Delta water transfers would be limited to July through September, and the volume would be limited to 600,000 acre-feet per year in drier years and 360,000 acre-feet in all other years, in accordance with the 2008 USFWS BO and 2009 NMFS BO. As indicated in Table 5.93, capacity would be available under the No Action Alternative between July and September for water transfers in all water year types.

Overall, the potential for water transfer conveyance would be similar under Alternative 5 as compared to the No Action Alternative.

San Francisco Bay Area, Central Coast, and Southern California Regions

Potential Changes in Surface Water Resources at Reservoirs that Store CVP and SWP Water

The San Francisco Bay Area, Central Coast, and Southern California regions include numerous reservoirs that store CVP and SWP water supplies, including CVP and SWP reservoirs, that primarily provide water supplies for M&I water users. Changes in the availability CVP and SWP water supplies for storage in these reservoirs under Alternative 5 as compared to the No Action Alternative would be consistent with the following changes in water deliveries to M&I water users, as summarized in Tables 5.94 and 5.95.

- Deliveries to CVP South of Delta M&I contractors would be similar over the long-term conditions and in dry and critical dry years.
- Deliveries without Article 21 water to SWP South of Delta water contractors would be similar over the long-term conditions and in dry and critical dry years.
- Deliveries of Article 21 water to SWP South of Delta water contractors would be reduced by 8 percent over the long-term conditions and 41 percent in critical dry years; and increased by 12 percent in dry years.

Changes in CVP and SWP Exports and Deliveries

Deliveries to CVP and SWP water users are described above in the Central Valley Region.

5.4.3.6.2 Alternative 5 Compared to the Second Basis of Comparison

Trinity River Region

Changes in CVP and SWP Reservoir Storage and Downstream River Flows

Changes in Trinity Lake storage and surface water elevations under Alternative 5 as compared to the Second Basis of Comparison are summarized in Tables 5.96 and 5.97. The results are summarized following Table 5.97.

Table 5.96 Changes in Trinity Lake Storage under Alternative 5 as Compared to the Second Basis of Comparison

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 5												
Wet	1,494	1,520	1,635	1,759	1,926	2,056	2,222	2,246	2,191	2,068	1,940	1,781
Above Normal	1,155	1,180	1,290	1,459	1,662	1,850	2,030	2,004	1,912	1,778	1,627	1,503
Below Normal	1,398	1,405	1,422	1,493	1,580	1,667	1,813	1,741	1,637	1,474	1,311	1,190
Dry	1,155	1,150	1,175	1,183	1,275	1,404	1,540	1,492	1,415	1,259	1,110	1,012
Critical Dry	744	726	741	743	784	866	913	878	856	755	622	539
Second Basis of Comparison												
Wet	1,501	1,535	1,644	1,767	1,931	2,055	2,224	2,250	2,194	2,068	1,939	1,805
Above Normal	1,208	1,245	1,363	1,524	1,718	1,901	2,079	2,053	1,955	1,815	1,647	1,513
Below Normal	1,451	1,472	1,492	1,554	1,641	1,729	1,872	1,799	1,696	1,515	1,337	1,204
Dry	1,178	1,184	1,210	1,230	1,322	1,453	1,586	1,536	1,466	1,302	1,152	1,055
Critical Dry	819	803	813	825	868	949	999	962	929	811	667	598
Alternative 5 as Compared to Second Basis of Comparison												
Wet	-7	-16	-9	-8	-5	1	-2	-3	-3	0	1	-23
Above Normal	-53	-65	-73	-65	-56	-51	-49	-49	-43	-37	-20	-11
Below Normal	-54	-67	-69	-61	-62	-62	-59	-58	-60	-40	-26	-14
Dry	-23	-35	-35	-48	-47	-48	-46	-45	-51	-42	-42	-43
Critical Dry	-75	-77	-72	-82	-84	-84	-86	-84	-73	-56	-45	-59
Alternative 5 as Compared to Second Basis of Comparison (percent change)												
Wet	-0.5	-1.0	-0.5	-0.4	-0.3	0.0	-0.1	-0.2	-0.1	0.0	0.0	-1.3
Above Normal	-4.4	-5.2	-5.3	-4.3	-3.3	-2.7	-2.4	-2.4	-2.2	-2.0	-1.2	-0.7
Below Normal	-3.7	-4.6	-4.7	-3.9	-3.7	-3.6	-3.2	-3.2	-3.5	-2.7	-1.9	-1.2
Dry	-2.0	-3.0	-2.9	-3.9	-3.5	-3.3	-2.9	-2.9	-3.5	-3.3	-3.6	-4.1
Critical Dry	-9.1	-9.6	-8.8	-10.0	-9.6	-8.8	-8.6	-8.8	-7.9	-6.9	-6.7	-9.8

Table 5.97 Changes in Trinity Lake Elevation under Alternative 5 as Compared to the Second Basis of Comparison

Water Year	End of Month Elevation (Feet)											
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Alternative 5												
Wet	2,300	2,303	2,313	2,325	2,338	2,347	2,357	2,358	2,355	2,347	2,338	2,326
Above Normal	2,259	2,262	2,276	2,294	2,314	2,330	2,343	2,342	2,335	2,326	2,313	2,303
Below Normal	2,289	2,290	2,292	2,299	2,308	2,315	2,326	2,321	2,313	2,299	2,284	2,272
Dry	2,263	2,265	2,268	2,269	2,279	2,292	2,305	2,301	2,294	2,279	2,265	2,254
Critical Dry	2,209	2,206	2,209	2,212	2,220	2,234	2,241	2,237	2,235	2,221	2,199	2,183
Second Basis of Comparison												
Wet	2,301	2,305	2,314	2,325	2,339	2,347	2,357	2,358	2,355	2,347	2,338	2,328
Above Normal	2,270	2,273	2,286	2,303	2,320	2,335	2,347	2,346	2,339	2,329	2,315	2,304
Below Normal	2,295	2,296	2,298	2,305	2,313	2,320	2,331	2,326	2,318	2,303	2,287	2,274
Dry	2,266	2,269	2,272	2,274	2,284	2,296	2,309	2,304	2,298	2,284	2,269	2,259
Critical Dry	2,218	2,216	2,217	2,222	2,229	2,243	2,250	2,246	2,243	2,227	2,204	2,191
Alternative 5 as Compared to Second Basis of Comparison												
Wet	-1	-2	-1	-1	0	0	0	0	0	0	0	-2
Above Normal	-10	-11	-11	-9	-7	-5	-4	-4	-4	-3	-2	-1
Below Normal	-5	-6	-6	-5	-5	-5	-5	-5	-5	-3	-3	-2
Dry	-2	-3	-3	-5	-4	-4	-4	-4	-4	-4	-5	-5
Critical Dry	-9	-9	-8	-9	-9	-9	-9	-9	-8	-6	-5	-8
Alternative 5 as Compared to Second Basis of Comparison (percent change)												
Wet	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
Above Normal	-0.5	-0.5	-0.5	-0.4	-0.3	-0.2	-0.2	-0.2	-0.2	-0.1	-0.1	0.0
Below Normal	-0.2	-0.3	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.1	-0.1
Dry	-0.1	-0.1	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Critical Dry	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.3	-0.2	-0.4

The following changes in Trinity Lake storage and surface water elevations would occur under Alternative 5 as compared to the Second Basis of Comparison.

- In wet, below normal, and dry years, storage would be similar.
- In above normal years, storage would be similar in January through October and reduced in November and December (up to 5.3 percent).
- In critical dry years, storage would be reduced in all months (up to 10.0 percent).
- In all months, in all water year types, surface water elevations would be similar.

The following changes would occur on the Trinity River under Alternative 5 as compared to the Second Basis of Comparison, as summarized on Figures 5.53 through 5.55.

- Over long-term conditions, flows would be similar in March through November and January and reduced in December and February (up to 9.6 percent).
- In wet years, flows would be similar in January and April through November and reduced in December, February, and March (up to 13.9 percent).
- In dry years, flows would be similar in all months.

Central Valley Region

Changes in CVP and SWP Reservoir Storage and Downstream River Flows

Shasta Lake and Sacramento River

Storage levels and surface water elevations in Shasta Lake under Alternative 5 as compared to the Second Basis of Comparison are summarized in Tables 5.98 and 5.99. Changes in flows in the Sacramento River downstream of Keswick Dam and at Freeport are shown on Figures 5.56 through 5.61. The results are summarized following Table 5.99.

Table 5.98 Changes in Shasta Lake Storage under Alternative 5 as Compared to the Second Basis of Comparison

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 5												
Wet	2,704	2,716	3,078	3,385	3,590	3,836	4,299	4,461	4,243	3,736	3,410	2,989
Above Normal	2,369	2,388	2,598	3,164	3,454	4,019	4,401	4,430	4,042	3,409	3,071	2,842
Below Normal	2,603	2,565	2,704	3,077	3,450	3,820	4,039	3,970	3,602	3,012	2,663	2,620
Dry	2,344	2,287	2,433	2,627	3,039	3,509	3,745	3,699	3,315	2,787	2,497	2,459
Critical Dry	1,676	1,611	1,700	1,856	2,015	2,258	2,203	2,104	1,749	1,246	958	910
Second Basis of Comparison												
Wet	2,817	2,926	3,154	3,406	3,597	3,841	4,301	4,453	4,228	3,733	3,362	3,252
Above Normal	2,499	2,578	2,808	3,313	3,515	4,038	4,416	4,417	3,979	3,347	2,975	2,921
Below Normal	2,826	2,846	2,977	3,299	3,646	3,966	4,164	4,042	3,599	3,010	2,601	2,574
Dry	2,409	2,431	2,578	2,755	3,168	3,644	3,861	3,774	3,333	2,800	2,539	2,496
Critical Dry	1,873	1,826	1,911	2,050	2,222	2,460	2,386	2,270	1,861	1,409	1,151	1,086
Alternative 5 as Compared to Second Basis of Comparison												
Wet	-114	-211	-76	-21	-8	-5	-2	7	15	3	48	-263
Above Normal	-130	-190	-210	-149	-62	-19	-15	13	63	62	97	-79
Below Normal	-224	-281	-273	-221	-196	-146	-125	-72	3	1	62	45
Dry	-64	-144	-145	-129	-129	-135	-116	-75	-18	-13	-41	-38
Critical Dry	-197	-215	-211	-194	-207	-202	-183	-166	-111	-163	-193	-176
Alternative 5 as Compared to Second Basis of Comparison (percent change)												
Wet	-4.0	-7.2	-2.4	-0.6	-0.2	-0.1	0.0	0.2	0.4	0.1	1.4	-8.1
Above Normal	-5.2	-7.4	-7.5	-4.5	-1.8	-0.5	-0.3	0.3	1.6	1.8	3.3	-2.7
Below Normal	-7.9	-9.9	-9.2	-6.7	-5.4	-3.7	-3.0	-1.8	0.1	0.0	2.4	1.8
Dry	-2.7	-5.9	-5.6	-4.7	-4.1	-3.7	-3.0	-2.0	-0.5	-0.5	-1.6	-1.5
Critical Dry	-10.5	-11.8	-11.0	-9.5	-9.3	-8.2	-7.7	-7.3	-6.0	-11.5	-16.8	-16.2

Table 5.99 Changes in Shasta Lake Elevation under Alternative 5 as Compared to the Second Basis of Comparison

Water Year	End of Month Elevation (Feet)											
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Alternative 5												
Wet	991	992	1,008	1,023	1,031	1,041	1,058	1,064	1,056	1,037	1,024	1,005
Above Normal	967	968	982	1,012	1,025	1,048	1,062	1,063	1,049	1,024	1,009	999
Below Normal	987	985	992	1,009	1,025	1,040	1,048	1,045	1,031	1,006	990	988
Dry	969	967	975	986	1,006	1,027	1,037	1,035	1,019	996	982	980
Critical Dry	925	921	928	938	950	967	965	959	937	899	874	869
Second Basis of Comparison												
Wet	997	1,002	1,012	1,024	1,032	1,041	1,058	1,063	1,055	1,037	1,022	1,017
Above Normal	974	978	992	1,019	1,028	1,048	1,062	1,062	1,046	1,021	1,005	1,003
Below Normal	997	998	1,004	1,019	1,034	1,046	1,053	1,049	1,031	1,006	987	986
Dry	972	974	982	992	1,012	1,032	1,041	1,038	1,020	997	984	982
Critical Dry	938	935	941	950	961	977	974	967	943	910	889	884
Alternative 5 as Compared to Second Basis of Comparison												
Wet	-6	-10	-4	-1	0	0	0	0	1	0	2	-12
Above Normal	-7	-10	-10	-7	-3	-1	-1	0	2	3	4	-4
Below Normal	-10	-13	-12	-10	-8	-6	-5	-3	0	0	3	2
Dry	-3	-7	-7	-6	-6	-5	-4	-3	-1	-1	-3	-2
Critical Dry	-13	-14	-14	-12	-11	-10	-9	-8	-5	-11	-15	-14
Alternative 5 as Compared to Second Basis of Comparison (percent change)												
Wet	-0.6	-1.0	-0.4	-0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.2	-1.2
Above Normal	-0.7	-1.0	-1.0	-0.7	-0.3	-0.1	-0.1	0.0	0.2	0.3	0.4	-0.4
Below Normal	-1.0	-1.3	-1.2	-0.9	-0.8	-0.6	-0.4	-0.3	0.0	0.0	0.3	0.2
Dry	-0.3	-0.7	-0.7	-0.6	-0.6	-0.5	-0.4	-0.3	-0.1	-0.1	-0.3	-0.2
Critical Dry	-1.4	-1.5	-1.4	-1.3	-1.1	-1.0	-0.9	-0.9	-0.5	-1.2	-1.7	-1.6

The following changes in Shasta Lake storage and surface water elevation would occur under Alternative 5 as compared to the Second Basis of Comparison.

- In wet years, storage would be similar in October and December through August and reduced in November and September (up to 8.1 percent).
- In above normal years, storage would be similar in February through September and reduced in October through December (up to 7.5 percent).
- In below normal years, storage would be similar in March through September and reduced in October through February (up to 9.9 percent).
- In dry years, storage would be similar in January through October and reduced in November through December (up to 5.9 percent).
- In critical dry years, storage would be reduced in all months (up to 16.8 percent).
- In all months, in all water year types, surface water elevations are similar.

The following changes in Sacramento River flows would occur under Alternative 5 as compared to the Second Basis of Comparison, as shown on Figures 5.56 through 5.61.

- Sacramento River downstream of Keswick Dam (Figures 5.56 through 5.58).
  - Over long-term conditions, flows would be similar in July, August, October, and February through April; reduced in December, January, May and June (up to 8.2 percent); and increased in September and November (up to 38.5 percent).
  - In wet years, flows would be similar in January through July; reduced in December and August (up to 15.0 percent); and increased in September through November (up to 77.3 percent).
  - In dry years, similar flows would occur in July through October and December through March; reduced in April through June (up to 10.1 percent); and increased flows in November (32.1 percent).
- Sacramento River near Freeport (near the northern boundary of the Delta) (Figures 5.59 through 5.61).
  - Over long-term conditions, flows would be similar in October and December through April; reduced in May and June (up to 11.5 percent); and increased in July through September and November (43.4 percent).
  - In wet years, flows would be similar in October and January through June; reduced in December (6.2 percent); and increased in July through September and November (up to 89.0 percent).
  - In dry years, similar flows would occur in August through October and December through April; reduced in May and June (up to 13.6 percent); and increased flows in July and November (up to 19.3 percent).

Lake Oroville and Feather River

Storage levels and surface water elevations in Lake Oroville under Alternative 5 as compared to the Second Basis of Comparison are summarized in Tables 5.100 and 5.101. Changes in flows in the Feather River downstream of Thermalito Complex are shown on Figures 5.62 through 5.64. The results are summarized following Table 5.101.

Table 5.100 Changes in Lake Oroville Storage under Alternative 5 as Compared to the Second Basis of Comparison

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 5												
Wet	1,681	1,723	2,179	2,556	2,833	2,942	3,300	3,488	3,447	2,961	2,613	2,103
Above Normal	1,275	1,310	1,471	1,948	2,512	2,892	3,247	3,401	3,241	2,608	2,125	1,668
Below Normal	1,552	1,507	1,517	1,728	2,132	2,406	2,663	2,746	2,569	1,959	1,521	1,305
Dry	1,223	1,173	1,190	1,319	1,595	1,952	2,193	2,255	1,992	1,502	1,295	1,150
Critical Dry	1,102	1,037	1,025	1,114	1,229	1,383	1,415	1,411	1,266	1,045	929	873
Second Basis of Comparison												
Wet	1,936	1,984	2,354	2,636	2,871	2,942	3,300	3,477	3,402	2,976	2,728	2,569
Above Normal	1,465	1,523	1,702	2,173	2,648	2,937	3,271	3,357	3,081	2,493	2,087	1,827
Below Normal	1,823	1,783	1,831	2,037	2,361	2,627	2,875	2,836	2,461	1,930	1,637	1,424
Dry	1,371	1,324	1,344	1,473	1,764	2,120	2,363	2,357	2,031	1,688	1,427	1,261
Critical Dry	1,117	1,044	1,041	1,125	1,235	1,406	1,423	1,407	1,219	1,027	911	839
Alternative 5 as Compared to Second Basis of Comparison												
Wet	-255	-261	-175	-81	-38	0	0	10	45	-15	-115	-466
Above Normal	-190	-213	-231	-225	-136	-44	-24	44	159	115	37	-159
Below Normal	-271	-275	-314	-309	-228	-220	-212	-90	109	28	-116	-118
Dry	-148	-151	-153	-155	-169	-168	-170	-102	-39	-186	-132	-111
Critical Dry	-15	-7	-17	-11	-7	-23	-8	4	47	19	18	34
Alternative 5 as Compared to Second Basis of Comparison (percent change)												
Wet	-13.1	-13.1	-7.4	-3.1	-1.3	0.0	0.0	0.3	1.3	-0.5	-4.2	-18.1
Above Normal	-13.0	-14.0	-13.6	-10.4	-5.1	-1.5	-0.7	1.3	5.2	4.6	1.8	-8.7
Below Normal	-14.9	-15.4	-17.1	-15.1	-9.7	-8.4	-7.4	-3.2	4.4	1.5	-7.1	-8.3
Dry	-10.8	-11.4	-11.4	-10.5	-9.6	-7.9	-7.2	-4.3	-1.9	-11.0	-9.2	-8.8
Critical Dry	-1.4	-0.6	-1.6	-0.9	-0.5	-1.6	-0.6	0.3	3.8	1.8	2.0	4.1

Table 5.101 Changes in Lake Oroville Elevation under Alternative 5 as Compared to the Second Basis of Comparison

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 5												
Wet	742	746	793	829	852	859	884	897	894	860	835	789
Above Normal	698	701	720	775	827	856	880	891	880	836	795	747
Below Normal	731	726	728	752	794	818	839	845	831	777	730	704
Dry	691	685	688	706	738	777	799	804	779	727	703	685
Critical Dry	676	668	665	679	694	712	716	715	696	667	650	642
Second Basis of Comparison												
Wet	768	773	810	837	854	859	884	896	891	861	844	831
Above Normal	717	723	745	796	838	859	882	888	869	826	790	763
Below Normal	757	752	757	779	812	834	854	852	823	775	743	719
Dry	706	701	705	721	755	791	814	813	784	748	718	698
Critical Dry	677	668	668	680	694	715	716	714	691	664	647	636
Alternative 5 as Compared to Second Basis of Comparison												
Wet	-26	-26	-16	-7	-3	0	0	1	3	-1	-9	-42
Above Normal	-19	-22	-25	-21	-11	-3	-2	3	11	10	5	-17
Below Normal	-26	-26	-29	-27	-19	-16	-15	-7	8	2	-13	-14
Dry	-15	-16	-16	-16	-17	-15	-14	-9	-5	-22	-15	-13
Critical Dry	-1	0	-2	-1	-1	-3	-1	1	5	4	3	6
Alternative 5 as Compared to Second Basis of Comparison (percent change)												
Wet	-3.3	-3.4	-2.0	-0.9	-0.3	0.0	0.0	0.1	0.3	-0.1	-1.0	-5.1
Above Normal	-2.7	-3.1	-3.4	-2.7	-1.3	-0.4	-0.2	0.3	1.3	1.2	0.6	-2.2
Below Normal	-3.4	-3.4	-3.8	-3.4	-2.3	-1.9	-1.8	-0.8	1.0	0.3	-1.8	-2.0
Dry	-2.1	-2.2	-2.3	-2.2	-2.2	-1.9	-1.7	-1.2	-0.7	-2.9	-2.2	-1.9
Critical Dry	-0.2	0.0	-0.3	-0.2	-0.1	-0.4	-0.1	0.1	0.8	0.6	0.5	0.9

The following changes in Lake Oroville storage and surface water elevation would occur under Alternative 5 as compared to the Second Basis of Comparison.

- In wet years, storage would be similar in January through August and reduced in September through December (up to 18.1 percent).
- In above-normal years, storage would be similar in March through August and reduced in September through February (up to 14.0 percent).
- In below-normal years, storage would be similar in May through July and reduced in August through April (up to 17.1 percent).
- In dry years, storage would be similar in May and June and reduced in July through April (up to 11.4 percent).
- In critical dry years, storage would be similar in all months.
- Surface water elevations would be similar in all months, in all years.

The following changes in Feather River flows would occur under Alternative 5 as compared to the No Action Alternative, as shown on Figures 5.62 through 5.64.

- Over long-term conditions, similar flows would occur in November and April; reduced flows in October, December through March, May, and June (up to 27.7 percent); and increased flows in July through September (up to 76.2 percent).
- In wet years, similar flows would occur in October, November, March through May; reduced flows in December through February and June (up to 25.6 percent); and increased flows in July through September (up to 181.9 percent).
- In dry years, similar flows would occur in November through April; reduced flows in October, May, June, August, and September (up to 45.4 percent); and increased flows in July (60.4 percent).

Folsom Lake and American River

Storage levels and surface water elevations in Folsom Lake under Alternative 5 as compared to the Second Basis of Comparison are summarized in Tables 5.102 and 5.103. Changes in flows in the American River downstream of Nimbus Dam are shown on Figures 5.65 through 5.67. The results are summarized below following 5.103.

Table 5.102 Changes in Folsom Lake Storage under Alternative 5 as Compared to the Second Basis of Comparison

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 5												
Wet	454	435	515	518	515	632	785	952	941	794	710	577
Above Normal	375	379	428	513	532	640	787	946	888	622	554	478
Below Normal	440	425	461	483	534	620	758	845	783	523	469	450
Dry	397	386	411	426	479	579	691	766	664	489	435	410
Critical Dry	325	304	314	320	367	433	483	499	411	324	257	231
Second Basis of Comparison												
Wet	483	470	522	524	515	632	785	951	937	793	688	646
Above Normal	390	412	467	537	538	640	787	946	857	591	522	485
Below Normal	506	489	502	514	541	626	761	847	739	475	408	387
Dry	405	399	423	437	486	585	698	769	664	486	432	408
Critical Dry	339	317	323	325	369	436	469	482	430	352	288	258
Alternative 5 as Compared to Second Basis of Comparison												
Wet	-29	-35	-8	-6	0	0	0	0	4	1	23	-69
Above Normal	-16	-34	-39	-24	-6	0	0	1	30	32	32	-7
Below Normal	-66	-65	-41	-31	-7	-7	-3	-2	44	49	60	63
Dry	-9	-13	-12	-12	-7	-5	-7	-3	0	4	3	2
Critical Dry	-14	-12	-9	-5	-2	-3	14	17	-19	-28	-31	-27
Alternative 5 as Compared to Second Basis of Comparison (percent change)												
Wet	-6.0	-7.4	-1.5	-1.2	0.0	0.0	0.0	0.0	0.5	0.1	-6.0	-7.4
Above Normal	-4.0	-8.2	-8.3	-4.4	-1.2	0.0	0.0	0.1	3.5	5.4	-4.0	-8.2
Below Normal	-13.0	-13.2	-8.2	-6.1	-1.4	-1.1	-0.4	-0.2	5.9	10.2	-13.0	-13.2
Dry	-2.2	-3.2	-2.9	-2.7	-1.4	-0.9	-1.0	-0.4	0.0	0.8	-2.2	-3.2
Critical Dry	-4.1	-3.8	-2.8	-1.5	-0.6	-0.7	3.0	3.5	-4.5	-8.0	-4.1	-3.8

Table 5.103 Changes in Folsom Lake Elevation under Alternative 5 as Compared to the Second Basis of Comparison

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 5												
Wet	409	407	418	418	418	432	448	465	464	449	440	425
Above Normal	394	395	405	418	420	433	449	464	458	431	423	413
Below Normal	406	405	410	413	420	431	445	454	447	417	411	408
Dry	400	400	404	406	413	426	438	446	435	413	406	403
Critical Dry	386	384	389	390	396	406	412	414	400	385	370	365
Second Basis of Comparison												
Wet	412	412	419	419	418	432	448	465	464	449	438	433
Above Normal	397	400	410	421	421	433	448	465	456	427	419	414
Below Normal	415	414	416	417	421	432	446	455	443	410	401	398
Dry	401	401	405	407	414	427	439	446	435	413	406	403
Critical Dry	389	386	390	391	397	406	410	411	404	391	378	372
Alternative 5 as Compared to Second Basis of Comparison												
Wet	-4	-5	-1	-1	0	0	0	-1	0	0	3	-8
Above Normal	-3	-6	-5	-3	-1	0	0	-1	3	4	4	-1
Below Normal	-9	-9	-6	-4	-1	-1	0	-1	5	7	10	10
Dry	-1	-1	-1	-2	-1	-1	-1	-1	0	0	0	0
Critical Dry	-3	-3	-2	-1	0	0	2	2	-3	-6	-8	-7
Alternative 5 as Compared to Second Basis of Comparison (percent change)												
Wet	-0.8	-1.1	-0.2	-0.2	0.0	0.0	0.0	-0.2	-0.1	0.0	0.6	-1.9
Above Normal	-0.7	-1.4	-1.3	-0.7	-0.2	0.0	0.0	-0.1	0.6	0.9	0.9	-0.2
Below Normal	-2.3	-2.2	-1.4	-1.0	-0.2	-0.2	-0.1	-0.2	1.0	1.8	2.4	2.5
Dry	-0.2	-0.4	-0.4	-0.4	-0.2	-0.2	-0.2	-0.1	-0.1	0.0	-0.1	-0.1
Critical Dry	-0.7	-0.7	-0.4	-0.2	0.0	-0.1	0.4	0.5	-0.8	-1.6	-2.0	-1.8

The following changes in Folsom Lake storage and surface water elevation would occur under Alternative 5 as compared to the Second Basis of Comparison.

- In wet years, storage would be similar in December through July and reduced in August through November (up to 7.4 percent).
- In above normal years, storage would be similar in January through June, August, and October; reduced in September, November, and December (up to 8.3 percent); and increased in July (5.4 percent).
- In below normal years, storage would be similar in February through May; reduced in August through January (up to 13.2 percent); and increased in June and July (up to 10.2 percent).
- In dry years, storage would be similar in all months.
- In critical dry years, storage would be similar in August and June and reduced in July (8.0 percent).
- Surface water elevations would be similar in all months, in all years.

The following changes in American River flows would occur under Alternative 5 as compared to the Second Basis of Comparison, as shown on Figures 5.62 through 5.64.

- Over long-term conditions, similar flows would occur in November through July; reduced flows in August (5.8 percent) and increased in September and October (42.4 percent).
- In wet years, similar flows would occur in October, November, and January through July; reduced flows in December and August (up to 13.7 percent); and increased flows in September (88.2 percent).
- In dry years, similar flows would occur in November through September and increased flows in October (16.7 percent).

Clear Creek

Changes in flows in Clear Creek downstream of Whiskeytown Dam are summarized in Table 5.104.

Monthly Clear Creek flows under Alternative 5 as compared to the Second Basis of Comparison are identical except in May. In May, under Alternative 5, flows are up to 40.7 percent higher than under the Second Basis of Comparison.

Table 5.104 Changes in Clear Creek Flows below Whiskeytown Dam under Alternative 5 as Compared to the Second Basis of Comparison

Water Year	Average Monthly Flow (cfs)											
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Alternative 5												
Wet	200	200	200	309	356	272	200	277	200	85	85	150
Above Normal	181	182	188	192	196	196	196	277	200	85	85	150
Below Normal	195	195	195	195	195	195	195	274	191	85	85	150
Dry	177	184	188	190	190	190	190	267	183	85	85	150
Critical Dry	163	167	167	167	167	167	167	214	111	85	85	133
Second Basis of Comparison												
Wet	200	200	200	309	356	272	200	200	200	85	85	150
Above Normal	181	182	188	192	196	196	196	200	200	85	85	150
Below Normal	195	195	195	195	195	195	195	195	191	85	85	150
Dry	178	184	188	190	190	190	190	190	183	85	85	150
Critical Dry	163	167	167	167	167	167	167	167	111	85	85	133
Alternative 5 as Compared to Second Basis of Comparison												
Wet	0	0	0	0	0	0	0	77	0	0	0	0
Above Normal	0	0	0	0	0	0	0	77	0	0	0	0
Below Normal	0	0	0	0	0	0	0	78	0	0	0	0
Dry	**-1**	0	0	0	0	0	0	77	0	0	0	0
Critical Dry	0	0	0	0	0	0	0	47	0	0	0	0
Alternative 5 as Compared to Second Basis of Comparison (percent change)												
Wet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.7	0.0	0.0	0.0	0.0
Above Normal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.7	0.0	0.0	0.0	0.0
Below Normal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40.1	0.0	0.0	0.0	0.0
Dry	-0.3	0.0	0.0	0.0	0.0	0.0	0.0	40.7	0.0	0.0	0.0	0.0
Critical Dry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.3	0.0	0.0	0.1	0.0

New Melones Reservoir and Stanislaus River

Storage levels and surface water elevations in New Melones Reservoir under Alternative 5 as compared to the Second Basis of Comparison are summarized in Tables 5.105 and 5.106. Changes in flows in the Stanislaus River downstream of Goodwin Dam are shown on Figures 5.68 through 5.70. The results are summarized following Table 5.106.

Table 5.105 Changes in New Melones Reservoir Storage under Alternative 5 as Compared to the Second Basis of Comparison

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 5												
Wet	1,309	1,321	1,388	1,496	1,602	1,668	1,704	1,812	1,906	1,833	1,722	1,653
Above Normal	983	1,014	1,079	1,168	1,271	1,361	1,363	1,413	1,396	1,302	1,207	1,162
Below Normal	1,210	1,220	1,242	1,267	1,329	1,354	1,298	1,276	1,254	1,163	1,071	1,028
Dry	1,018	1,018	1,030	1,045	1,081	1,114	1,066	1,031	990	903	823	781
Critical Dry	558	559	570	578	597	591	506	449	433	391	355	336
Second Basis of Comparison												
Wet	1,443	1,446	1,502	1,606	1,709	1,794	1,833	1,962	1,994	1,917	1,803	1,731
Above Normal	1,092	1,116	1,175	1,261	1,360	1,455	1,481	1,543	1,516	1,419	1,321	1,274
Below Normal	1,364	1,366	1,378	1,397	1,453	1,479	1,461	1,447	1,415	1,322	1,228	1,183
Dry	1,149	1,143	1,149	1,161	1,191	1,221	1,210	1,176	1,131	1,039	956	912
Critical Dry	667	663	674	680	696	690	646	585	557	498	449	426
Alternative 5 as Compared to Second Basis of Comparison												
Wet	-134	-125	-114	-110	-108	-126	-129	-149	-88	-84	-81	-77
Above Normal	-108	-102	-96	-92	-89	-94	-118	-130	-120	-117	-114	-112
Below Normal	-154	-145	-137	-130	-124	-125	-164	-170	-161	-159	-157	-155
Dry	-132	-125	-119	-116	-110	-107	-144	-145	-141	-136	-133	-131
Critical Dry	-109	-104	-104	-102	-99	-99	-140	-136	-123	-107	-95	-90
Alternative 5 as Compared to Second Basis of Comparison (percent change)												
Wet	-9.3	-8.6	-7.6	-6.8	-6.3	-7.0	-7.0	-7.6	-4.4	-4.4	-4.5	-4.5
Above Normal	-9.9	-9.1	-8.1	-7.3	-6.5	-6.5	-8.0	-8.4	-7.9	-8.2	-8.7	-8.8
Below Normal	-11.3	-10.6	-9.9	-9.3	-8.5	-8.5	-11.2	-11.8	-11.4	-12.0	-12.8	-13.1
Dry	-11.5	-11.0	-10.4	-10.0	-9.3	-8.7	-11.9	-12.3	-12.5	-13.1	-13.9	-14.3
Critical Dry	-16.4	-15.7	-15.5	-15.0	-14.2	-14.4	-21.7	-23.2	-22.2	-21.5	-21.1	-21.2

Table 5.106 Changes in New Melones Reservoir Elevation under Alternative 5 as Compared to the Second Basis of Comparison

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 5												
Wet	969	971	980	995	1,007	1,016	1,020	1,031	1,040	1,033	1,022	1,015
Above Normal	924	930	939	954	968	980	982	988	987	975	963	890
Below Normal	954	956	959	962	973	977	972	970	968	957	944	938
Dry	930	930	932	934	939	945	940	936	931	918	905	898
Critical Dry	837	838	842	845	853	855	834	818	815	804	796	791
Second Basis of Comparison												
Wet	989	990	997	1,009	1,021	1,030	1,034	1,047	1,050	1,043	1,032	1,025
Above Normal	941	944	951	966	979	992	995	1,003	1,001	990	978	901
Below Normal	977	977	979	982	991	994	994	993	991	980	968	962
Dry	951	950	950	953	957	962	963	960	954	941	929	922
Critical Dry	866	866	870	872	878	879	871	856	850	835	823	817
Alternative 5 as Compared to Second Basis of Comparison												
Wet	-20	-19	-17	-15	-14	-15	-15	-16	-10	-10	-10	-9
Above Normal	-17	-14	-12	-12	-12	-11	-14	-15	-14	-15	-15	-11
Below Normal	-23	-22	-20	-20	-18	-18	-22	-23	-22	-23	-24	-24
Dry	-21	-20	-19	-19	-18	-17	-23	-24	-23	-24	-24	-25
Critical Dry	-29	-28	-29	-27	-25	-24	-37	-38	-35	-31	-27	-27
Alternative 5 as Compared to Second Basis of Comparison (percent change)												
Wet	-2.1	-1.9	-1.7	-1.4	-1.4	-1.4	-1.4	-1.5	-0.9	-0.9	-0.9	-0.9
Above Normal	-1.8	-1.5	-1.3	-1.3	-1.2	-1.2	-1.4	-1.5	-1.4	-1.5	-1.5	-1.2
Below Normal	-2.3	-2.2	-2.1	-2.0	-1.8	-1.8	-2.2	-2.3	-2.3	-2.4	-2.5	-2.5
Dry	-2.2	-2.1	-2.0	-2.0	-1.8	-1.8	-2.4	-2.5	-2.5	-2.5	-2.6	-2.7
Critical Dry	-3.4	-3.2	-3.3	-3.1	-2.9	-2.7	-4.2	-4.5	-4.1	-3.7	-3.3	-3.3

The following changes in New Melones Reservoir storage would occur under Alternative 5 as compared to the Second Basis of Comparison.

- In wet years, storage would be reduced in all months (up to 9.3 percent).
- In above-normal years, storage would be reduced in all months (up to 9.9 percent).
- In below-normal years, storage would be reduced in all months (up to 13.1 percent).
- In dry years, storage would be reduced in all months (up to 14.3 percent).

- In critical dry years, storage would be reduced in all months (up to 23.2 percent).
- Surface water elevations would be similar in all months, in all water year types.

Flows in the Stanislaus River downstream of Goodwin Dam are shown on Figures 5.68 to 5.70. Changes in flows in the river are summarized below.

- Over long-term conditions, similar flows would occur in August; reduced flows would occur in November through February, June, July, August, and September (up to 35.8 percent) and increased flows in October and March through May (up to 144.8 percent).
- In wet years, similar flows would occur in February and April; reduced flows in November through January and June through September (up to 52.8 percent) and increased flows in October and March (up to 113.1 percent).
- In dry years, similar flows would occur in July through September; reduced flows in November through March and June (up to 35.7 percent); and increased flows in October, April, and May (150.1 percent).

San Joaquin River at Vernalis

Flows in the San Joaquin River at Vernalis under Alternative 5 as compared to the Second Basis of Comparison are summarized below, as shown on Figures 5.71 through 5.73.

- Over long-term conditions, similar flows would occur in November through March, May, and July through September; reduced flows in June (8.2 percent); and increased flows in October and April (18.7 percent).
- In wet years, similar flows would occur in November through May and July through September; reduced flows in June (9.8 percent); and increased flows in October (16.2 percent).
- In dry years, similar flows would occur in November through March and June through September and increased flows in October, April, and May (up to 24.5 percent).

San Luis Reservoir

Storage levels and surface water elevations in San Luis Reservoir under Alternative 5 as compared to the Second Basis of Comparison are summarized in Tables 5.107 and 5.108. The results are summarized following Table 5.108.

Table 5.107 Changes in San Luis Reservoir Storage under Alternative 5 as Compared to the Second Basis of Comparison

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 5												
Wet	576	706	958	1,251	1,539	1,804	1,624	1,279	984	787	680	726
Above Normal	488	622	932	1,213	1,440	1,660	1,447	1,046	672	477	442	520
Below Normal	541	628	923	1,157	1,335	1,496	1,305	928	524	476	414	463
Dry	464	572	856	1,139	1,327	1,481	1,324	1,002	691	655	412	418
Critical Dry	429	505	698	994	1,166	1,216	1,103	875	600	428	284	270
Second Basis of Comparison												
Wet	790	1,017	1,365	1,748	1,965	2,033	2,031	1,852	1,487	1,167	889	925
Above Normal	658	883	1,213	1,671	1,913	2,001	1,995	1,717	1,263	861	612	631
Below Normal	854	1,064	1,334	1,742	1,908	1,980	1,908	1,628	1,251	964	635	591
Dry	617	764	998	1,427	1,728	1,925	1,870	1,665	1,341	1,007	660	596
Critical Dry	622	709	910	1,257	1,556	1,664	1,623	1,451	1,168	808	545	472
Alternative 5 as Compared to Second Basis of Comparison												
Wet	-214	-311	-407	-498	-426	-229	-408	-573	-503	-380	-210	-199
Above Normal	-170	-261	-281	-458	-473	-342	-548	-671	-591	-385	-170	-111
Below Normal	-313	-435	-411	-584	-572	-483	-603	-699	-727	-489	-221	-128
Dry	-153	-192	-141	-289	-402	-444	-546	-663	-650	-352	-249	-178
Critical Dry	-193	-204	-212	-263	-390	-448	-520	-577	-569	-379	-261	-202
Alternative 5 as Compared to Second Basis of Comparison (percent change)												
Wet	-32.8	-41.2	-42.7	-38.1	-27.8	-14.4	-24.5	-40.8	-48.9	-42.3	-28.2	-22.9
Above Normal	-27.2	-40.4	-32.7	-35.5	-29.5	-19.7	-30.2	-47.2	-59.3	-51.4	-33.4	-15.2
Below Normal	-43.5	-53.6	-42.3	-43.4	-37.9	-29.3	-36.5	-51.0	-70.0	-61.5	-40.1	-27.4
Dry	-23.0	-26.7	-12.8	-23.4	-27.7	-26.2	-31.9	-44.1	-51.4	-30.7	-35.2	-26.2
Critical Dry	-37.0	-38.2	-28.3	-24.7	-30.5	-30.8	-33.8	-39.5	-46.3	-41.0	-43.7	-30.8

Table 5.108 Changes in San Luis Elevation Storage under Alternative 5 as Compared to the Second Basis of Comparison

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 5												
Wet	402	417	446	475	501	525	509	478	448	427	416	422
Above Normal	391	408	443	471	492	512	494	456	416	390	386	398
Below Normal	399	411	443	467	483	498	481	444	397	390	381	388
Dry	389	404	436	465	483	497	482	451	417	413	381	381
Critical Dry	383	393	417	450	467	471	460	437	405	383	359	357
Second Basis of Comparison												
Wet	426	451	485	520	538	543	543	529	497	468	440	443
Above Normal	412	437	470	513	534	541	540	518	477	437	409	411
Below Normal	435	457	483	519	533	539	533	510	476	448	412	406
Dry	407	425	450	492	518	535	530	513	484	453	415	406
Critical Dry	409	419	441	475	502	512	509	494	468	432	400	389
Alternative 5 as Compared to Second Basis of Comparison												
Wet	-24	-34	-40	-45	-36	-19	-34	-51	-49	-41	-24	-22
Above Normal	-21	-29	-28	-42	-41	-29	-47	-62	-61	-47	-23	-13
Below Normal	-36	-46	-40	-53	-50	-41	-53	-66	-80	-58	-31	-17
Dry	-18	-21	-14	-26	-35	-38	-48	-62	-68	-39	-34	-25
Critical Dry	-26	-26	-24	-26	-36	-41	-49	-57	-63	-48	-42	-33
Alternative 5 as Compared to Second Basis of Comparison (percent change)												
Wet	-5.6	-7.6	-8.2	-8.6	-6.8	-3.5	-6.3	-9.6	-9.9	-8.7	-5.5	-4.9
Above Normal	-5.2	-6.6	-5.9	-8.2	-7.7	-5.3	-8.6	-11.9	-12.9	-10.7	-5.5	-3.1
Below Normal	-8.2	-10.1	-8.3	-10.1	-9.4	-7.6	-9.9	-12.9	-16.7	-13.0	-7.6	-4.3
Dry	-4.5	-4.9	-3.0	-5.3	-6.8	-7.1	-9.0	-12.0	-13.9	-8.7	-8.1	-6.2
Critical Dry	-6.4	-6.2	-5.4	-5.4	-7.1	-8.0	-9.5	-11.6	-13.5	-11.2	-10.4	-8.5

The following changes in San Luis Reservoir storage and surface water elevations would occur under Alternative 5 as compared to the Second Basis of Comparison.

- In wet years, storage would be reduced in all months (up to 48.9 percent). Surface water elevations would be similar in September and March and reduced in October through February and April through August (up to 9.9 percent).
- In above-normal years, storage would be reduced in all months (up to 59.3 percent). Surface water elevations would be similar in September and reduced in October through August (up to 12.9 percent).
- In below-normal years, storage would be reduced in all months (up to 70.0 percent). Surface water elevations would be similar in September and reduced in October through August (up to 16.7 percent).
- In dry years, storage would be reduced in all months (up to 51.4 percent). Surface water elevations would be similar in October through December and reduced in January through September (up to 13.9 percent).
- In critical dry years, storage would be reduced in all months (46.3 percent). Surface water elevations would be reduced in all months (up to 13.5 percent).

Changes in Flows into the Yolo Bypass

Flows from the Sacramento River into the Yolo Bypass at Fremont Weir under Alternative 5 as compared to the Second Basis of Comparison are summarized in Table 5.109. The results are summarized following Table 5.109.

Table 5.109 Changes in Flows into the Yolo Bypass at Fremont Weir under Alternative 5 as Compared to the Second Basis of Comparison

Water Year	Average Monthly Flow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 5												
Wet	170	933	8,400	24,048	29,507	18,512	5,627	289	113	0	0	100
Above Normal	100	100	2,786	6,000	12,885	7,895	1,688	100	100	0	0	100
Below Normal	100	100	242	1,004	3,115	886	293	100	100	0	0	100
Dry	100	100	317	896	2,015	1,398	407	100	100	0	0	100
Critical Dry	100	100	151	525	531	393	106	100	100	0	0	100
Second Basis of Comparison												
Wet	147	996	9,888	25,442	30,547	18,997	5,602	289	113	0	0	100
Above Normal	100	100	2,659	6,349	15,114	8,566	1,765	100	100	0	0	100
Below Normal	100	100	262	1,256	4,057	1,166	292	100	100	0	0	100
Dry	100	100	342	932	2,032	1,411	411	100	100	0	0	100
Critical Dry	100	100	149	542	533	408	106	100	100	0	0	100
Alternative 5 as Compared to Second Basis of Comparison												
Wet	23	-63	-1,488	-1,394	-1,040	-486	25	0	0	0	0	0
Above Normal	0	0	128	-349	-2,230	-671	-77	0	0	0	0	0
Below Normal	0	0	-20	-252	-942	-280	1	0	0	0	0	0
Dry	0	0	-25	-36	-17	-13	-4	0	0	0	0	0
Critical Dry	0	0	2	-17	-2	-15	0	0	0	0	0	0
Alternative 5 as Compared to Second Basis of Comparison (percent change)												
Wet	15.8	-6.3	-15.0	-5.5	-3.4	-2.6	0.4	-0.1	-0.1	0.0	0.0	0.0
Above Normal	0.0	0.0	4.8	-5.5	-14.8	-7.8	-4.4	0.0	0.0	0.0	0.0	0.0
Below Normal	0.0	0.0	-7.7	-20.1	-23.2	-24.0	0.3	0.0	0.0	0.0	0.0	0.0
Dry	0.0	0.0	-7.4	-3.9	-0.8	-0.9	-0.9	0.0	0.0	0.0	0.0	0.0
Critical Dry	0.0	0.0	1.0	-3.2	-0.4	-3.6	0.0	0.0	0.0	0.0	0.0	0.0

The following changes in flows from the Sacramento River into the Yolo Bypass at Fremont Weir would occur under Alternative 5 as compared to the Second Basis of Comparison.

- In wet years, flows would be similar in February through September; reduced flows in November through January (up to 15.0 percent); and increased in October (15.8 percent).
- In above-normal years, flows would be similar in April through December and reduced flows in January through March (up to 14.8 percent).
- In below-normal years, flows would be similar in April through November and reduced flows in December through March (up to 24.0 percent).
- In dry years, flows would be similar in January through November and reduced flows in December (up to 7.4 percent).
- In critical dry years, flows would be similar in all months.

Changes in Delta Conditions

Delta outflow under Alternative 5 as compared to the Second Basis of Comparison are summarized below and shown on Figures 5.74 through 5.76.

- In wet years, average monthly Delta outflow would be increased in July through November, January, and April and May (up to 13,666 cfs) and reduced in December, February, March, and June (up to 1,713 cfs).
- In dry years, average monthly Delta outflow would be increased in July through May (up to 3,384 cfs) and reduced in June (526 cfs).

Changes in OMR Flows

The OMR conditions under Alternative 5 as compared to the Second Basis of Comparison are shown on Figures 5.77 through 5.79.

- Under Alternative 5, OMR flows would be negative except in April and May of all water year types. Under the Second Basis of Comparison, OMR flows would be negative in all months.
- In wet years, OMR flows would be more positive in September through February, April and May (up to 10,017 cfs) and more negative in March and June through August (up to 964 cfs).
- In dry years, OMR flows would be more positive in September through June (up to 4,724 cfs) and more negative in July and August (up to 2,620 cfs).

Changes in CVP and SWP Exports and Deliveries

Delta exports under Alternative 5 as compared to the Second Basis of Comparison are summarized in Table 5.110.

Table 5.110 Changes in Exports at Jones and Banks Pumping Plants under Alternative 5 as Compared to the Second Basis of Comparison

Water Year	Monthly Volume (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alternative 5												
Wet	408	505	564	514	532	592	202	202	444	667	718	627
Above Normal	376	423	561	407	405	496	127	92	315	590	705	625
Below Normal	381	456	588	387	359	397	103	55	208	663	632	561
Dry	370	394	513	392	315	318	80	41	205	577	333	433
Critical Dry	313	293	382	355	249	179	34	20	69	239	222	243
Second Basis of Comparison												
Wet	549	619	716	724	609	543	476	430	456	632	655	660
Above Normal	428	521	641	716	584	570	453	363	415	572	647	651
Below Normal	548	595	623	674	497	500	337	304	414	629	517	539
Dry	435	475	546	579	518	493	259	228	274	403	325	438
Critical Dry	340	345	455	433	406	266	134	121	132	139	203	249
Alternative 5 as Compared to Second Basis of Comparison												
Wet	-141	-115	-152	-210	-77	49	-274	-228	-11	35	63	-33
Above Normal	-51	-99	-79	-310	-179	-74	-326	-271	-100	17	58	-26
Below Normal	-167	-139	-35	-288	-138	-102	-234	-249	-205	34	115	22
Dry	-65	-81	-33	-187	-203	-175	-178	-186	-69	174	8	-5
Critical Dry	-27	-52	-73	-77	-157	-88	-100	-100	-63	101	19	-6
Alternative 5 as Compared to Second Basis of Comparison (percent change)												
Wet	-25.7	-18.5	-21.2	-29.1	-12.6	9.0	-57.6	-53.1	-2.5	5.6	9.6	-5.0
Above Normal	-12.0	-18.9	-12.3	-43.2	-30.7	-12.9	-72.0	-74.7	-24.2	3.0	8.9	-4.0
Below Normal	-30.5	-23.4	-5.6	-42.6	-27.7	-20.5	-69.5	-82.0	-49.7	5.4	22.3	4.0
Dry	-14.9	-17.1	-6.0	-32.3	-39.2	-35.5	-68.9	-81.8	-25.3	43.2	2.4	-1.0
Critical Dry	-7.9	-15.1	-16.0	-17.9	-38.6	-32.9	-74.9	-83.2	-47.7	72.3	9.6	-2.5

The following changes would occur in CVP and SWP exports under Alternative 5 as compared to the Second Basis of Comparison.

- Long-term average annual exports would be 1,096 TAF (19 percent) less under Alternative 5 as compared to the Second Basis of Comparison.
- In wet years, total exports would be similar in June and September; increased exports in March, July, and August (up to 9.6 percent); and reduced in October through February, April, and May (up to 57.6 percent).
- In above-normal years, total exports would be similar in July and September; increased exports in August (8.9 percent); and reduced in October through June (up to 74.7 percent).
- In below-normal years, total exports would be similar in September; increased exports in July and August (up to 22.3 percent); and reduced in October through June (up to 82.0 percent).
- In dry years, total exports would be similar in August and September; increased in July (43.2 percent); and reduced exports in October through June (up to 81.8 percent).
- In critical dry years, total exports would be similar in September; increased in July and August (up to 72.3 percent); and reduced exports in October through June (up to 83.2 percent).

Deliveries to CVP and SWP water users would decline under Alternative 5 as compared to the Second Basis of Comparison, as summarized in Tables 5.111 and 5.112, respectively, due to reduced water supply availability and export limitations.

Table 5.111 Changes CVP Water Deliveries under Alternative 5 as Compared to the Second Basis of Comparison

Annual Average Deliveries (TAF)					
				Alternative 5 as compared to the Second Basis of Comparison	
		Alternative 5	Second Basis of Comparison	Difference	Percent Change
North of Delta					
CVP Agricultural Water Service Contractors	Long Term	185	219	-34	-16
	Dry	85	122	-37	-30
	Critical Dry	24	35	-11	-31
CVP M&I (Including American River Contractors and Contra Costa Water District)	Long Term	386	392	-6	-2
	Dry	384	390	-6	-2
	Critical Dry	384	383	1	0
CVP M&I American River Contractors	Long Term	112	120	-7	-6
	Dry	96	105	-9	-9
	Critical Dry	74	79	-6	-8
CVP Sacramento River Settlement Contractors	Long Term	1,861	1,858	3	0
	Dry	1,906	1,905	1	0
	Critical Dry	1,747	1,732	15	1
CVP Refuge Level 2 Deliveries	Long Term	146	155	-8	-5
	Dry	145	151	-6	-4
	Critical Dry	103	105	-2	-2
Total CVP Agricultural, M&I, Sacramento River Settlement Contractors, and Refuge Level 2 Deliveries	Long Term	2,578	2,624	-46	-2
	Dry	2,520	2,568	-48	-2
	Critical Dry	2,258	2,255	3	0

Annual Average Deliveries (TAF)					
				Alternative 5 as compared to the Second Basis of Comparison	
		Alternative 5	**Second Basis of Comparison**	**Difference**	**Percent Change**
South of Delta (Does not include Eastside Contractors)					
CVP Agricultural Users Water Service Contractors	Long Term	834	1,100	-266	-24
	Dry	433	650	-217	-33
	Critical Dry	130	195	-65	-33
CVP M&I Users	Long Term	112	125	-13	-10
	Dry	100	109	-9	-8
	Critical Dry	80	85	-5	-6
San Joaquin River Exchange Contractors	Long Term	852	852	0	0
	Dry	875	875	0	0
	Critical Dry	741	741	0	0
CVP Refuge Level 2 Deliveries	Long Term	273	272	0	0
	Dry	281	280	1	0
	Critical Dry	232	232	0	0
Total CVP Agricultural, M&I, San Joaquin River Exchange Contractors, and Refuge Level 2 Deliveries	Long Term	2,071	2,349	-278	-12
	Dry	1,689	1,914	-225	-12
	Critical Dry	1,183	1,253	-70	-6
Eastside Contractors Deliveries					
Water Rights	Long Term	502	514	-12	-2
	Dry	524	524	0	0
	Critical Dry	406	486	-80	-16
CVP Water Service Contracts	Long Term	100	118	-19	-16
	Dry	69	98	-29	-30
	Critical Dry	8	25	-17	-68

Annual Average Deliveries (TAF)					
				Alternative 5 as compared to the Second Basis of Comparison	
		Alternative 5	**Second Basis of Comparison**	**Difference**	**Percent Change**
Total Water Rights and CVP Service Contracts Deliveries	Long Term	602	632	-30	-5
	Dry	593	622	-29	-5
	Critical Dry	414	511	-97	-19

The following changes in CVP water deliveries would occur under Alternative 5 as compared to the Second Basis of Comparison.

- Deliveries to CVP North of Delta agricultural water service contractors would be reduced by 16 percent over the long-term conditions, 30 percent in dry years, and 31 percent in critical dry years.
- Deliveries to CVP North of Delta M&I contractors would be similar in long-term conditions and dry and critical dry years; however, American River Contractors would be reduced by 6 percent over the long-term conditions, 9 percent in dry years, and 8 percent in critical dry years.
- Deliveries to CVP South of Delta agricultural water service contractors would be reduced by 24 percent over the long-term conditions, 33 percent in dry years, and 33 percent in critical dry years.
- Deliveries to CVP South of Delta M&I contractors would be reduced by 10 percent in long-term conditions, 8 percent in dry years, and 6 percent in critical dry years.
- Deliveries to the Eastside contractors would be reduced by 5 percent under long-term conditions and dry years and 19 percent in critical dry years.

1 **Table 5.112 Changes SWP Water Deliveries under Alternative 5 as Compared to the**
2 **Second Basis of Comparison**

Annual Average Deliveries (TAF)					
				Alternative 5 as compared to the Second Basis of Comparison	
		Alternative 5	**Second Basis of Comparison**	**Difference**	**Percent Change**
North of Delta					
SWP Agricultural Uses	Long Term	0	0	0	0
	Dry	0	0	0	0
	Critical Dry	0	0	0	0
SWP M&I (without Article 21)	Long Term	67	83	-16	-19
	Dry	51	62	-11	-18
	Critical Dry	42	53	-11	-21
SWP M&I Article 21 Deliveries	Long Term	13	12	1	13
	Dry	14	13	1	11
	Critical Dry	13	12	1	15
Total SWP Agricultural and M&I (without Article 21)	Long Term	67	83	-16	-19
	Dry	51	62	-11	-18
	Critical Dry	42	53	-11	-21
Total SWP Agricultural and M&I Article 21 Deliveries	Long Term	13	12	1	13
	Dry	14	13	1	11
	Critical Dry	13	12	1	15
South of Delta					
SWP Agricultural Users (without Article 21)	Long Term	598	750	-152	-20
	Dry	449	567	-118	-21
	Critical Dry	369	484	-115	-24

Annual Average Deliveries (TAF)					
		Alternative 5	Second Basis of Comparison	Alternative 5 as compared to the Second Basis of Comparison	
				Difference	Percent Change
SWP Agricultural Article 21 Deliveries	Long Term	24	178	-154	-86
	Dry	6	143	-137	-96
	Critical Dry	4	100	-96	-96
SWP M&I Users (without Article 21)	Long Term	1,784	2,183	-399	-18
	Dry	1,397	1,732	-335	-19
	Critical Dry	1,157	1,494	-337	-23
SWP M&I Article 21 Deliveries	Long Term	19	104	-83	-82
	Dry	5	86	-82	-95
	Critical Dry	3	58	-55	-95
Total SWP Agricultural and M&I Users (without Article 21)	Long Term	2,383	2,933	-550	-19
	Dry	1,845	2,299	-454	-20
	Critical Dry	1,526	1,978	-452	-23
Total SWP Agricultural and M&I Article 21 Deliveries	Long Term	43	282	-239	-85
	Dry	11	229	-218	-95
	Critical Dry	7	158	-151	-95

The following changes in SWP water deliveries would occur under Alternative 5 as compared to the Second Basis of Comparison.

- Deliveries without Article 21 water to SWP North of Delta water contractors would be reduced by 19 percent over the long-term conditions, 18 percent in dry years, and 21 percent in critical dry years.
- Deliveries without Article 21 water to SWP South of Delta water contractors would be reduced by 19 percent over the long-term conditions, 20 percent in dry years, and 23 percent in critical dry years.

- Deliveries of Article 21 water to SWP North of Delta water contractors would be increased by 13 percent over the long-term conditions, 11 percent in dry years, and 15 percent in critical dry years.
- Deliveries of Article 21 water to SWP South of Delta water contractors would be reduced by 85 percent over the long-term conditions, 95 percent in dry years, and 95 percent in critical dry years.

Effects Related to Cross Delta Water Transfers

Potential effects to surface water resources could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014i). Potential effects were identified as reduced surface water storage in upstream reservoirs and changes in flow patterns in river downstream of the reservoirs if water was released from the reservoirs in patterns that were different than would have been used by the water seller's. Because all water transfers would be required to avoid adverse impacts to other water users and biological resources (see Section 3.A.6.3, Transfers), including impacts associated with changes in reservoir storage and river flow patterns, the analysis indicated that water transfers would not result in substantial changes in storage or river flows. For the purposes of this EIS, it is anticipated that similar conditions would occur due to cross Delta water transfers under Alternative 5 and the Second Basis of Comparison.

Under Alternative 5, the timing of cross Delta water transfers would be limited to July through September in accordance with the 2008 USFWS BO and 2009 NMFS BO. The maximum amount of water to be transferred would be 600,000 acre-feet per year in critical dry years or in dry years following a dry or critical dry year. In all other water year types, the maximum amount of water would be 360,000 acre-feet per year. The maximum amount of water that can be exported in the CVP and SWP facilities is approximately 770,000 acre-feet per month. As indicated in Table 5.110, capacity would be available under Alternative 5 between July and September for water transfers in all water year types.

Under the Second Basis of Comparison, water could be transferred throughout the year. As indicated in Table 5.110, capacity would be available under the Second Basis of Comparison in all months of all water year types without a maximum volume of transferred water.

Overall, the potential for water transfer conveyance would be less under Alternative 5 than under the Second Basis of Comparison.

San Francisco Bay Area, Central Coast, and Southern California Regions

Potential Changes in Surface Water Resources at Reservoirs that Store CVP and SWP Water

The San Francisco Bay Area, Central Coast, and Southern California regions include numerous reservoirs that store CVP and SWP water supplies, including CVP and SWP reservoirs, that primarily provide water supplies for M&I water users. Changes in the availability CVP and SWP water supplies for storage in these reservoirs under Alternative 5 as compared to the Second Basis of Comparison would be consistent with the following changes in water deliveries to M&I water users, as summarized in Tables 5.111 and 5.112.

- Deliveries to CVP South of Delta M&I contractors would be reduced by 10 percent in long-term conditions, 9 percent in dry years, and 8 percent in critical dry years.
- Deliveries without Article 21 water to SWP South of Delta water contractors would be reduced by 19 percent over the long-term conditions, 20 percent in dry years, and 23 percent in critical dry years.
- Deliveries of Article 21 water to SWP South of Delta water contractors would be reduced by 85 percent over the long-term conditions, 95 percent in dry years, and 95 percent in critical dry years.

Changes in CVP and SWP Exports and Deliveries

Deliveries to CVP and SWP water users are described above in the Central Valley Region.

5.4.3.7 Summary of Impact Analysis

The results of the impact analysis on surface water conditions and water supplies due to implementation of Alternatives 1 through 5 as compared to the No Action Alternative and the Second Basis of Comparison are presented in Tables 5.113 through 5.116.

Table 5.113 Comparison of Surface Water Conditions under Alternatives 1 through 5 to the No Action Alternative

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	**Trinity Lake** In wet years and dry years, storage would be similar in all months. In above-normal years, storage would be similar in January through October and increased in November and December (up to 6 percent). In below-normal years, storage would be similar in January through October and increased in November and December (up to 5 percent). In critical dry years, storage would be increased in all months (up to 12 percent). In all months, in all water year types, surface water elevations would be similar. **Trinity River downstream of Lewiston Dam** Over long-term conditions, flows would be similar in March through November; and increased in December through February (up to 11 percent). In wet years, flows would be similar in April through November and increased in December through March (up to 13 percent). In dry years, flows would be similar all months. **Shasta Lake** In wet years, storage would be similar in December through August and October and increased in September and November (up to 9 percent).	Environmental effects associated with changes in the following physical conditions are related to impacts on biological resources (as described in Chapter 9, Fish and Aquatic Resources, and Chapter 10, Terrestrial Biological Resources), and recreation resources (as described in Chapter 15, Recreation Resources). Mitigation measures, if needed, related to environmental changes caused by changes in surface water conditions are presented in Chapters 9, 10, and 15.

Alternative	Potential Change	Consideration for Mitigation Measures
	In above-normal years, storage would be similar in January through September and increased in October through December (up to 8 percent). In below-normal years, storage would be similar in March through September and increased in October through February (up to 12 percent). In dry years, storage would be similar in February through October and increased in November through January (up to 7 percent). In critical dry years, storage would be increased under all months (up to 17 percent). In all months, in all water year types, surface water elevations would be similar. **Sacramento River at Keswick** Over long-term conditions, similar flows would occur in October, February through May, July, and August; reduced flows in September and November (up to 27 percent); and increased flows in December, January, and June (up to 8 percent). In wet years, similar flows would occur in January through July; reduced flows in September through November (up to 44 percent); and increased flows in December and August (up to 17 percent). In dry years, similar flows would occur in July through October, December through March, and May; reduced flows in November (25 percent); and increased flows in April and June (up to 8 percent). **Sacramento River at Freeport** Over long-term conditions, similar flows would occur in October, December through May, and August; reduced flows in September, November, and July (up to 30 percent); and increased flows in June (13 percent). In wet years, similar flows would occur in January through June and October; reduced flows in July through September and November (up to 47 percent); and increased flows in December (7 percent). In dry years, similar flows would occur in August through October and December through April; reduced flows in November and July (up to 14 percent); and increased flows in May and June (up to 14 percent). **Lake Oroville** In wet years, storage would be similar in January through August and reduced in September through December (up to 22 percent). In above-normal years, storage would be similar in February through August and reduced in September through January (up to 15 percent). In below-normal years, storage would be similar in May through July and reduced in August through April (up to 22 percent). In dry years, storage would be similar in June and reduced in all other months (up to 14 percent). In critical dry years, storage would be similar under all months. In all months, in all water year types, surface water elevations would be similar. **Feather River downstream of Thermalito Complex** Over long-term conditions, similar flows would occur in November and April; reduced flows in July through September (up to 43 percent); and increased flows in October, December through March, May, and June (up to 37 percent).	

Alternative	Potential Change	Consideration for Mitigation Measures
	In wet years, similar flows would occur in October, November, and March through May; reduced flows in July through September (up to 65 percent); and increased flows in December through February and June (up to 35 percent). In dry years, similar flows would occur in December through April; reduced flows in July (34 percent); and increased flows in August through October, May, and June (up to 38 percent). **Folsom Lake** In wet years, storage would be similar in December through August; and increased in September through December (up to 12 percent). In above-normal years, storage would be similar in January through July and September through October; increased in November and December (up to 9 percent); and reduced in August (5 percent). In below-normal years, storage would be similar in February through May; reduced in June through September (up to 15 percent); and increased in October through January (up to 14 percent). In dry years, storage would be similar in all months. In critical dry years, storage would be similar in October through June and increased in July through September (up to 12 percent). In all months, in all water year types, surface water elevations would be similar. **American River downstream of Nimbus Dam** Over long-term conditions, similar flows would occur in November through May and July; reduced flows in September and October (up to 31 percent); and increased flows in June (5 percent). In wet years, similar flows would occur in October, November, and January through July; reduced flows in September (48 percent); and increased flows in August (12 percent). In dry years, similar flows would occur in November through January, March through June, August, and September; reduced flows in October (14 percent); and increased flows in February and July (up to 8 percent). **Clear Creek downstream of Whiskeytown Dam** Flows identical June through April and reduced in May (41 percent). **New Melones Reservoir** In wet years, storage would be similar in all months. In above normal years, storage would be similar in December through September and increased in October and November (up to 6 percent). In below normal years, storage would be similar in November through September and increased in October (5 percent). In dry years, storage would be similar in all months. In critical dry years, storage would be similar in July through September and increased in October through June (up to 8 percent). In all months, in all water year types, surface water elevations would be similar. **Stanislaus River downstream of Goodwin Dam** Over long-term conditions, similar flows would occur in July through September; reduced flows in October, March, and April (up to 60 percent); and increased flows in November through February and June (up to 51 percent).	

Alternative	Potential Change	Consideration for Mitigation Measures
	In wet years, similar flows would occur in February and April; reduced flows in October, March, May, July, and August (up to 54 percent); and increased flows in September, November through January, and June (up to 103 percent). In dry years, similar flows would occur in July through September; reduced flows in October and April (up to 61 percent); and increased flows in November through March, May, and June (up to 56 percent). **San Joaquin River at Vernalis** Over long-term conditions, similar flows would occur in July through September and November through May; reduced flows in October (16 percent); and increased flows in June (8 percent). In wet years, similar flows would occur in July through September and November through May; reduced flows in October (14 percent); and increased flows in June (10 percent). In dry years, similar flows would occur in November through March and May through September and reduced flows in October and April (up to 15 percent). **San Luis Reservoir** In wet years, storage would be increased in all months (up to 109 percent). Water storage elevations would be increased in all months (up to 12 percent). In above-normal years, storage would be increased in all months (up to 151 percent). Water storage elevations would be increased in all months (up to 15 percent). In below-normal years, storage would be increased in all months (up to 203 percent). Water storage elevations would be increased in all months (up to 19 percent). In dry years, storage would be increased in all months (up to 70 percent). Water storage elevations would be increased in all months (up to 12 percent). In critical dry years, storage would be increased in all months (up to 57 percent). Water storage elevations would be increased in all months (up to 11 percent). **Yolo Bypass** In wet years, flows into Yolo Bypass would be similar in January through September; reduced in October (20 percent); and increased in November and December (up to 17 percent). In above-normal years, flows into Yolo Bypass would be similar in April through December and increased in January through March (up to 16 percent). In below-normal years, flows into Yolo Bypass would be similar in April through November and increased in December through March (up to 34 percent). In dry years, flows into Yolo Bypass would be similar in January through November and increased in December (6 percent). In critical dry years, flows into Yolo Bypass would be similar in all months. **Delta Outflow** In wet years, average monthly Delta outflow would increase in December, February, March, and June (up to 1,492 cfs) and decrease in July through November, January, April, and May (up to 13,683 cfs). In dry years, average monthly Delta outflow would be similar in September; decrease in July, August, and October through May (up to 3,114 cfs); and increase in June (385 cfs).	

Alternative	Potential Change	Consideration for Mitigation Measures
	Reverse Flows in Old and Middle Rivers In wet years, average monthly OMR flows, would be more positive in June through August and March (up to 923 cfs) and more negative in April through June and September through February (up to 10,005 cfs). In dry years, average monthly OMR flows would be positive in July (up to 2,073 cfs) and more negative in August through June (up to 3,489 cfs).	
Alternative 2	Surface water conditions identical under Alternative 2 as under No Action Alternative.	None needed.
Alternative 3	**Trinity Lake** In wet, above-normal years, below normal, and dry years, storage would be similar in all months. In critical dry years, storage would be increased in all months (up to 12 percent). In all months, in all water year types, surface water elevations would be similar. **Trinity River downstream of Lewiston Dam** Over long-term conditions, flows would be similar in March through November; and increased in December through February (up to 12 percent). In wet years, flows would be similar in April through October; reduced in November (7 percent); and increased in December through March (up to 15 percent). In dry years, flows would be similar in all months. **Shasta Lake** In wet years, storage would be similar in December through August and increased in September and November (up to 9 percent). In above-normal years, storage would be similar in January through October and increased in November and December (up to 7 percent). In below-normal years, storage would be similar in March through September; and increased in October through February (up to 12 percent). In dry years, storage would be similar in March through October and increased in November through January (up to 7 percent). In critical dry years, storage would increase in all months (up to 12 percent). In all months, in all water year types, surface water elevations would be similar. **Sacramento River at Keswick** Over long-term conditions, similar flows would occur in October, February through May, July, and August; reduced flows in September and November (up to 20 percent); and increased flows in December, January, and June (up to 9 percent). In wet years, similar flows would occur in February through August; reduced flows in September through November (up to 42 percent); and increased flows in December and January (up to 17 percent). In dry years, similar flows would occur in July through September and December through May; reduced flows in November (25 percent) and increased flows in January and June (up to 7 percent). **Sacramento River at Freeport** Over long-term conditions, similar flows would occur in October, December through May, July, and August; reduced flows in September and November (up to 30 percent); and increased flows in June (12 percent).	Environmental effects associated with changes in the following physical conditions are related to impacts on biological resources (as described in Chapter 9, Fish and Aquatic Resources, and Chapter 10, Terrestrial Biological Resources), and recreation resources (as described in Chapter 15, Recreation Resources). Mitigation measures, if needed, related to environmental changes caused by changes in surface water conditions are presented in Chapters 9, 10, and 15.

Alternative	Potential Change	Consideration for Mitigation Measures
	In wet years, similar flows would occur in January through May, July, and October; reduced flows in August, September, and November (up to 48.1 percent); and increased flows in December and June (up to 7 percent). In dry years, similar flows would occur in July through October and December through April; reduced flows in November (14 percent); and increased flows in May and June (up to 16 percent). **Lake Oroville** In wet years, storage would be similar in January through August and increased in September through December (up to 19 percent). In above-normal years, storage would be similar in February through August; and increased in September through January (up to 19 percent). In below-normal years, storage would be similar in June through September; and increased in October through May (up to 23 percent). In dry years, storage would be similar in May through September and increased in October through April (up to 12 percent). In critical dry years, storage would be similar under all months. In all months, in all water year types, surface water elevations would be similar. **Feather River downstream of Thermalito Complex** Over long-term conditions, similar flows would occur in October, November, March, April, and July; reduced flows in August and September (up to 49 percent); and increased flows in December through February, May, and June (up to 34 percent). In wet years, similar flows would occur in October, November, February through May, and July; reduced flows in August and September (up to 70 percent) and increased flows in December, January, and June (up to 28 percent). In dry years, similar flows would occur in September and January through April; reduced flows in October through December and July (up to 14 percent); and increased flows in May, June, and August (37 percent). **Folsom Lake** In wet years, storage would be similar in December through August and increased in September through December (up to 12 percent). In above-normal years, storage would be similar in January through June, September, and October; increased in November and December (up to 6 percent); and reduced in July and August (up to 7 percent). In below-normal years, storage would be similar in February through July; reduced in August and September (up to 10 percent); and increased in October through January (up to 15 percent). In dry years, storage would be similar in all months. In critical dry years, storage would be similar in October through July and increased in August and September (up to 12 percent). In all months, in all water year types, surface water elevations would be similar. **American River downstream of Nimbus Dam** Over long-term conditions, similar flows would occur in November, January through May, July, and August; reduced flows in September and October (up to 29 percent); and increased flows in June (6 percent).	

Alternative	Potential Change	Consideration for Mitigation Measures
	In wet years, similar flows would occur in October, November, and January through July; reduced flows in September (46 percent); and increased flows in August and December (up to 9 percent). In dry years, similar flows would occur in November through January and March through September; reduced flows in October (11 percent); and increased flows in February (6 percent). **Clear Creek downstream of Whiskeytown Dam** Flows would be identical June through April and reduced in May (29 percent). **New Melones Reservoir** In wet years, storage would be increased in all months (up to 13 percent). In above-normal years, storage would be increased in all months (up to 23 percent). In below-normal years, storage would be increased in all months (up to 20 percent). In dry years, storage would be increased in all months (up to 25 percent). In critical dry years, storage would be increased in all months (up to 38 percent). In all months, in all water year types, surface water elevations would be similar. **Stanislaus River downstream of Goodwin Dam** Over long-term conditions, reduced flows would occur in October and March through June (up to 58 percent) and increased flows in November through February and July through September (up to 37 percent). In wet years, similar flows would occur in April; reduced flows in October, March, and May (up to 53 percent) and increased flows in June through September and November through February (up to 68 percent). In dry years, similar flows would occur in March and July through September; reduced flows in October and April through June (up to 60 percent); and increased flows in November through February (up to 37 percent). **San Joaquin River at Vernalis** Over long-term conditions, similar flows would occur in November through September and reduced flows in October (16 percent). In wet years, similar flows would occur in November through August; reduced flows in October (14 percent); and increased flows in September (6 percent). In dry years, similar flows would occur in November through March and July through September and reduced flows in October and April through June (up to 15 percent). **San Luis Reservoir** In wet years, storage would be increased in all months (up to 96 percent). Water storage elevations would be increased in all months (up to 13 percent). In above-normal years, storage would be increased in all months (up to 111 percent). Water storage elevations would be similar in October through March and increased in April through September (up to 11 percent). In below-normal years, storage would be increased in all months (up to 107 percent). Water storage elevations would be similar in September and increased in October through August (up to 11 percent).	

Alternative	Potential Change	Consideration for Mitigation Measures
	In dry years, storage would be similar in September; and increased in October through August (up to 52 percent). Water storage elevations would be similar December through May and July through October and increased in November and June (up to 7 percent). In critical dry years, storage would be similar in February through May and increased in June through January (up to 29 percent). Water storage elevations would be similar in all months. **Yolo Bypass** In wet years, flows into Yolo Bypass would be similar in January through September; reduced in October (25 percent); and increased in November and December (up to 15 percent). In above-normal years, storage would be similar in April through January and increased in February and March (up to 17 percent). In below-normal years, flows into Yolo Bypass would be similar in April through November and increased in December through March (up to 32 percent). In dry years, flows into Yolo Bypass would be similar in January through November and increased in December (6 percent). In critical dry years, flows into Yolo Bypass would be similar in all months. **Delta Outflow** In wet years, average monthly Delta outflow would increase in December through March (up to 3,307 cfs) and decrease in April through November (up to 13,678 cfs). In dry years, average monthly Delta outflow would increase in January, February, June, and July (up to 277 cfs) and decrease in August through December and March through May (up to 2,902 cfs). **Reverse Flows in Old and Middle Rivers** In wet years, average monthly OMR flows would be more positive in July and August (up to 800 cfs) and more negative in September through June (up to 4,477 cfs). In dry years, average monthly OMR flows would be more positive in July and January (up to 728 cfs) and more negative in August through December and February through June (up to 1,847 cfs).	
Alternative 4	**Trinity Lake** In wet years and dry years, storage would be similar in all months. In above-normal years, storage would be similar in January through October and increased in November and December (up to 6 percent). In below-normal years, storage would be similar in January through October and increased in November and December (up to 5 percent). In critical dry years, storage would be increased in all months (up to 12 percent). In all months, in all water year types, surface water elevations would be similar. **Trinity River downstream of Lewiston Dam** Over long-term conditions, flows would be similar in March through November; and increased in December through February (up to 11 percent). In wet years, flows would be similar in April through November and increased in December through March (up to 13 percent). In dry years, flows would be similar all months.	Environmental effects associated with changes in the following physical conditions are related to impacts on biological resources (as described in Chapter 9, Fish and Aquatic Resources, and Chapter 10, Terrestrial Biological Resources), and recreation resources (as described in Chapter 15, Recreation Resources). Mitigation measures, if needed, related to environmental changes caused by changes in surface water conditions are presented in Chapters 9, 10, and 15.

Alternative	Potential Change	Consideration for Mitigation Measures
	Shasta Lake In wet years, storage would be similar in December through August and October and increased in September and November (up to 9 percent). In above-normal years, storage would be similar in January through September and increased in October through December (up to 8 percent). In below-normal years, storage would be similar in March through September and increased in October through February (up to 12 percent). In dry years, storage would be similar in February through October and increased in November through January (up to 7 percent). In critical dry years, storage would be increased under all months (up to 17 percent). In all months, in all water year types, surface water elevations would be similar. **Sacramento River at Keswick** Over long-term conditions, similar flows would occur in October, February through May, July, and August; reduced flows in September and November (up to 27 percent); and increased flows in December, January, and June (up to 8 percent). In wet years, similar flows would occur in January through July; reduced flows in September through November (up to 44 percent); and increased flows in December and August (up to 17 percent). In dry years, similar flows would occur in July through October, December through March, and May; reduced flows in November (25 percent); and increased flows in April and June (up to 8 percent). **Sacramento River at Freeport** Over long-term conditions, similar flows would occur in October, December through May, and August; reduced flows in September, November, and July (up to 30 percent); and increased flows in June (13 percent). In wet years, similar flows would occur in January through June and October; reduced flows in July through September and November (up to 47 percent); and increased flows in December (7 percent). In dry years, similar flows would occur in August through October and December through April; reduced flows in November and July (up to 14 percent); and increased flows in May and June (up to 14 percent). **Lake Oroville** In wet years, storage would be similar in January through August and reduced in September through December (up to 22 percent). In above-normal years, storage would be similar in February through August and reduced in September through January (up to 15 percent). In below-normal years, storage would be similar in May through July and reduced in August through April (up to 22 percent). In dry years, storage would be similar in June and reduced in all other months (up to 14 percent). In critical dry years, storage would be similar under all months. In all months, in all water year types, surface water elevations would be similar.	

Alternative	Potential Change	Consideration for Mitigation Measures
	Feather River downstream of Thermalito Complex Over long-term conditions, similar flows would occur in November and April; reduced flows in July through September (up to 43 percent); and increased flows in October, December through March, May, and June (up to 37 percent). In wet years, similar flows would occur in October, November, and March through May; reduced flows in July through September (up to 65 percent); and increased flows in December through February and June (up to 35 percent). In dry years, similar flows would occur in December through April; reduced flows in July (34 percent); and increased flows in August through October, May, and June (up to 38 percent). **Folsom Lake** In wet years, storage would be similar in December through August; and increased in September through December (up to 12 percent). In above-normal years, storage would be similar in January through July and September through October; increased in November and December (up to 9 percent); and reduced in August (5 percent). In below-normal years, storage would be similar in February through May; reduced in June through September (up to 15 percent); and increased in October through January (up to 14 percent). In dry years, storage would be similar in all months. In critical dry years, storage would be similar in October through June and increased in July through September (up to 12 percent). In all months, in all water year types, surface water elevations would be similar. **American River downstream of Nimbus Dam** Over long-term conditions, similar flows would occur in November through May and July; reduced flows in September and October (up to 31 percent); and increased flows in June (5 percent). In wet years, similar flows would occur in October, November, and January through July; reduced flows in September (48 percent); and increased flows in August (12 percent). In dry years, similar flows would occur in November through January, March through June, August, and September; reduced flows in October (14 percent); and increased flows in February and July (up to 8 percent). **Clear Creek downstream of Whiskeytown Dam** Flows identical June through April and reduced in May (41 percent). **New Melones Reservoir** In wet years, storage would be similar in all months. In above normal years, storage would be similar in December through September and increased in October and November (up to 6 percent). In below normal years, storage would be similar in November through September and increased in October (5 percent). In dry years, storage would be similar in all months. In critical dry years, storage would be similar in July through September and increased in October through June (up to 8 percent).	

Alternative	Potential Change	Consideration for Mitigation Measures
	In all months, in all water year types, surface water elevations would be similar. **Stanislaus River downstream of Goodwin Dam** Over long-term conditions, similar flows would occur in July through September; reduced flows in October, March, and April (up to 60 percent); and increased flows in November through February and June (up to 51 percent). In wet years, similar flows would occur in February and April; reduced flows in October, March, May, July, and August (up to 54 percent); and increased flows in September, November through January, and June (up to 103 percent). In dry years, similar flows would occur in July through September; reduced flows in October and April (up to 61 percent); and increased flows in November through March, May, and June (up to 56 percent). **San Joaquin River at Vernalis** Over long-term conditions, similar flows would occur in July through September and November through May; reduced flows in October (16 percent); and increased flows in June (8 percent). In wet years, similar flows would occur in July through September and November through May; reduced flows in October (14 percent); and increased flows in June (10 percent). In dry years, similar flows would occur in November through March and May through September and reduced flows in October and April (up to 15 percent). **San Luis Reservoir** In wet years, storage would be increased in all months (up to 109 percent). Water storage elevations would be increased in all months (up to 12 percent). In above-normal years, storage would be increased in all months (up to 151 percent). Water storage elevations would be increased in all months (up to 15 percent). In below-normal years, storage would be increased in all months (up to 203 percent). Water storage elevations would be increased in all months (up to 19 percent). In dry years, storage would be increased in all months (up to 70 percent). Water storage elevations would be increased in all months (up to 12 percent). In critical dry years, storage would be increased in all months (up to 57 percent). Water storage elevations would be increased in all months (up to 11 percent). **Yolo Bypass** In wet years, flows into Yolo Bypass would be similar in January through September; reduced in October (20 percent); and increased in November and December (up to 17 percent). In above-normal years, flows into Yolo Bypass would be similar in April through December and increased in January through March (up to 16 percent). In below-normal years, flows into Yolo Bypass would be similar in April through November and increased in December through March (up to 34 percent). In dry years, flows into Yolo Bypass would be similar in January through November and increased in December (6 percent). In critical dry years, flows into Yolo Bypass would be similar in all months.	

Alternative	Potential Change	Consideration for Mitigation Measures
	Delta Outflow In wet years, average monthly Delta outflow would increase in December, February, March, and June (up to 1,492 cfs) and decrease in July through November, January, April, and May (up to 13,683 cfs). In dry years, average monthly Delta outflow would be similar in September; decrease in July, August, and October through May (up to 3,114 cfs); and increase in June (385 cfs). **Reverse Flows in Old and Middle Rivers** In wet years, average monthly OMR flows, would be more positive in June through August and March (up to 923 cfs) and more negative in April through June and September through February (up to 10,005 cfs). In dry years, average monthly OMR flows would be positive in July (up to 2,073 cfs) and more negative in August through June (up to 3,489 cfs).	
Alternative 5	**Trinity Lake** Similar storage and surface water elevations in all months and all water year types. **Trinity River downstream of Lewiston Dam** Similar flows in all months for long-term conditions and wet and dry years. **Shasta Lake** Similar storage and surface water elevations in all months and all water year types. **Sacramento River at Keswick** Similar flows in all months for long-term conditions and wet and dry years. **Sacramento River at Freeport** Similar flows in all months for long-term conditions and wet and dry years. **Lake Oroville** Similar storage and surface water elevations in all months and all water year types. **Feather River downstream of Thermalito Complex** Over long-term conditions, similar flows would occur in June through April and reduced flows in May (7 percent). In wet years, similar flows would occur in all months. In dry years, similar flows would occur in September through April and June; reduced flows in May (27 percent); and increased flows in July and August (up to 9 percent). **Folsom Lake** Similar storage and surface water elevations in all months and all water year types. **American River downstream of Nimbus Dam** Similar flows in all months for long-term conditions and wet and dry years. **Clear Creek downstream of Whiskeytown Dam** Flows would be identical in all months. **New Melones Reservoir** In wet years, storage would be similar in all months. In above normal years, storage would be similar in October through June and reduced in July through September (up to 6 percent). In below normal years, storage would be reduced in all months (up to 9 percent). In dry years, storage would be reduced in all months (up to 10 percent).	Environmental effects associated with changes in stream flows and reservoir storage related to fish and aquatic resources, terrestrial resources, and recreation are related to impacts on biological resources (as described in Chapter 9, Fish and Aquatic Resources, and Chapter 10, Terrestrial Biological Resources), and recreation resources (as described in Chapter 15, Recreation Resources). Mitigation measures, if needed, related to environmental changes caused by changes in surface water conditions are presented in Chapters 9, 10, and 15.

Alternative	Potential Change	Consideration for Mitigation Measures
	In critical dry years, storage would be reduced in all months (up to 19 percent). In all months, in all water year types, surface water elevations would be similar. **Stanislaus River downstream of Goodwin Dam** Over long-term conditions, flows would be similar in September through February and June; reduced flows would occur in March, July, and August (up to 8 percent); and increased flows in April and May (up to 22 percent). In wet years, similar flows would occur in October, November, January, February, and April through June and reduced flows in December, March, and July through September (up to 18 percent). In dry years, similar flows would occur in June through March and increased flows in April and May (up to 47 percent). **San Joaquin River at Vernalis** Over long-term conditions and wet years, similar flows would occur in all months. In dry years, similar flows would occur in June through March and increased flows in April and May (up to 16 percent). **San Luis Reservoir** In wet years, storage would be similar in January through May and increased in June through December (up to 10 percent). In above-normal years, storage would be similar in all months. In below-normal years, storage would be similar in November, February through April, August, and September; reduced in June and July (up to 9 percent); and increased in October, December, January, and May (up to 8 percent). In dry years, storage would be similar in October through March; and reduced in April through September (up to 17 percent). In critical dry years, storage would be similar in February and March and reduced in April through January (up to 18 percent). Surface water elevations would be similar in all months, in all water years. **Yolo Bypass** Similar flows into the Yolo Bypass in all months and all water year types. **Delta Outflow** In wet years, average monthly Delta outflow would be similar. In dry years, average monthly Delta outflow would be similar in July through April and increased in May and June (up to 1,377 cfs). **Reverse Flows in Old and Middle Rivers** In wet years, OMR flows would be more positive or no change in September, October, January, and April through June (up to 171 cfs) and more negative in November, December, March, and August (up to 124 cfs). In dry years, OMR flows would be more positive or no change in October through March (up to 1,359 cfs) and more negative in June through September (up to 568 cfs).	

Table 5.114 Comparison of CVP and SWP Water Supply Deliveries under Alternatives 1 through 5 to the No Action Alternative

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	Long-term average annual exports would be 1,051 TAF (22 percent) more under Alternative 1 as compared to the No Action Alternative. Deliveries to CVP North of Delta agricultural water service contractors would be increased by 18 percent over the long-term conditions, 43 percent in dry years, and 50 percent in critical dry years. Deliveries to CVP North of Delta M&I contractors would be similar in total; however, deliveries to the American River CVP contractors would be increased by 6 percent over the long-term conditions, 8 percent in dry years, and 7 percent in critical dry years. Deliveries to CVP South of Delta agricultural water service contractors would be increased by 30 percent over the long-term conditions, 46 percent in dry years, and 49 percent in critical dry years. Deliveries to CVP South of Delta M&I contractors would be increased by 12 percent over the long-term conditions, 10 percent in dry years, and 5 percent in critical dry years. Deliveries to the Eastside contractors would be similar under long-term conditions and in dry years, but increased by 14 percent in critical dry years. Deliveries under Table A contracts without Article 21 water to SWP North of Delta water contractors would be increased by 22 percent over the long-term conditions, 22 percent in dry years, and 25 percent in critical dry years. Deliveries under Table A contracts without Article 21 water to SWP South of Delta water contractors would be increased by 22 percent over the long-term conditions, 24 percent in dry years, and 28 percent in critical dry years.	None needed.
Alternative 2	Water supply conditions identical under Alternative 2 as under No Action Alternative.	None needed.
Alternative 3	Long-term average annual exports would be 726 TAF (15 percent) more under Alternative 3 as compared to the No Action Alternative. Deliveries to CVP North of Delta agricultural water service contractors would be increased by 13 percent over the long-term conditions and 29 percent in dry and critical dry years. Deliveries to CVP North of Delta M&I contractors would be similar in total; however, deliveries to the American River CVP contractors would increase by 5 percent over the long-term conditions and 7 percent in dry years, but remain similar in critical dry years. Deliveries to CVP South of Delta agricultural water service contractors would be increased by 28 percent over the long-term conditions, 34 percent in dry years, and 27 percent in critical dry years. Deliveries to CVP South of Delta M&I contractors would be similar in critical dry years and increased by 10 percent over the long-term conditions and 8 percent in dry years. Deliveries to the Eastside contractors would be similar under long-term conditions and dry years and increased by 14 percent in critical dry years.	None needed.

Alternative	Potential Change	Consideration for Mitigation Measures
	Deliveries under Table A contracts without Article 21 water to SWP North of Delta water contractors would be increased by 17 percent over the long-term conditions and in dry years and 13 percent in critical dry years. Deliveries under Table A contracts without Article 21 water to SWP South of Delta water contractors would be increased by 17 percent over the long-term conditions and in dry years and 14 percent in critical dry years.	
Alternative 4	Same water supply conditions as described for Alternative 1 compared to the No Action Alternative.	None needed.
Alternative 5	Long-term average annual exports would be 45 TAF (1 percent) less under Alternative 5 as compared to the No Action Alternative. Deliveries to CVP North of Delta agricultural water service contractors would be similar over the long-term conditions and in dry and critical dry years. Deliveries to CVP North of Delta M&I contractors would be similar over the long-term conditions and in dry and critical dry years in total and for the American River CVP contractors. Deliveries to CVP South of Delta agricultural water service contractors would be similar over the long-term conditions and in dry and critical dry years. Deliveries to CVP South of Delta M&I contractors would be similar over the long-term conditions and in dry and critical dry years. Deliveries to the Eastside contractors would be similar under long-term conditions and dry years; and reduced by 8 percent in critical dry years. Deliveries under Table A contracts without Article 21 water to SWP North of Delta water contractors would be similar over the long-term conditions and in dry and critical dry years. Deliveries under Table A contracts without Article 21 water to SWP South of Delta water contractors would be similar over the long-term conditions and in dry and critical dry years.	To mitigate reductions of up to 7 percent in critical dry years to the Eastside Contractors, Reclamation would support water transfers from other basin water rights holders to the Eastside Contractors.

Note: Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools, incremental differences of 5 percent or less between alternatives and the No Action Alternative are considered to be "similar."

Table 5.115 Comparison of Surface Water Conditions under the No Action Alternative and Alternatives 1 through 5 to the Second Basis of Comparison

Alternative	Potential Change	Consideration for Mitigation Measures
No Action Alternative	**Trinity Lake** In wet years, below normal, and dry years, storage would be similar in all months. In above-normal years, storage would be similar in January through October; and less in November and December (up to 6 percent). In critical dry years, storage would be less in all months (up to 10 percent). In all months, in all water year types, surface water elevations would be similar. **Trinity River downstream of Lewiston Dam** Over long-term conditions (over the 82-year analysis period), flows would be similar in March through November and reduced in December through February (up to 10 percent). In wet years, flows would be similar in April through November and reduced in December through March (up to 11 percent). In dry years, flows would be similar all months. **Shasta Lake** In wet years, storage would be similar in October and December through August and reduced in September and November (up to 8 percent). In above-normal years, storage would be similar in January through September and reduced in October through December (up to 8 percent). In below-normal years, storage would be similar in March through September and reduced in October through February (up to 11 percent). In dry years, storage would be similar in January through October and reduced in November and December (up to 6 percent). In critical dry years, storage would be reduced under all months (up to 14 percent). In all months, in all water year types, surface water elevations would be similar. **Sacramento River at Keswick** Over long-term conditions, similar flows would occur in October, February through May, July, and August; increased flows in September and November (up to 38 percent); and reduced flows in December, January, and June (up to 8 percent). In wet years, similar flows would occur in January through July; increased flows in September through November (up to 78 percent); and reduced flows in December and August (up to 15 percent). In dry years, similar flows would occur in July through October, December through March, and May; increased flows in November (33 percent); and reduced flows in April and June (up to 7 percent). **Sacramento River at Freeport** Over long-term conditions, similar flows would occur in October, December through May, and August; increased flows in September, November, and July (up to 43 percent); and reduced flows in June (11 percent). In wet years, similar flows would occur in January through June and October; increased flows in July through September and November (up to 90 percent); and reduced flows in December (11 percent).	Not considered for this comparison.

Alternative	Potential Change	Consideration for Mitigation Measures
	In dry years, similar flows would occur in August through October and December through April; increased flows in November and July (up to 16 percent); and reduced flows in May and June (up to 12 percent). **Lake Oroville** In wet years, storage would be similar in January through August; and reduced in September through December (up to 18 percent). In above normal years, storage would be similar in February through August and reduced in September through January (up to 13 percent). In below normal years, storage would be similar in May through July and reduced in August through April (up to 18 percent). In dry years, storage would be similar in June and reduced in all other months (up to 13 percent). In critical dry years, storage would be similar under all months. In all months, in all water year types, surface water elevations would be similar. **Feather River downstream of Thermalito Complex** Over long-term conditions, similar flows would occur in November and April; increased flows in July through September (up to 76 percent); and reduced flows in October, December through March, May, and June (up to 27 percent). In wet years, similar flows would occur in October through November and March through May; increased flows in July through September (up to 184 percent); and reduced flows in December through February (up to 26 percent). In dry years, similar flows would occur in November through March; increased flows in April and July (up to 52 percent); and reduced flows in August through October and May and June (up to 28 percent). **Folsom Lake** In wet years, storage would be similar in December through August and reduced in September through November (up to 11 percent). In above-normal years, storage would be similar in January through June, September, and October; reduced in November and December (up to 8 percent); and increased in July and August (up to 6 percent). In below-normal years, storage would be similar in February through May; reduced in October through January (up to 12 percent); and increased in July through September (up to 17 percent). In dry years, storage would be similar in all months. In critical dry years, storage would be similar in October through June and reduced in July through September (up to 11 percent). In all months, in all water year types, surface water elevations would be similar. **American River downstream of Nimbus Dam** Over long-term conditions, similar flows would occur in November through May and July; increased flows in September and October (up to 45 percent); and reduced flows in June and August (up to 6 percent). In wet years, similar flows would occur in October through November and January through July; increased flows in September (91 percent); and reduced flows in December and August (up to 11 percent).	

Alternative	Potential Change	Consideration for Mitigation Measures
	In dry years, similar flows would occur in all months except October, February and July; increased flows in October (17 percent); and reduced flows in February and July (up to 7 percent). **Clear Creek downstream of Whiskeytown Dam** Flows identical June through April and increased in May (41 percent). **New Melones Reservoir** In wet, below-normal, and dry years, storage would be similar in all months. In above-normal years, storage would be similar in all months except October when storage would be reduced by 6 percent. In critical dry years, storage would be similar in February, March, and July through September and reduced in October through January and April through June (up to 7 percent). In all months, in all water year types, surface water elevations would be similar. **Stanislaus River downstream of Goodwin Dam** Over long-term conditions, similar flows would occur in May and July through September; increased flows in October, March, and April (up to 149 percent); and reduced flows in November through February and June (up to 34 percent). In wet years, similar flows would occur in February and April; increased flows in October, March, May, July, and August (up to 117 percent); and reduced flows in September, November through January, and June (up to 51 percent). In dry years, similar flows would occur in July through September; increased flows in October and April (up to 154 percent); and reduced flows in November through March, May, and June (up to 36 percent). **San Joaquin River at Vernalis** Over long-term conditions, similar flows would occur in July through September and November through May; increased flows in October (19 percent); and reduced flows in June (8 percent). In wet years, similar flows would occur in July through September and November through May; increased flows in October (17 percent); and reduced flows in June (9 percent). In dry years, similar flows would occur in November through March and May through September and increased flows in October and April (up to 18 percent). **San Luis Reservoir** In wet years, storage would be similar in June and September; increased in March, July, and August (up to 10 percent); and reduced in October through February, April, and May (up to 57 percent). Surface water elevations would be less in all months (up to 11 percent). In above-normal years, storage would be similar in July and September; increased in August (10 percent); and reduced in October through June (up to 71 percent). Surface water elevations would be less in all months (up to 13 percent). In below-normal years, storage would be similar in July and September; increased in August (20 percent); and reduced in October through June (up to 67 percent). Surface water elevations would be less in all months (up to 16 percent).	

Alternative	Potential Change	Consideration for Mitigation Measures
	In dry years, storage would be similar in September; increased in July (34 percent); and reduced in October through June and August (up to 44 percent). Surface water elevations would be similar in September through January and less in February through August (up to 10 percent). In critical dry years, storage would be similar in September; increased in July (60 percent); and reduced in August and October through June (up to 51 percent). Surface water elevations would be similar in October through January and reduced in February through September (up to 10 percent). **Yolo Bypass** In wet years, flows into Yolo Bypass would be similar in January through September; increased in October (25 percent); and reduced in November and December (up to 15 percent). In above-normal years, flows into Yolo Bypass would be similar in April through December and reduced in January through March (up to 14 percent). In below-normal years, flows into Yolo Bypass would be similar in April through November and reduced in December through March (up to 25 percent). In dry years, flows into Yolo Bypass would be similar in January through November and reduced in December (6 percent). In critical dry years, flows into Yolo Bypass would be similar in all months. **Delta Outflow** In wet years, average monthly Delta outflow in July through November, January, April, and May (up to 13,683 cfs) and decrease in December, February, March, and June (up to 1,590 cfs). In dry years, average monthly Delta outflow would be similar or increase in all months (up to 3,114 cfs). **Reverse Flows in Old and Middle Rivers** In wet years, average monthly OMR flows would be more positive in September through February, April, and May (up to 10,005 cfs) and more negative in March and June through August (up to 923 cfs). In dry years, average monthly OMR flows would be more positive in August through June (up to 3,489 cfs) and more negative in June (2,073 cfs).	
Alternative 1	Surface water conditions identical under Alternative 1 as under Second Basis of Comparison.	None needed.
Alternative 2	Same surface water conditions as described for No Action Alternative as compared to the Second Basis of Comparison.	Not considered for this comparison.
Alternative 3	**Trinity Lake** Similar storage and surface water elevations in all months and all water year types. **Trinity River downstream of Lewiston Dam** Similar flows in all months for long-term conditions and wet and dry years. **Shasta Lake** Similar storage and surface water elevations in all months and all water year types. **Sacramento River at Keswick** Similar flows in all months for long-term conditions and wet and dry years.	Not considered for this comparison.

Alternative	Potential Change	Consideration for Mitigation Measures
	Sacramento River at Freeport Similar flows in all months for long-term conditions and wet years. In dry years, similar flows would occur in July through May and increased flows in June (11 percent). **Lake Oroville** Similar storage and surface water elevations in all months and all water year types. **Feather River downstream of Thermalito Complex** Over long-term conditions, similar flows would occur in November and January through June; reduced flows in October, December, and September (up to 13 percent); and increased flows in July and August (up to 17 percent). In wet years, similar flows would occur in November and January through May; reduced flows in October, December, and September (up to 15 percent); and increased flows in June through August (up to 11 percent). In dry years, similar flows would occur in November and January through June; reduced flows in August through October (up to 21 percent); and increased flows in July (37 percent). **Folsom Lake** Similar storage and surface water elevations in all months and all water year types. **American River downstream of Nimbus Dam** Similar flows in all months for long-term conditions and wet and dry years. **Clear Creek downstream of Whiskeytown Dam** Flows would be identical in all months. **New Melones Reservoir** In wet years, storage would be similar in March through May and increased in June through February (up to 8 percent). In above-normal years, storage would be increased in all months (up to 16 percent). In below-normal years, storage would be increased in all months (up to 15 percent). In dry years, storage would be increased in all months (up to 20 percent). In critical dry years, storage would be increased in all months (up to 32 percent). In all months, in all water year types, surface water elevations would be similar. **Stanislaus River downstream of Goodwin Dam** Over long-term conditions, similar flows would occur in October, December, January, and March; reduced flows would occur in November, May, and June (up to 52 percent); and increased flows in February, April, July, and August through September (up to 27 percent). In wet years, similar flows would occur in October, November, January, and April; reduced flows in May and June (up to 45 percent); and increased flows in December, February, March, and July through September (up to 69 percent). In dry years, similar flows would occur in July through October; reduced flows in November through March and May through June (up to 36 percent); and increased flows in April (40 percent).	

Alternative	Potential Change	Consideration for Mitigation Measures
	San Joaquin River at Vernalis Over long-term conditions, similar flows would occur in July through May and reduced flows in June (12 percent). In wet years, similar flows would occur in September through January, March through May, and July; reduced flows in June (8 percent); and increased flows in August and February (6 percent). In dry years, similar flows would occur in July through March; reduced flows in May and June (up to 12 percent); and increased flows in April (7 percent). **San Luis Reservoir** In wet years, storage would be similar in July through November and March through May and reduced in December through February and June (up to 16 percent). Surface water elevations would be similar in all months. In above-normal years, storage would be similar in November; increased in August and September (up to 12 percent); and reduced in October and December through July (up to 22 percent). Surface water elevations would be similar in March through December and reduced in January and February (up to 6 percent). In below-normal years, storage would be similar in August and September and reduced in October through July (up to 40 percent). Surface water elevations would be similar in all months. In dry years, storage would be reduced in January through September (up to 19 percent) and increased in October through December (up to 13 percent). Surface water elevations would be similar in all months. In critical dry years, storage would be reduced in October through August (up to 29 percent) and increased in September (8 percent). Surface water elevations would be similar September through January and reduced in February through August (up to 7 percent). **Yolo Bypass** In wet years, flows into the Yolo Bypass would be similar in November through September and reduced in October (6 percent). In above-normal, below-normal, dry, and critical dry years, flows into the Yolo Bypass would be similar in all months. **Delta Outflow** In wet years, average monthly Delta outflow would increase in November through February and July through September (up to 2,546 cfs) and decrease in October and March through June (up to 1,127 cfs). In dry years, average monthly Delta outflow would increase in November through April, July and August (up to 3,391 cfs) and decrease October, May, and June (up to 373 cfs). **Reverse Flows in Old and Middle Rivers** In wet years, flows would be more positive in September through February, April, and May (up to 5,528 cfs) and more negative in March and June through August (up to 1,453 cfs). In dry years, flows would be more positive in August through May (up to 3,249 cfs) and more negative flows in June and July (up to 1,345 cfs).	
Alternative 4	Surface water conditions identical under Alternative 4 as under Second Basis of Comparison.	None needed.

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 5	**Trinity Lake** In wet, below-normal, and dry years, storage would be similar. In above-normal years, storage would be similar in January through October and reduced in November and December (up to 5 percent). In critical dry years, storage would be reduced in all months (up to 10 percent). In all months, in all water year types, surface water elevations would be similar. **Trinity River downstream of Lewiston Dam** Over long-term conditions, flows would be similar in March through November and January and reduced in December and February (up to 10 percent). In wet years, flows would be similar in January and April through November and reduced in December, February, and March (up to 14 percent). In dry years, flows would be similar in all months. **Shasta Lake** In wet years, storage would be similar in October and December through August and reduced in November and September (up to 8 percent). In above-normal years, storage would be similar in February through September and reduced in October through December (up to 8 percent). In below-normal years, storage would be similar in March through September and reduced in October through February (up to 10 percent). In dry years, storage would be similar in January through October and reduced in November through December (up to 6 percent). In critical dry years, storage would be reduced in all months (up to 17 percent). In all months, in all water year types, surface water elevations are similar. **Sacramento River at Keswick** Over long-term conditions, flows would be similar in July, August, October, and February through April; reduced in December, January, May and June (up to 8 percent); and increased in September and November (up to 39 percent). In wet years, flows would be similar in January through July; reduced in December and August (up to 15 percent); and increased in September through November (up to 77 percent). In dry years, similar flows would occur in July through October and December through March; reduced in April through June (up to 10 percent); and increased flows in November (32 percent). **Sacramento River at Freeport** Over long-term conditions, flows would be similar in October and December through April; reduced in May and June (up to 12 percent); and increased in July through September and November (43 percent). In wet years, flows would be similar in October and January through June; reduced in December (6 percent); and increased in July through September and November (up to 89 percent). In dry years, similar flows would occur in August through October and December through April; reduced in May and June (up to 14 percent); and increased flows in July and November (up to 19 percent).	Not considered for this comparison.

Alternative	Potential Change	Consideration for Mitigation Measures
	Lake Oroville In wet years, storage would be similar in January through August; and reduced in September through December (up to 18 percent). In above-normal years, storage would be similar in March through August and reduced in September through February (up to 14 percent). In below-normal years, storage would be similar in May through July and reduced in August through April (up to 17 percent). In dry years, storage would be similar in May and June and reduced in July through April (up to 11 percent). In critical dry years, storage would be similar in all months. Surface water elevations would be similar in all months, in all years. **Feather River downstream of Thermalito Complex** Over long-term conditions, similar flows would occur in November and April; reduced flows in October, December through March, May, and June (up to 28 percent); and increased flows in July through September (up to 76 percent). In wet years, similar flows would occur in October, November, March through May; reduced flows in December through February and June (up to 26 percent); and increased flows in July through September (up to 182 percent). In dry years, similar flows would occur in November through April; reduced flows in October, May, June, August, and September (up to 45 percent); and increased flows in July (60 percent). **Folsom Lake** In wet years, storage would be similar in December through July and reduced in August through November (up to 7 percent). In above-normal years, storage would be similar in January through June, August, and October; reduced in September, November, and December (up to 8 percent); and increased in July (5 percent). In below-normal years, storage would be similar in February through May; reduced in August through January (up to 13 percent); and increased in June and July (up to 10 percent). In dry years, storage would be similar in all months. In critical dry years, storage would be similar in August and June and reduced in July (8 percent). Surface water elevations would be similar in all months, in all years. **American River downstream of Nimbus Dam** Over long-term conditions, similar flows would occur in November through July; reduced flows in August (6 percent); and increased in September and October (42 percent). In wet years, similar flows would occur in October, November, and January through July; reduced flows in December and August (up to 14 percent); and increased flows in September (88 percent). In dry years, similar flows would occur in November through September; and increased flows in October (17 percent).	

Alternative	Potential Change	Consideration for Mitigation Measures
	Clear Creek downstream of Whiskeytown Dam Flows identical June through April and increased in May (41 percent). **New Melones Reservoir** In wet years, storage would be reduced in all months (up to 9 percent). In above-normal years, storage would be reduced in all months (up to 10 percent). In below-normal years, storage would be reduced in all months (up to 13 percent). In dry years, storage would be reduced in all months (up to 14 percent). In critical dry years, storage would be reduced in all months (up to 23 percent). Surface water elevations would be similar in all months, in all water year types. **Stanislaus River downstream of Goodwin Dam** Over long-term conditions, similar flows would occur in August; reduced flows would occur in November through February, June, July, August, and September (up to 36 percent); and increased flows in October and March through May (up to 149 percent). In wet years, similar flows would occur in February and April; reduced flows in November through January and June through September (up to 53 percent); and increased flows in October and March (up to 113 percent). In dry years, similar flows would occur in July through September; reduced flows in November through March and June (up to 36 percent); and increased flows in October, April, and May (150 percent). **San Joaquin River at Vernalis** Over long-term conditions, similar flows would occur in November through March, May, and July through September; reduced flows in June (8 percent); increased flows in October and April (19 percent). In wet years, similar flows would occur in November through May and July through September; reduced flows in June (10 percent); and increased flows in October (16 percent). In dry years, similar flows would occur in November through March and June through September; and increased flows in October, April, and May (up to 25 percent). **San Luis Reservoir** In wet years, storage would be reduced in all months (up to 49 percent). Surface water elevations would be similar in September and March; and reduced in October through February and April through August (up to 10 percent). In above-normal years, storage would be reduced in all months (up to 59 percent). Surface water elevations would be similar in September; and reduced in October through August (up to 13 percent). In below-normal years, storage would be reduced in all months (up to 70 percent). Surface water elevations would be similar in September; and reduced in October through August (up to 17 percent). In dry years, storage would be reduced in all months (up to 51 percent). Surface water elevations would be similar in October through December; and reduced in January through September (up to 14 percent).	

Alternative	Potential Change	Consideration for Mitigation Measures
	In critical dry years, storage would be reduced in all months (46 percent). Surface water elevations would be reduced in all months (up to 14 percent). **Yolo Bypass** In wet years, flows would be similar in February through September; reduced flows in November through January (up to 15 percent); and increased in October (16 percent). In above-normal years, flows would be similar in April through December and reduced flows in January through March (up to 15 percent). In below-normal years, flows would be similar in April through November and reduced flows in December through March (up to 24 percent). In dry years, flows would be similar in January through November and reduced flows in December (up to 7 percent). In critical dry years, flows would be similar in all months. **Delta Outflow** In wet years, average monthly Delta outflow would be increased in July through November, January, and April and May (up to 13,666 cfs) and reduced in December, February, March, and June (up to 1,713 cfs). In dry years, average monthly Delta outflow would be increased in July through May (up to 3,384 cfs) and reduced in June (526 cfs). **Reverse Flows in Old and Middle Rivers** In wet years, OMR flows would be more positive in September through February, April and May (up to 10,017 cfs) and more negative in March and June through August (up to 964 cfs). In dry years, OMR flows would be more positive in September through June (up to 4,724 cfs) and more negative in July and August (up to 2,620 cfs).	

Table 5.116 Comparison of CVP and SWP Water Supply Deliveries under the No Action Alternative and Alternatives 1 through 5 to the Second Basis of Comparison

Alternative	Potential Change	Consideration for Mitigation Measures
No Action Alternative	Long-term average annual exports would be 1,051 TAF (18 percent) less under the No Action Alternative as compared to the Second Basis of Comparison. Deliveries to CVP North of Delta agricultural water service contractors would be reduced by 16 percent over the long-term conditions, 30 percent in dry years, and 34 percent in critical dry years. Deliveries to CVP North of Delta M&I contractors would be similar in total; however, deliveries to the American River CVP contractors would be reduced by 6 percent over the long-term conditions, 8 percent in dry years, and 6 percent in critical dry years. Deliveries to CVP South of Delta agricultural water service contractors would be reduced by 23 percent over the long-term conditions, 32 percent in dry years, and 33 percent in critical dry years. Deliveries to CVP South of Delta M&I contractors would be reduced by 10 percent over the long-term conditions, 9 percent in dry years, and 5 percent in critical dry years. Deliveries to the Eastside contractors would be similar under the long-term conditions and in dry years but were reduced by 12 percent in critical dry years. Deliveries under Table A contracts without Article 21 water to SWP North of Delta water contractors would be reduced by 18 percent over the long-term conditions, 18 percent in dry years, and 20 percent in critical dry years. Deliveries under Table A contracts without Article 21 water to SWP South of Delta water contractors would be reduced by 18 percent over the long-term conditions, 19 percent in dry years, and 22 percent in critical dry years.	Not considered for this comparison.
Alternative 1	Water supply conditions identical under Alternative 1 as under Second Basis of Comparison.	None needed.
Alternative 2	Same water supply effects as described for No Action Alternative as compared to the Second Basis of Comparison.	Not considered for this comparison.
Alternative 3	Long-term average annual exports would be 326 TAF (6 percent) less under Alternative 3 as compared to the Second Basis of Comparison. Deliveries to CVP North of Delta agricultural water service contractors would be reduced by 5 percent over the long-term conditions, 9 percent in dry years, and 11 percent in critical dry years. Deliveries to CVP North of Delta M&I contractors (including American River CVP contractors) would be similar in long-term conditions and dry and critical dry years. Deliveries to CVP South of Delta agricultural water service contractors would be similar over the long-term conditions and reduced by 8 percent in dry years and 14 percent in critical dry years. Deliveries to CVP South of Delta M&I contractors would be similar in long-term conditions and dry and critical dry years. Deliveries to the Eastside contractors would be similar under long-term conditions and dry and critical dry years. Deliveries under Table A contracts without Article 21 water to SWP North of Delta water contractors would be similar over the long-term conditions and in dry years and reduced by 10 percent in critical dry years.	Not considered for this comparison.

Alternative	Potential Change	Consideration for Mitigation Measures
	Deliveries under Table A contracts without Article 21 water to SWP South of Delta water contractors would be similar over the long-term conditions and in dry years and reduced by 11 percent in critical dry years.	
Alternative 4	Water supply conditions identical under Alternative 4 as under Second Basis of Comparison.	None needed.
Alternative 5	Long-term average annual exports would be 1,096 TAF (19 percent) less under Alternative 5 as compared to the Second Basis of Comparison. Deliveries to CVP North of Delta agricultural water service contractors would be reduced by 16 percent over the long-term conditions, 30 percent in dry years, and 31 percent in critical dry years. Deliveries to CVP North of Delta M&I contractors would be similar in long-term conditions and dry and critical dry years; however, American River Contractors would be reduced by 6 percent over the long-term conditions, 9 percent in dry years, and 8 percent in critical dry years. Deliveries to CVP South of Delta agricultural water service contractors would be reduced by 24 percent over the long-term conditions, 33 percent in dry years, and 33 percent in critical dry years. Deliveries to CVP South of Delta M&I contractors would be reduced by 10 percent in long-term conditions, 8 percent in dry years, and 6 percent in critical dry years. Deliveries to the Eastside contractors would be reduced by 5 percent under long-term conditions and dry years and reduced by 19 percent in critical dry years. Deliveries under Table A contracts without Article 21 water to SWP North of Delta water contractors would be reduced by 19 percent over the long-term conditions, 18 percent in dry years, and 21 percent in critical dry years. Deliveries under Table A contracts without Article 21 water to SWP South of Delta water contractors would be reduced by 19 percent over the long-term conditions, 20 percent in dry years, and 23 percent in critical dry years.	Not considered for this comparison.

Note: Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools, incremental differences of 5 percent or less between alternatives and the Second Basis of Comparison are considered to be "similar."

5.4.3.8 Potential Mitigation Measures

Mitigation measures are presented in this section to avoid, minimize, rectify, reduce, eliminate, or compensate for adverse environmental effects of Alternatives 1 through 5 as compared to the No Action Alternative. Mitigation measures were not included to address adverse impacts under the alternatives as compared to the Second Basis of Comparison because this analysis was included in this EIS for information purposes only.

5.4.3.8.1 Surface Water Conditions

As described above and summarized in Table 5.113, implementation of Alternatives 1 through 5 as compared to the No Action Alternative would result in reductions in river flows downstream of CVP and SWP reservoirs and Delta outflow, and increased negative OMR flows. Environmental effects associated with changes in these physical conditions are related to impacts on biological resources (as described in Chapter 9, Fish and Aquatic Resources, and Chapter 10, Terrestrial Biological Resources), and recreation resources (as described in Chapter 15, Recreation Resources). Mitigation measures, if needed, related to environmental changes caused by changes in surface water conditions are presented in Chapters 9, 10, and 15.

5.4.3.8.2 CVP and SWP Water Supply Deliveries

Implementation of Alternatives 1 through 4 would not result in adverse impacts to CVP and SWP water deliveries as compared to the No Action Alternative, as summarized in Table 5.114. Therefore, no mitigation measures are required.

Implementation of Alternative 5 would result in up to 8 percent reductions of CVP water deliveries to the Eastside Contractors (Stockton East Water District and Central San Joaquin Water Conservation District) in critical dry years. A potential mitigation measure for this reduction in critical dry years would be:

- Reclamation would support water transfers from other basin water rights holders to the Eastside Contractors. .

5.4.3.9 Cumulative Effects Analysis

As described in Chapter 3, the cumulative effects analysis considers projects, programs, and policies that are not speculative and are based upon known or reasonably foreseeable long-range plans, regulations, operating agreements, or other information that establishes them as reasonably foreseeable.

The cumulative effects analysis Alternatives 1 through 5 for Water Supplies are summarized in Table 5.117.

Table 5.117 Summary of Cumulative Effects on Water Supply Deliveries under Alternatives 1 through 5 as Compared to the No Action Alternative

Scenarios	Actions	Cumulative Effects of Actions
Past & Present, and Future Actions Included in All Alternatives in Year 2030	Consistent with Affected Environment conditions plus: Actions in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives), including climate change and sea level rise Actions not included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives): • Implementation of Federal and state policies and programs, including Clean Water Act (e.g.,Total Maximum Daily Loads); Safe Drinking Water Act; Clean Air Act; and flood management programs • General plans for 2030. • Trinity River Restoration Program. • Central Valley Project Improvement Act programs • Iron Mountain Mine Superfund Site • Nimbus Fish Hatchery Fish Passage Project • Folsom Dam Water Control Manual Update • FERC Relicensing for the Middle Fork of the American River Project • Lower Mokelumne River Spawning Habitat Improvement Project • Dutch Slough Tidal Marsh Restoration • Suisun Marsh Habitat Management, Preservation, and Restoration Plan Implementation • Tidal Wetland Restoration: Yolo Ranch, Northern Liberty Island Fish Restoration Project, Prospect Island Restoration Project, and Calhoun Cut/Lindsey Slough Tidal Habitat Restoration Project • San Joaquin River Restoration Program • Stockton Deep Water Ship Channel Dissolved Oxygen Project • Grasslands Bypass Project • Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) • Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities	<u>These effects would be the same under all alternatives.</u> Climate change and sea level rise, development under the general plans, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce carryover storage in reservoirs, stream flows and Delta outflow, and the availability of CVP and SWP water supplies as compared to past conditions. Some future water quality and habitat projects could modify surface water conditions; however, water supplies are not anticipated to be affected. Future water supply projects are anticipated to both improve water supply reliability due to reduced surface water supplies and to accommodate planned growth in the general plans. Most of these programs were initiated prior to implementation of the 2008 USFWS BO and 2009 NMFS BO which reduced CVP and SWP water supply reliability.

Scenarios	Actions	Cumulative Effects of Actions
Future Actions Considered as Cumulative Effects Actions in All Alternatives in Year 2030	Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives): • Bay-Delta Water Quality Control Plan Update • FERC Relicensing Projects • Bay Delta Conservation Plan (including the California WaterFix alternative) • Shasta Lake Water Resources, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations • El Dorado Water and Power Authority Supplemental Water Rights Project • Sacramento River Water Reliability Project • Semitropic Water Storage District Delta Wetlands • North Bay Aqueduct Alternative Intake • Irrigated Lands Regulatory Program • San Luis Reservoir Low Point Improvement Project • *Westlands Water District v. United States Settlement* • Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects that did not have completed environmental documents during preparation of the EIS)	<u>These effects would be the same under all alternatives.</u> Most of the future reasonably foreseeable actions are anticipated to reduce water supply impacts due to climate change, sea level rise, increased water allocated to improve habitat conditions, and future growth. Some of the reasonably foreseeable actions related to improved water quality and habitat conditions (e.g., Water Quality Control Plan Update and FERC Relicensing Projects), could in further reductions in CVP and SWP water deliveries.
No Action Alternative with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO	Implementation of No Action Alternative would result in changes stream flows, increased Delta outflow, and reduced CVP and SWP water supplies as compared to historical conditions prior to the BOs. The availability of future water supply projects (discussed above) could reduce the effects of reduced CVP and SWP water supplies. However, these actions also could result in less water for future growth as compared to future conditions without the No Action Alternative.

Scenarios	Actions	Cumulative Effects of Actions
Alternatives 1 and 4 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternatives 1 and 4 with reasonably foreseeable actions would result in changes in stream flows, reduced Delta outflows, and increased CVP and SWP water supplies as compared to the No Action Alternative with the added actions. The future water supply projects (discussed above) would be more available to provide water for future growth as compared to future conditions with the No Action Alternative.
Alternative 2 with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions No implementation of structural improvements or other actions that require further study to develop a more detailed action description.	Implementation of Alternative 2 with reasonably foreseeable actions for water supplies would be the same as for the No Action Alternative with the added actions.
Alternative 3 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant) Slight increase in positive Old and Middle River flows in the winter and spring months	Implementation of Alternative 3 with reasonably foreseeable actions would result in changes in stream flows, reduced Delta outflows, and increased CVP and SWP water supplies as compared to the No Action Alternative with the added actions. The future water supply projects (discussed above) would be more available to provide water for future growth as compared to future conditions with the No Action Alternative.
Alternative 5 with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO Positive Old and Middle River flows and increased Delta outflow in spring months	Implementation of Alternative 5 with reasonably foreseeable actions would result in changes in stream flows, increased Delta outflows, and reduced CVP and SWP water supplies as compared to the No Action Alternative with the added actions. The availability of future water supply projects (discussed above) could reduce the effects of reduced CVP and SWP water supplies. However, these actions also could result in less water for future growth as compared to future conditions under the No Action Alternative.

5.5 References

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Surface Water Resources and Water Supply Figures

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- 5.24 Historical Water Year 2001 – 2012 Sacramento River Mean Daily Flows at Verona
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- 5.78 Old and Middle River, Wet Year Long-Term Average Flow
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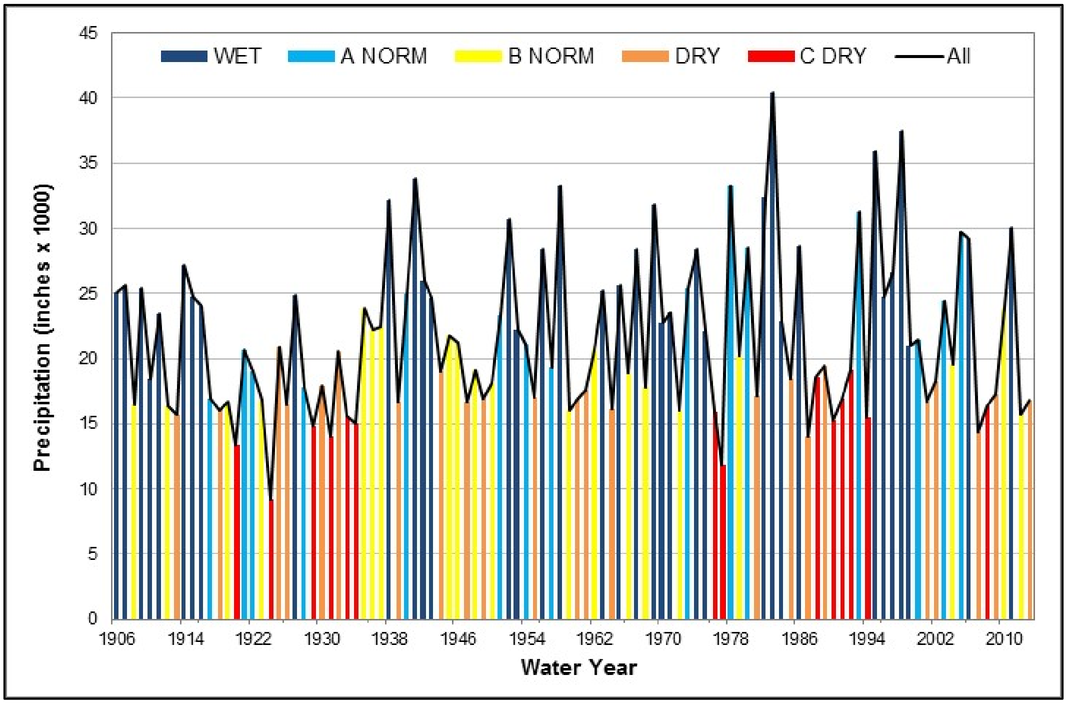
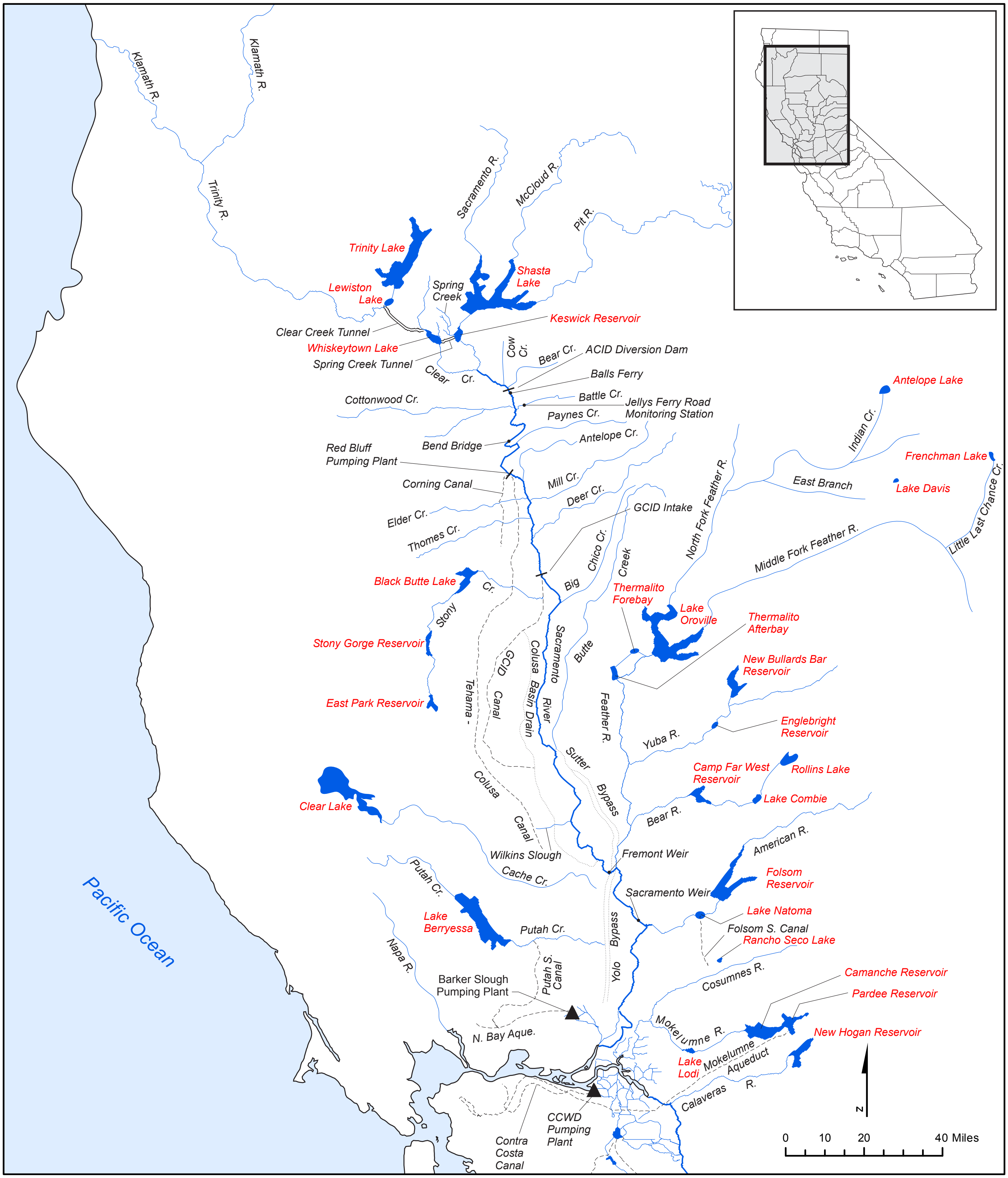
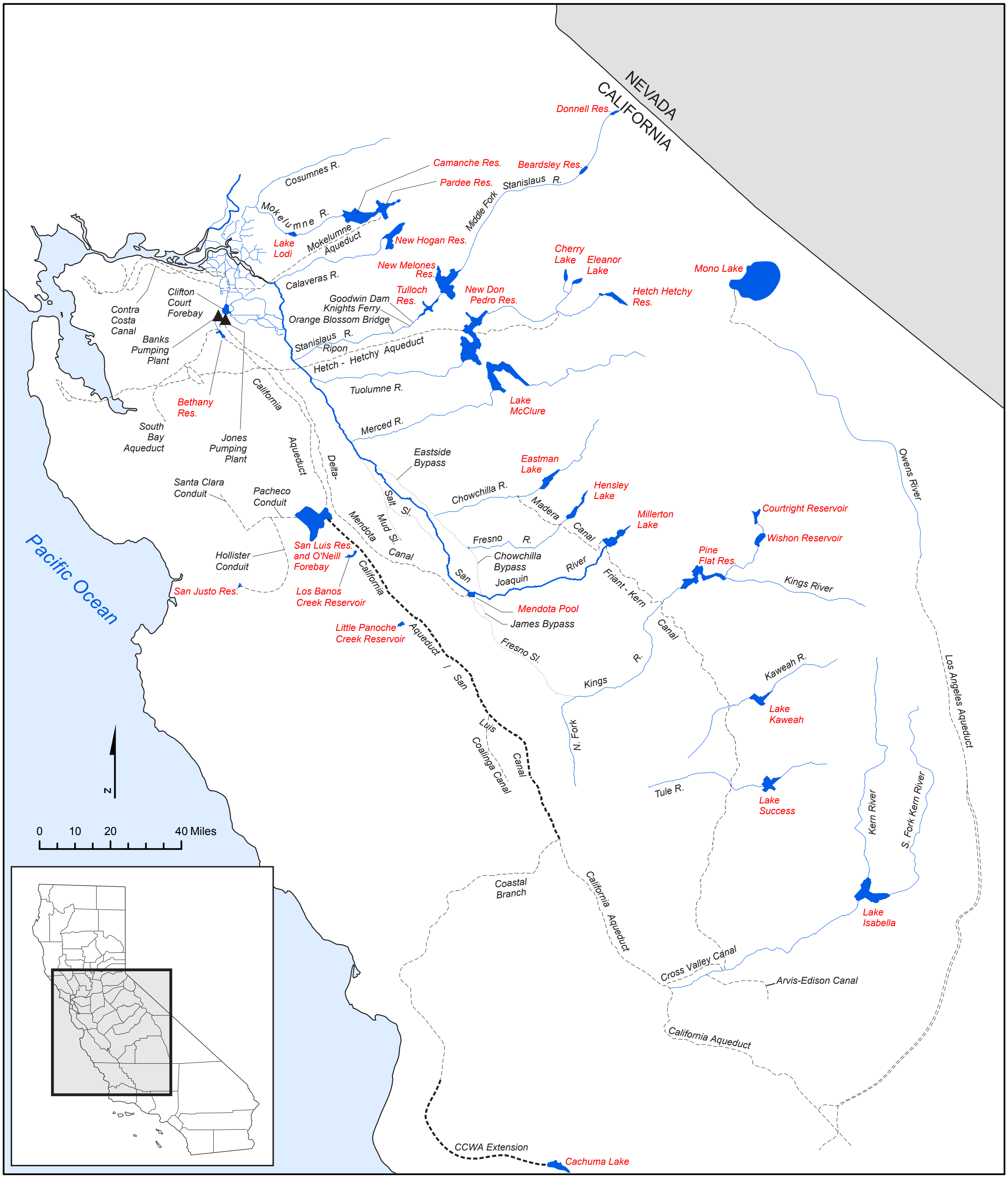


Figure 5.1 California Precipitation Trends

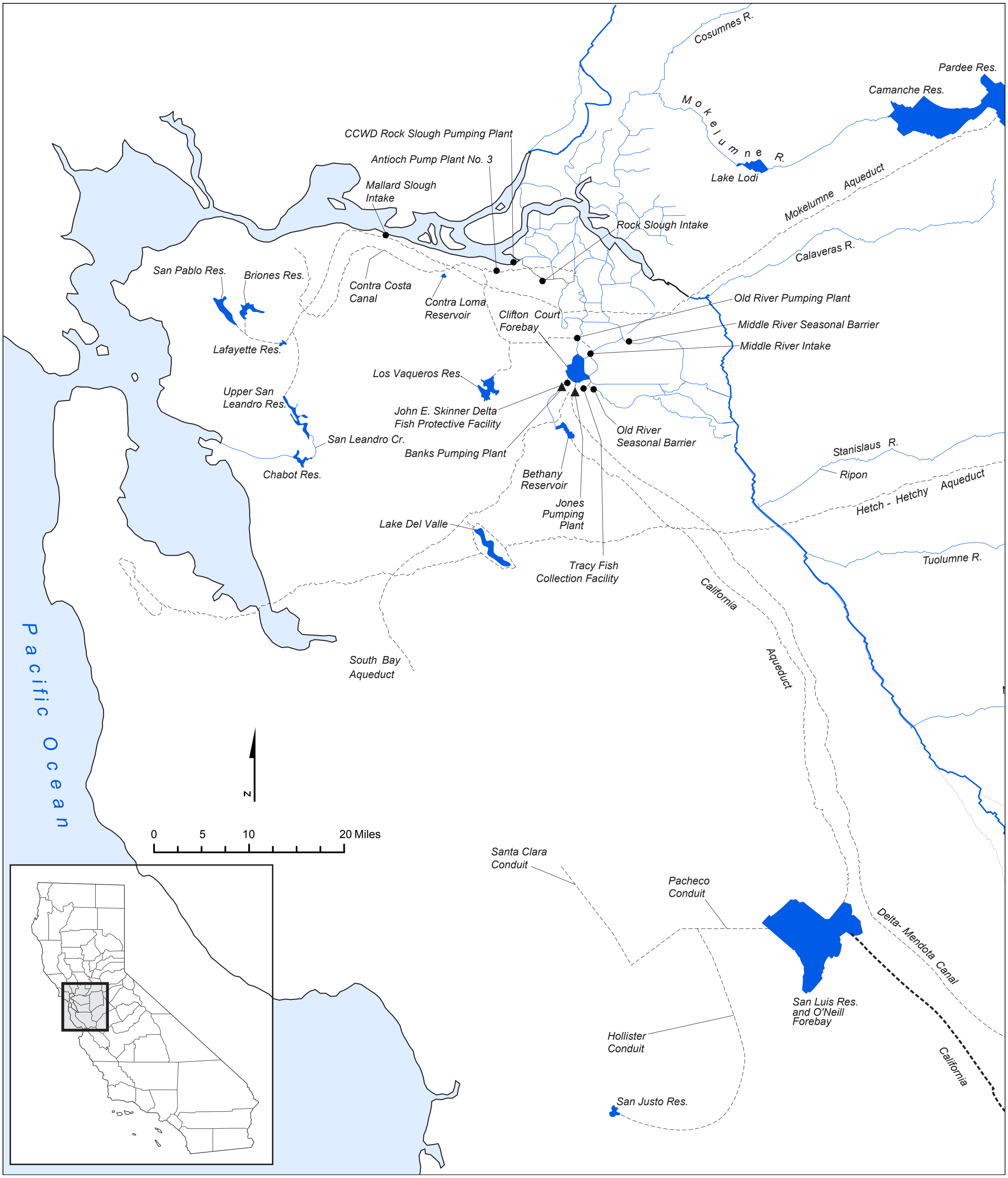
5.2 California Major Water Supply Facilities



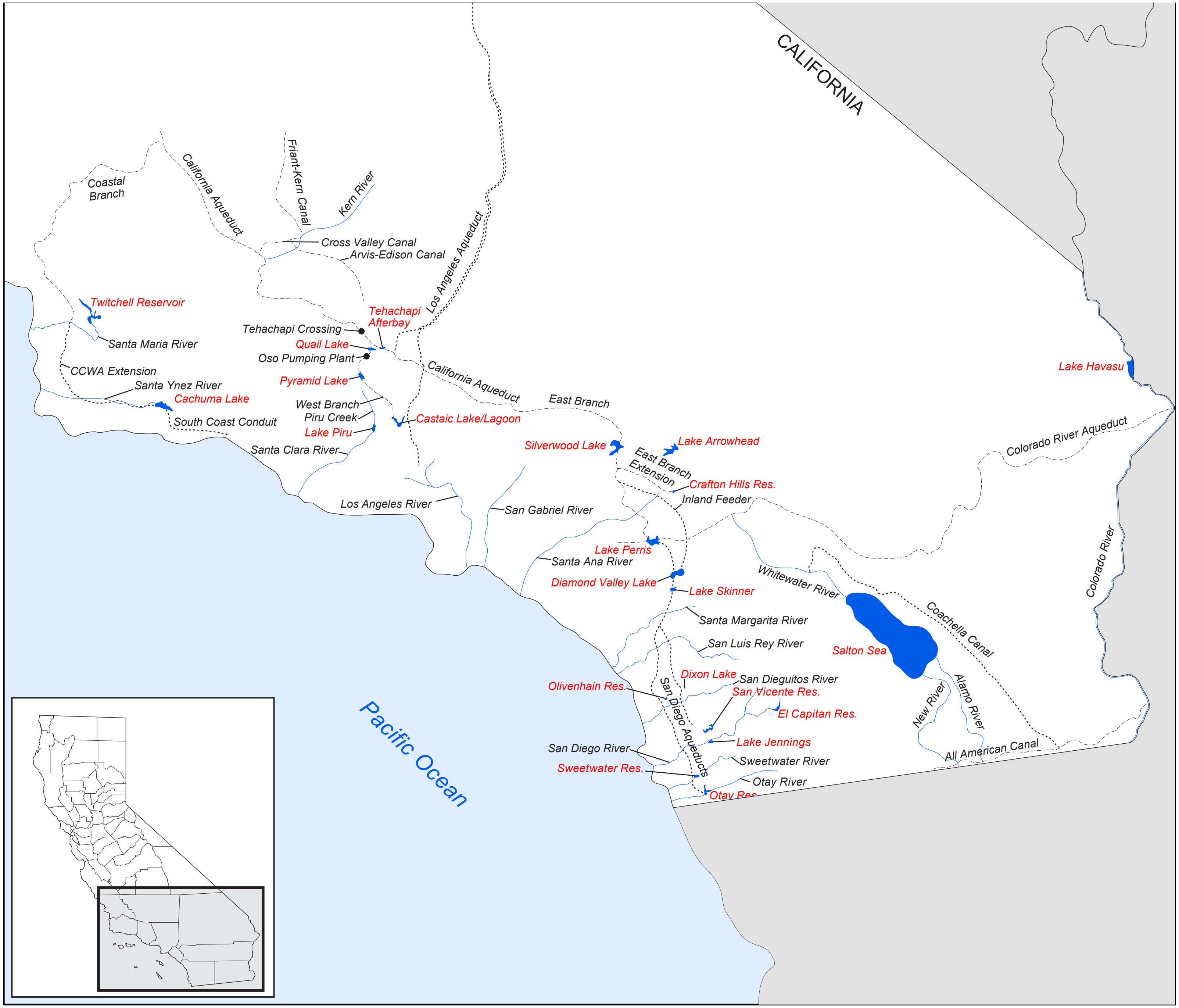
5.3 Northern California Major Water Supply Facilities



5.4 San Joaquin Valley and Tulare Lake Major Water Supply Facilities



5.5 San Francisco Bay Area Major Water Supply Facilities



5.6 Central Coast and Southern California Major Water Supply Facilities

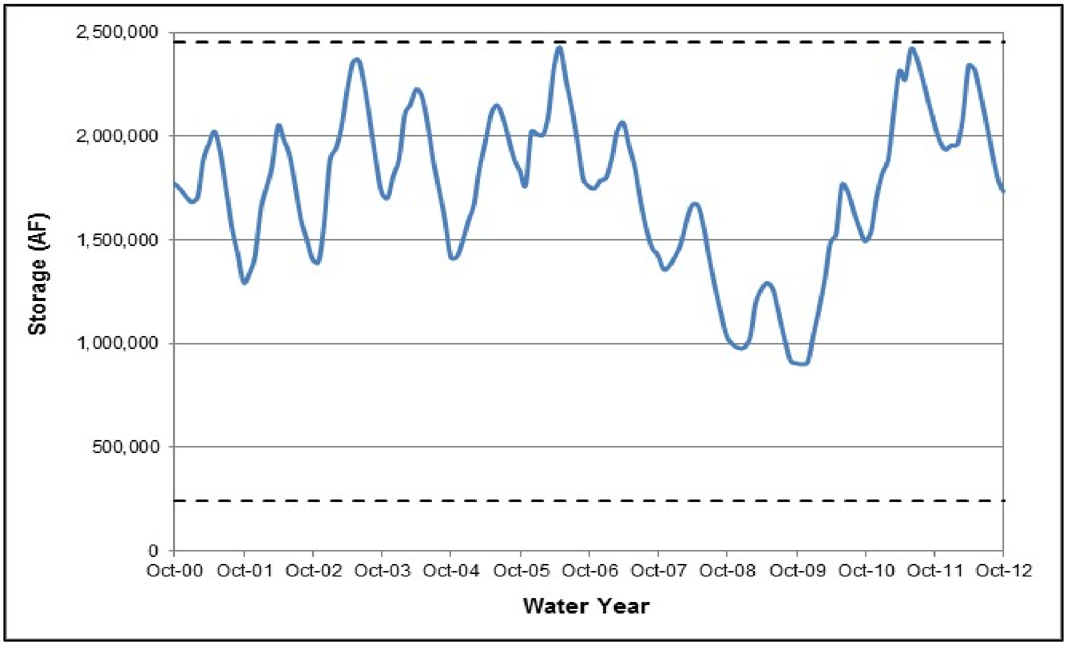


Figure 5.7 Historical Water Years 2001-2012 Trinity Lake Storage[1]

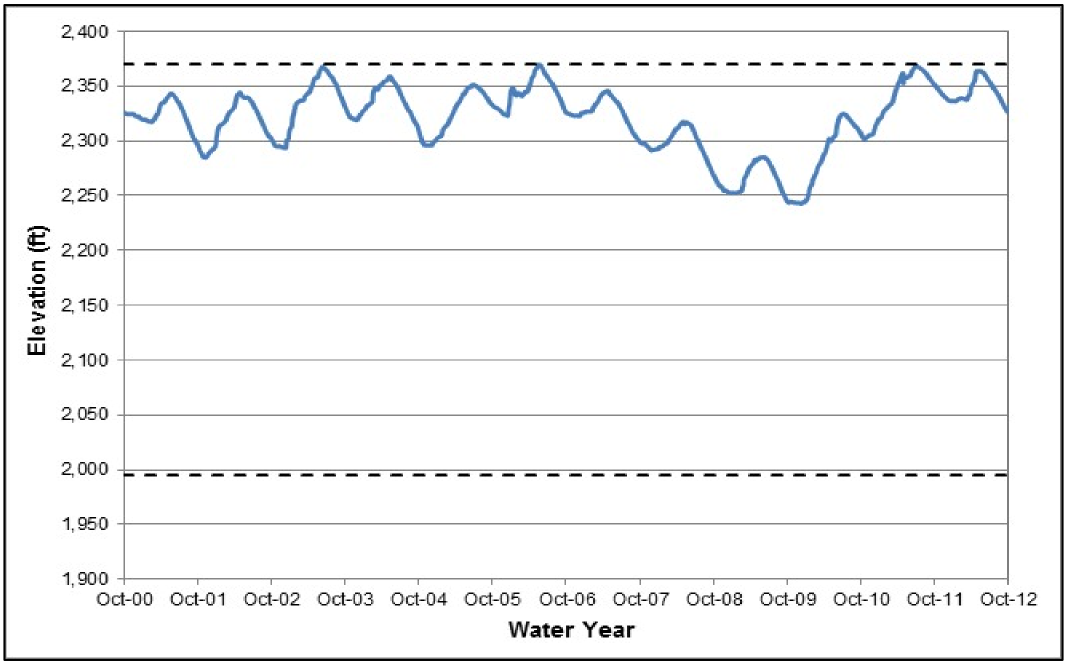


Figure 5.8 Historical Water Years 2001-2012 Trinity Lake Elevation[2]

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[1] The minimum storage line of 240,000 AF was taken from CalSim II. The maximum storage line of 2,448,000 AF was taken from the California Data Exchange Center website http://cdec.water.ca.gov/misc/resinfo.html.

[2] The minimum elevation line of 1995 ft was taken from Reclamation's website http://www.usbr.gov/projects/Facility.jsp?fac_Name=Trinity+Dam&groupName=Dimensions. The maximum elevation line of 2,370 ft was provided by Reclamation.

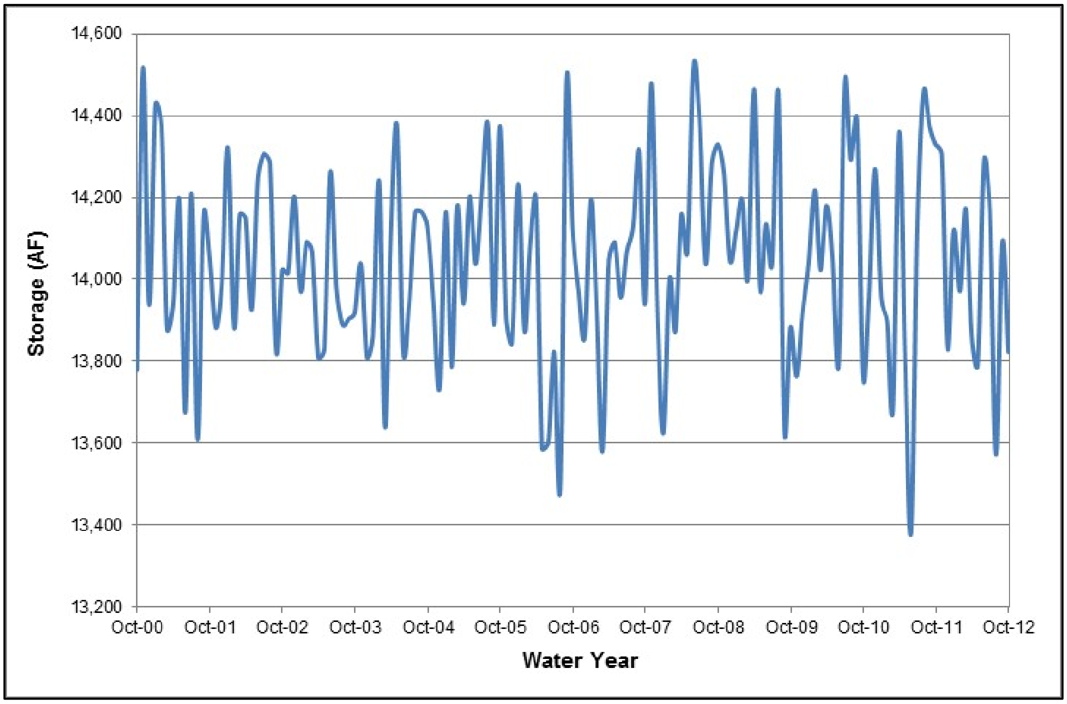

Figure 5.9 Historical Water Years 2001-2012 Lewiston Reservoir Storage

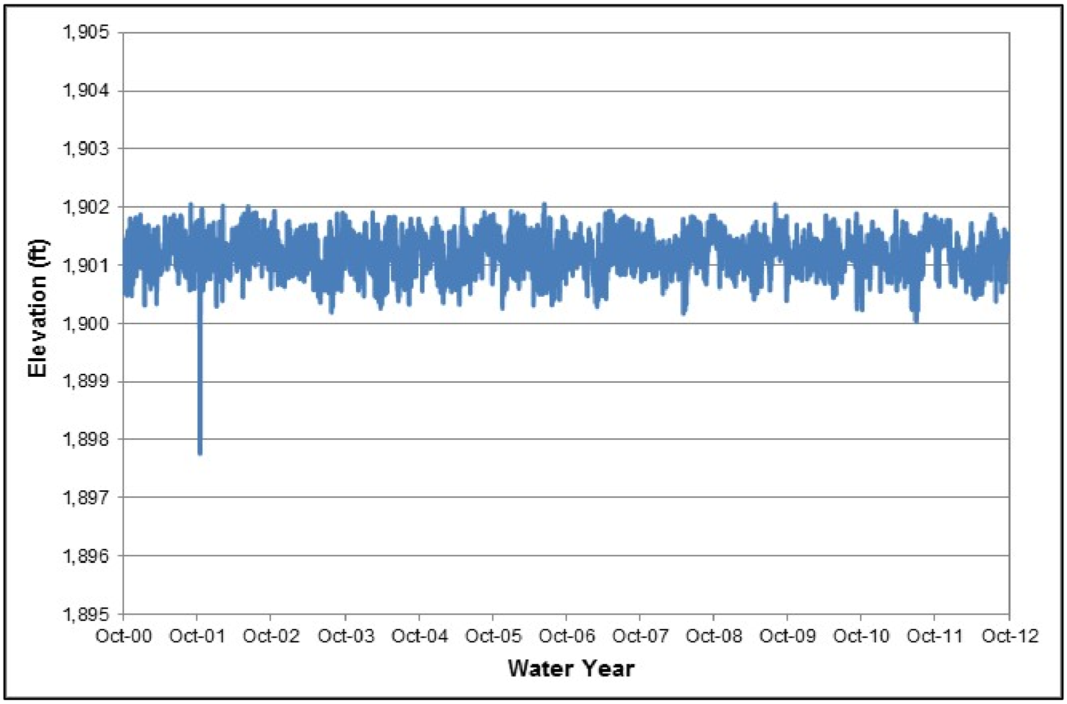

Figure 5.10 Historical Water Years 2001-2012 Lewiston Reservoir Elevation

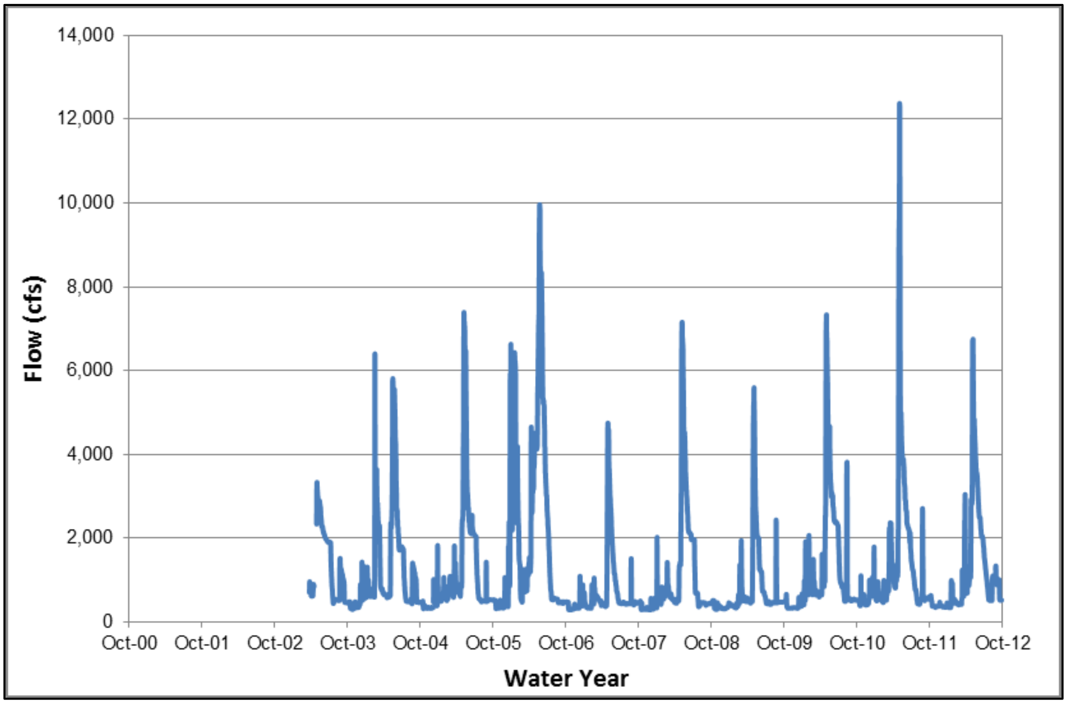

Figure 5.11 Historical Water Years 2003-2012 Trinity River Mean Daily Flows at Douglas City

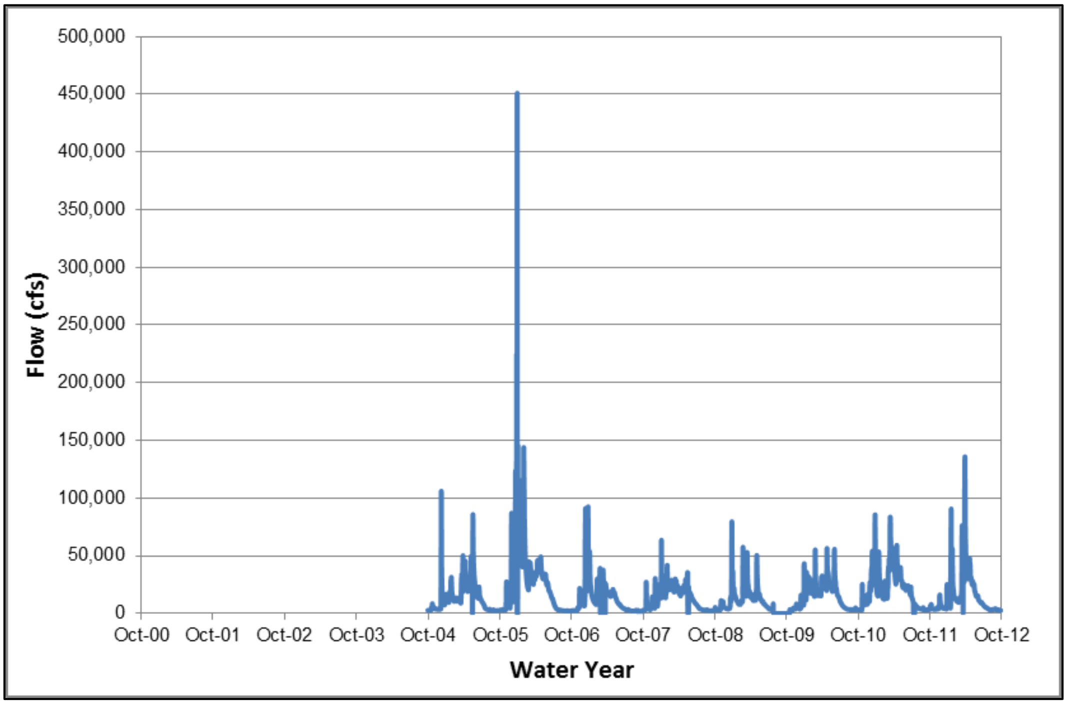

Figure 5.12 Historical Water Years 2005-2012 Klamath River Mean Daily Flows at Klamath

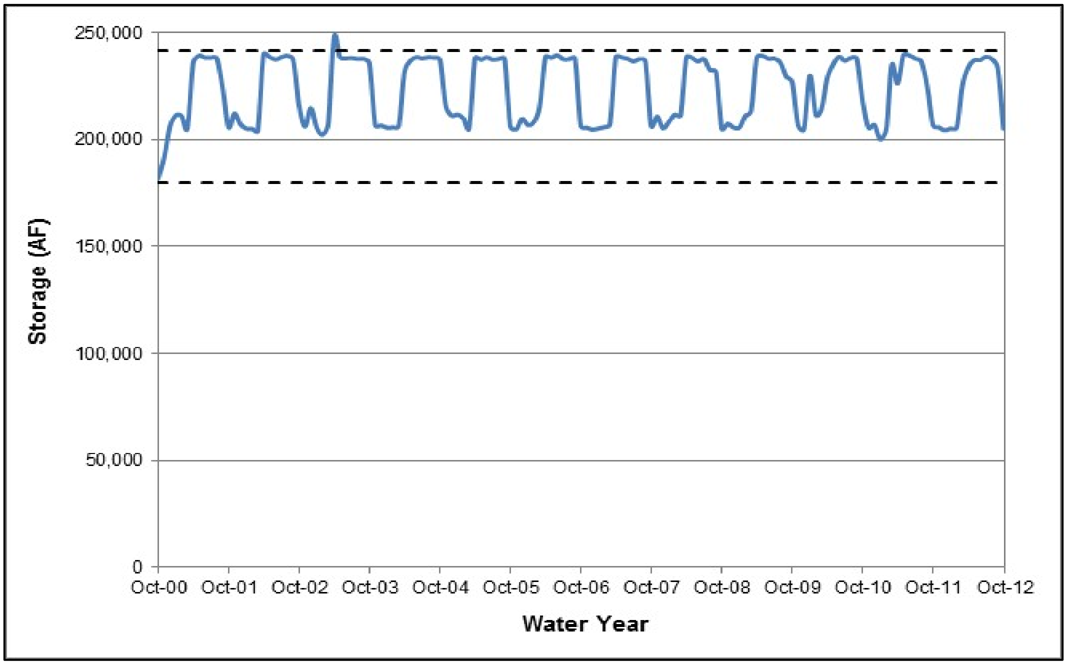

Figure 5.13 Historical Water Years 2001-2012 Whiskeytown Lake Storage[3]

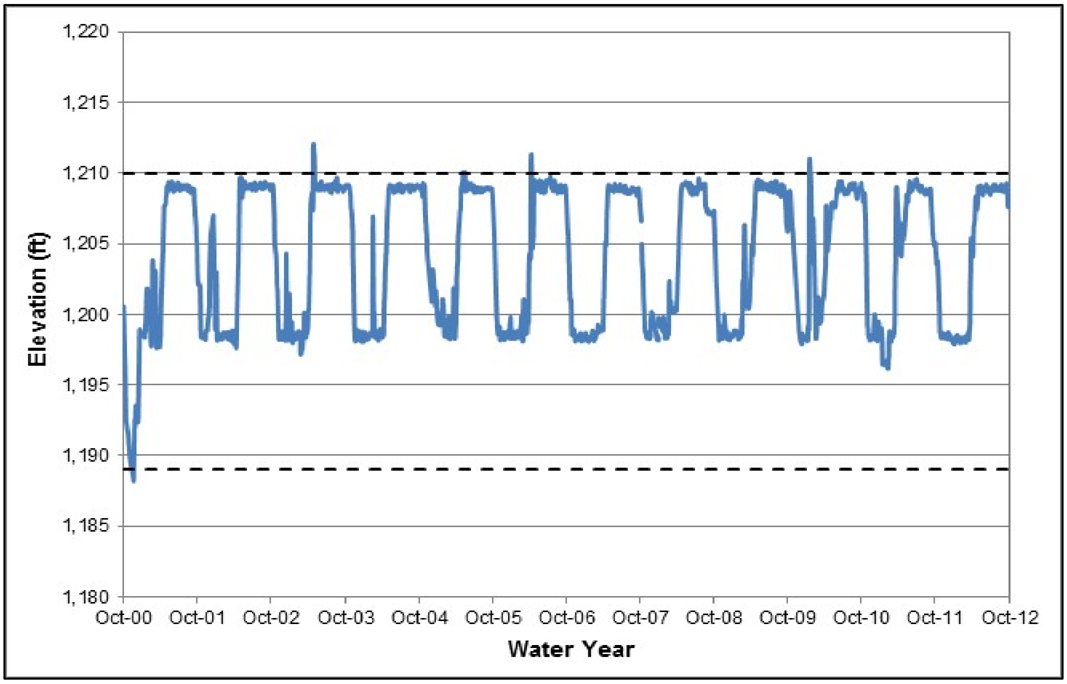

Figure 5.14 Historical Water Years 2001-2012 Whiskeytown Lake Elevation[4]

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[3] The minimum storage line of 180,000 AF was taken from CalSim II. The maximum storage line of 241,000 AF was taken from the California Data Exchange Center website http://cdec.water.ca.gov/misc/resinfo.html.

[4] The minimum elevation line of 1190 ft was taken from CalSim II. The maximum elevation line of 1,210 ft was provided by Reclamation.

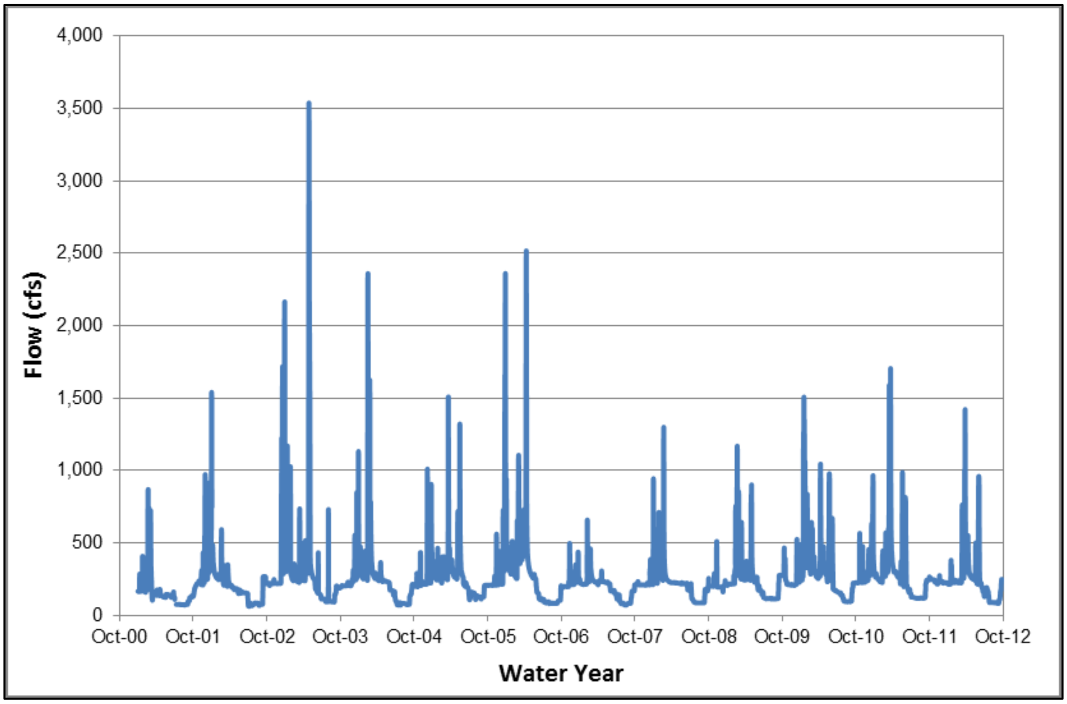

Figure 5.15 Historical Water Years 2001-2012 Clear Creek Mean Daily Flows at Igo

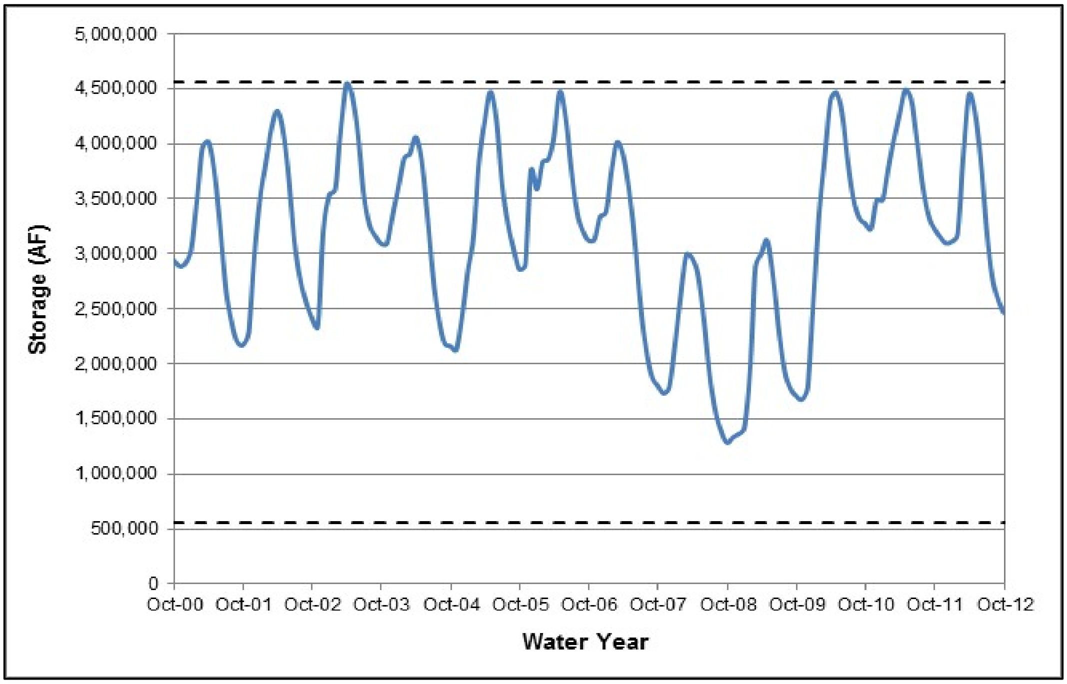

Figure 5.16 Historical Water Years 2001-2012 Shasta Lake Storage[5]

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[5] The minimum storage line of 550,000 AF was taken from CalSim II. The maximum storage line of 4,552,000 AF was taken from the California Data Exchange Center website http://cdec.water.ca.gov/misc/resinfo.html.

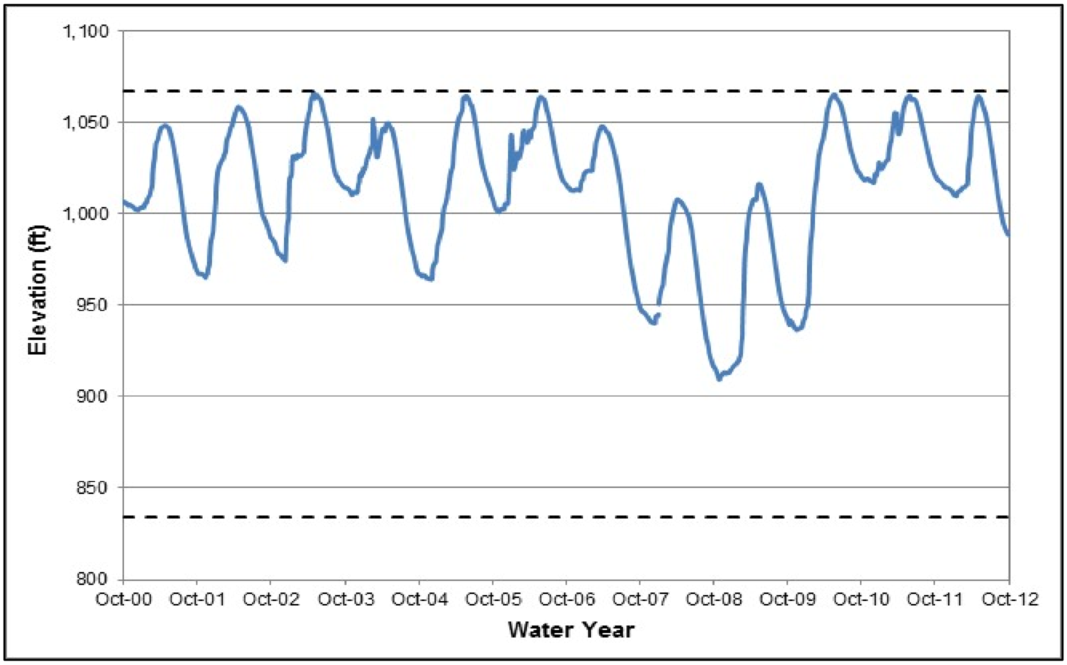

Figure 5.17 Historical Water Years 2001-2012 Shasta Lake Elevation[6]

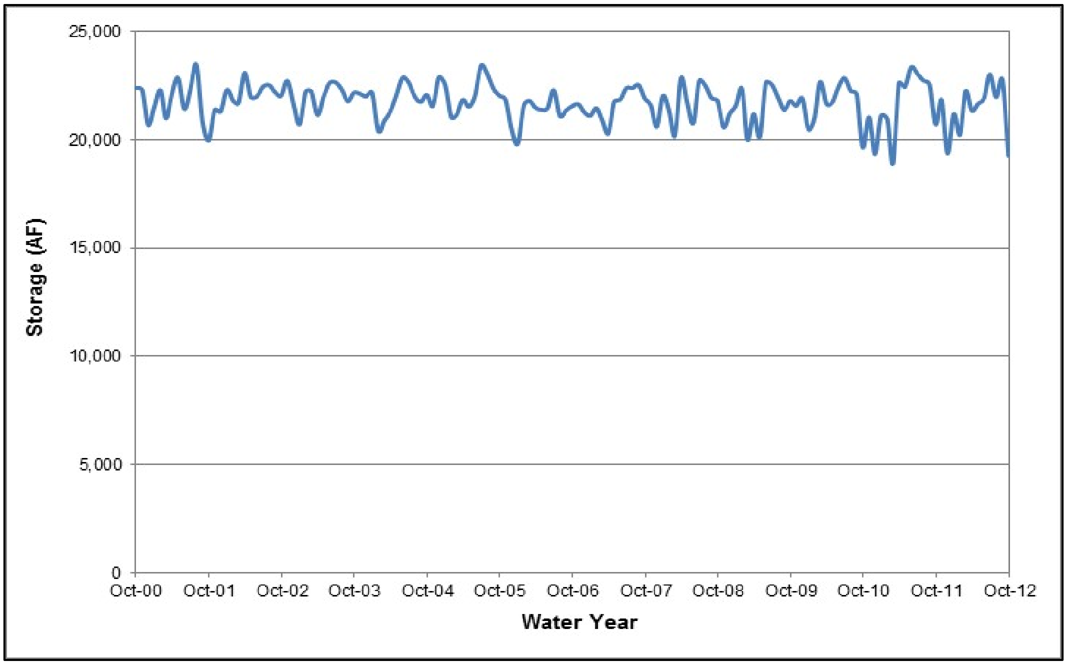

Figure 5.18 Historical Water Year 2001 - 2012 Keswick Reservoir Storage

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[6] The minimum elevation line of 834 ft was taken from CalSim II. The maximum elevation line of 1,067 ft was provided by Reclamation.

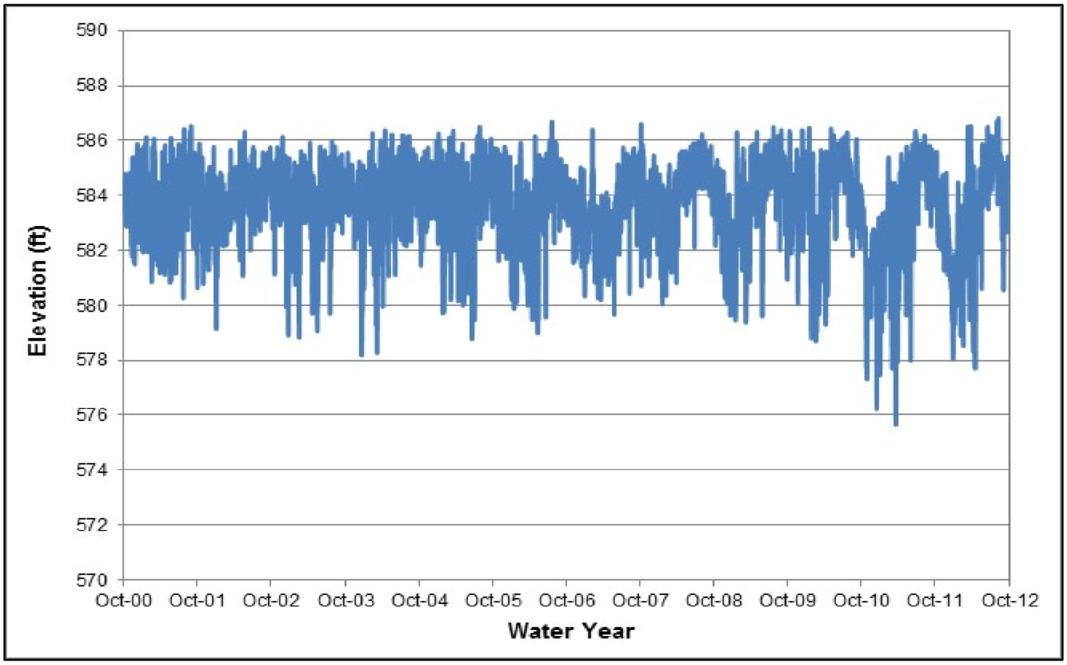

Figure 5.19 Historical Water Year 2001 - 2012 Keswick Reservoir Elevation

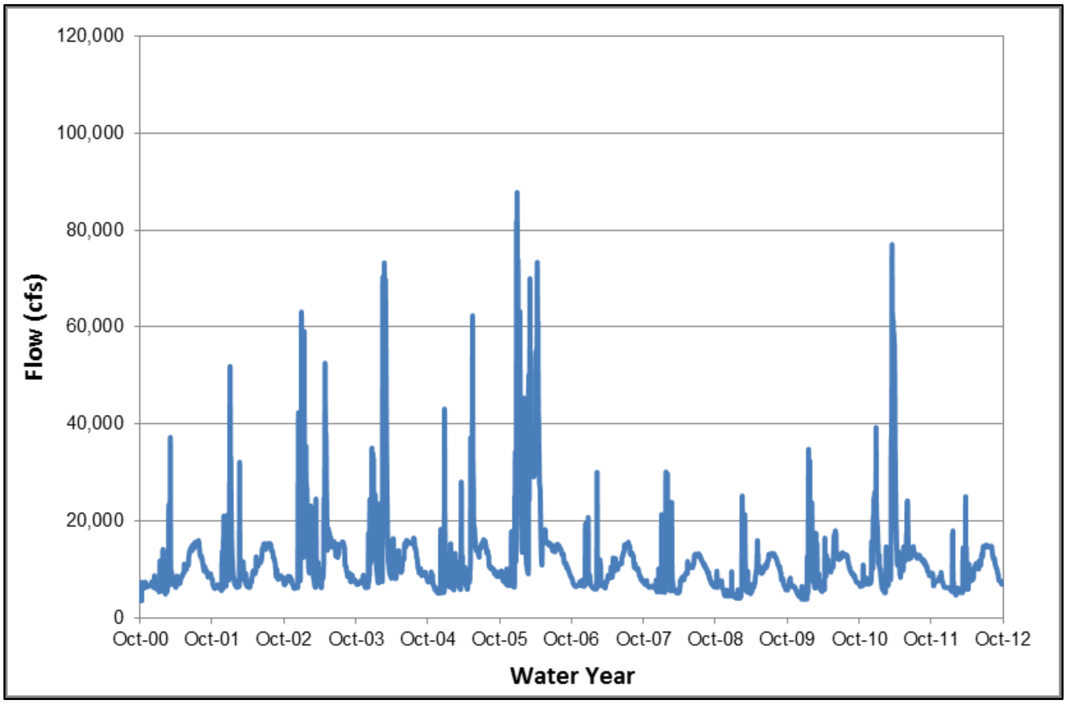

Figure 5.20 Historical Water Year 2001 - 2012 Sacramento River Mean Daily Flows at Bend Bridge

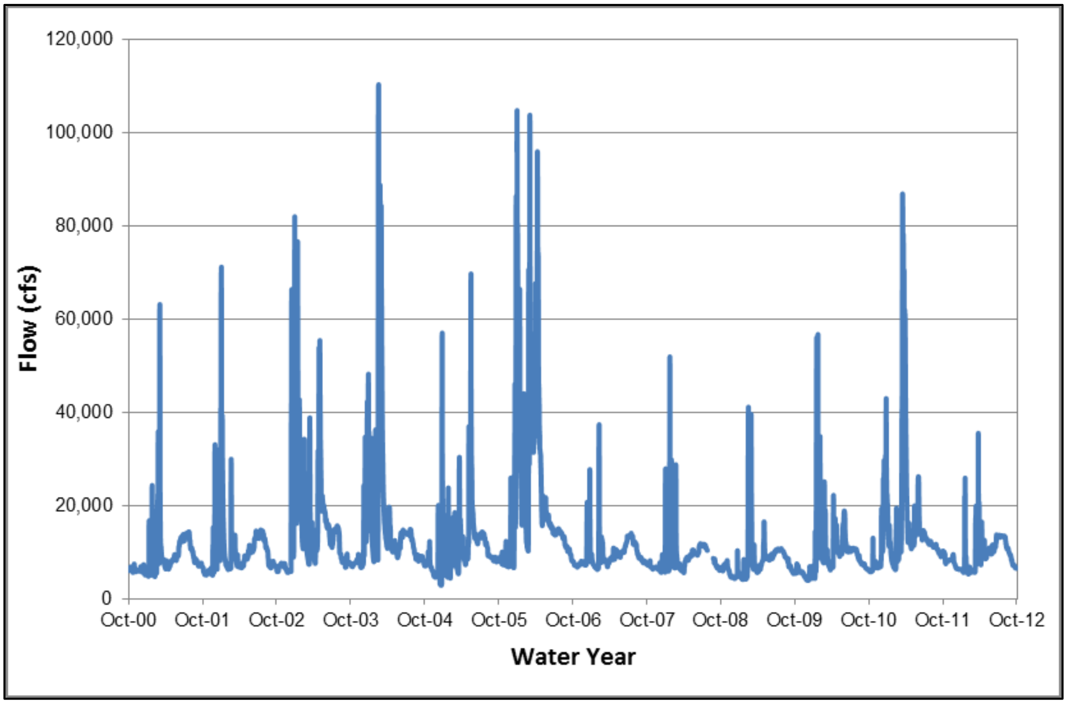

Figure 5.21 Historical Water Year 2001 - 2012 Sacramento River Mean Daily Flows at Vina Bridge

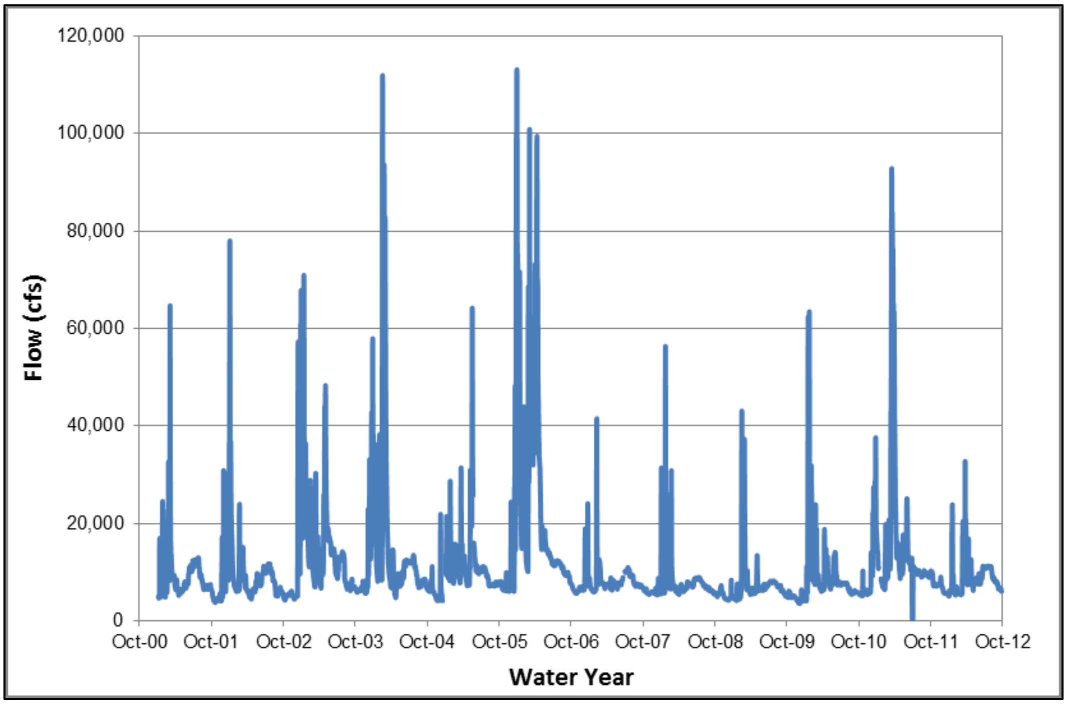

Figure 5.22 Historical Water Year 2001 - 2012 Sacramento River Mean Daily Flows at Hamilton City

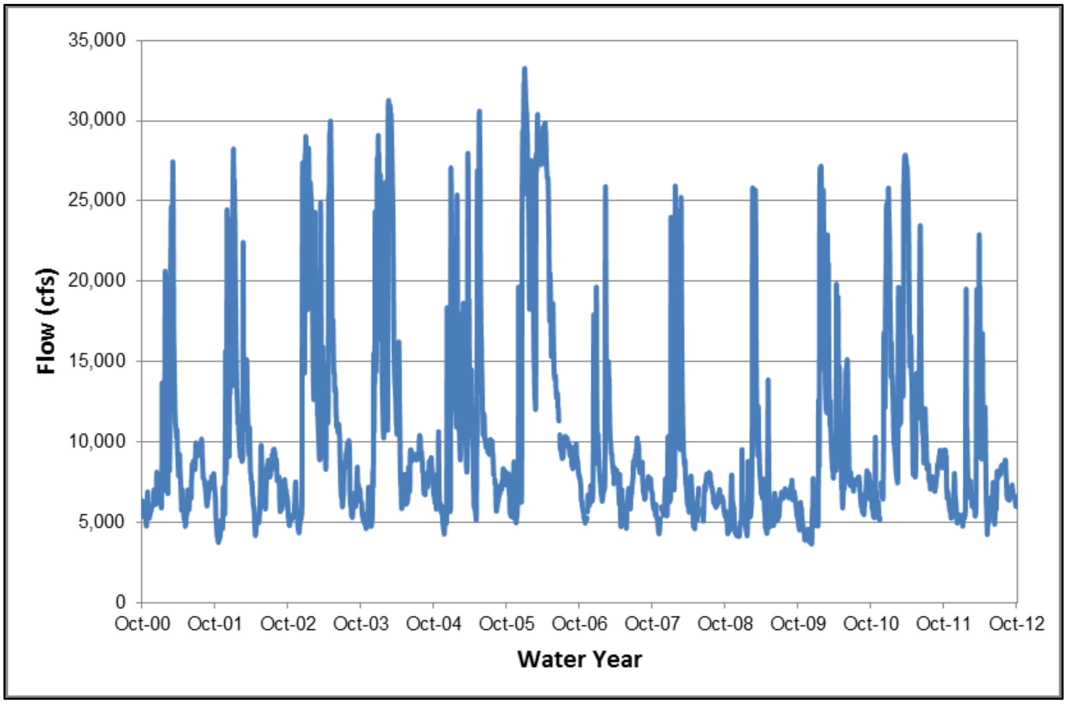

Figure 5.23 Historical Water Year 2001 - 2012 Sacramento River Mean Daily Flows at Wilkins Slough

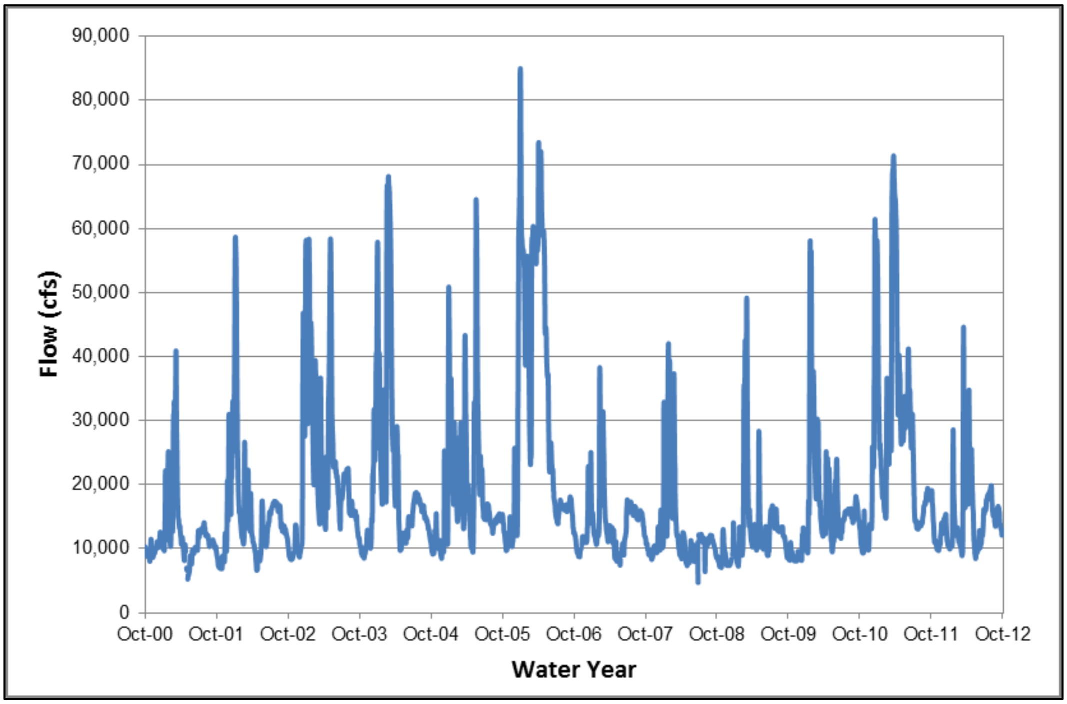

Figure 5.24 Historical Water Year 2001 - 2012 Sacramento River Mean Daily Flows at Verona

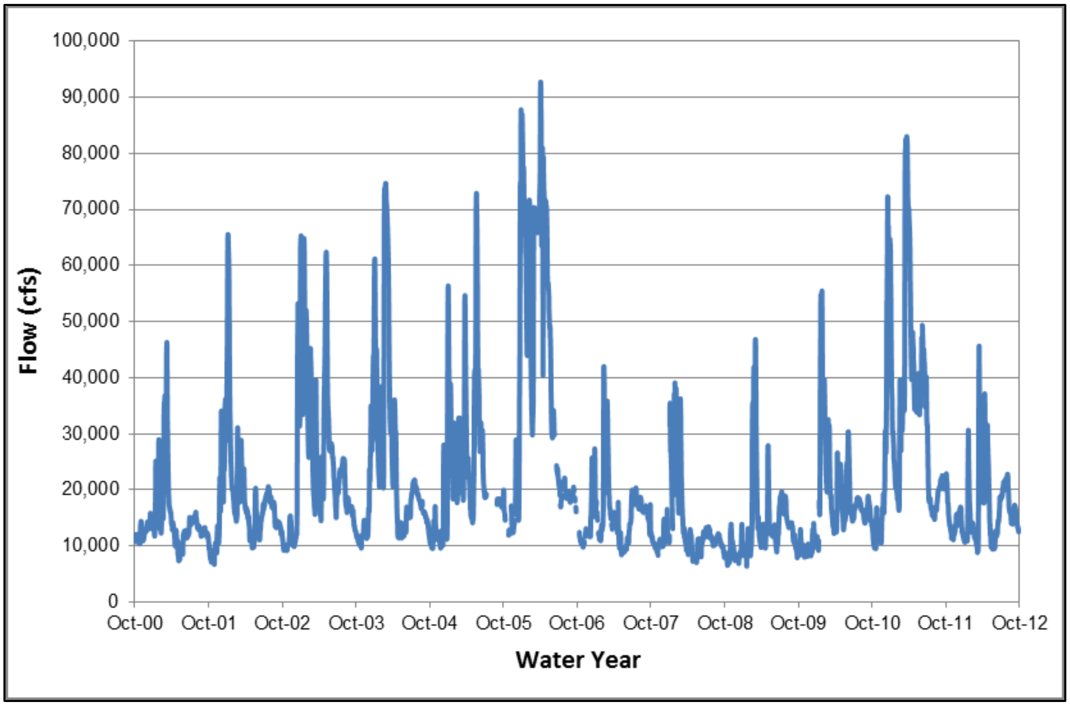

Figure 5.25 Historical Water Year 2001 - 2012 Sacramento River Mean Daily Flows at Freeport

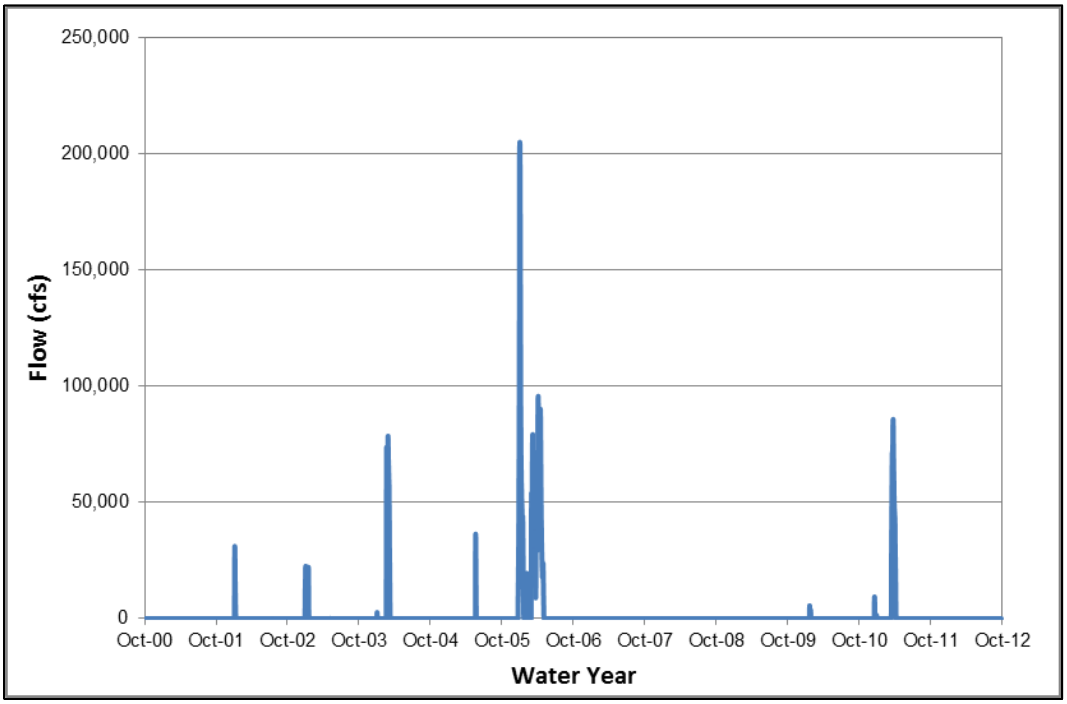

Figure 5.26 Historical Water Year 2001 - 2012 Flows into Yolo Bypass over Fremont Weir

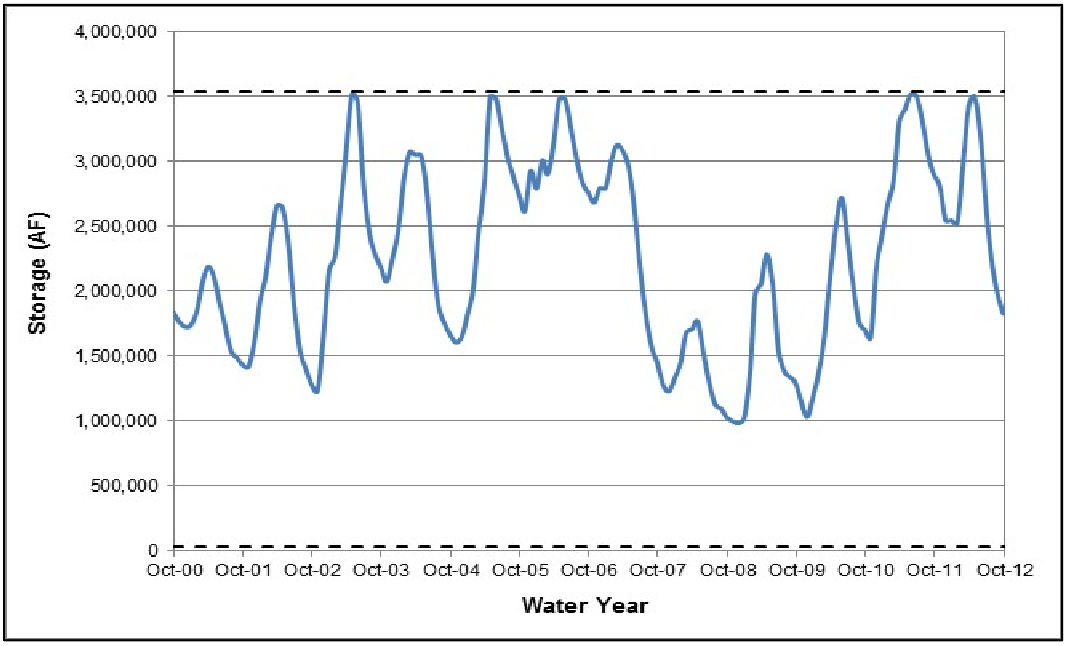

Figure 5.27 Historical Water Year 2001 - 2012 Lake Oroville Storage[7]

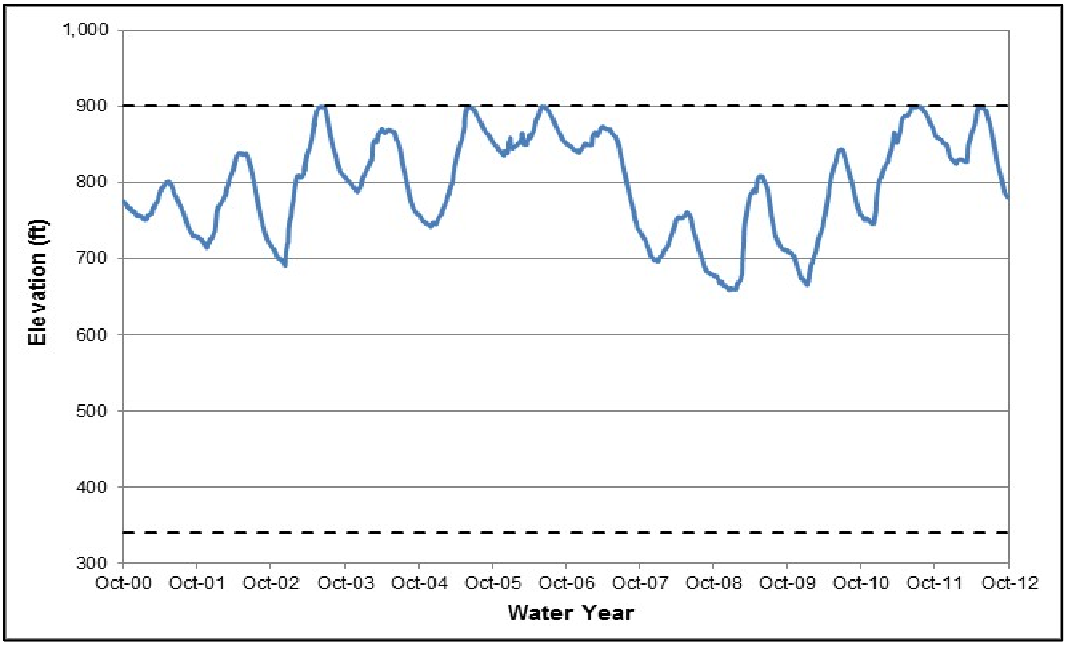

Figure 5.28 Historical Water Year 2001 - 2012 Lake Oroville Elevation[8]

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[7] The minimum storage line of 30,000 AF was taken from CalSim II. The maximum storage line of 3,537,577 AF was taken from the California Data Exchange Center website http://cdec.water.ca.gov/misc/resinfo.html.

[8] The minimum elevation line of 340 ft was taken from CalSim II. The maximum elevation line of 900 ft was provided by Reclamation. Erroneous data on 7/9/2005 was deleted.

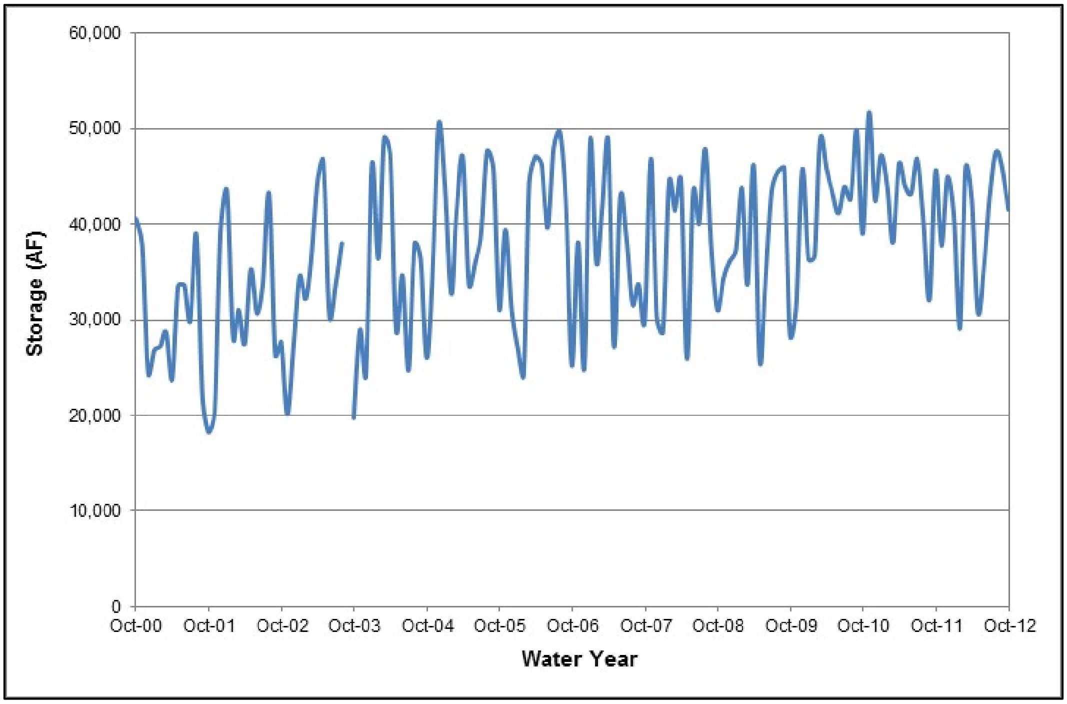

Figure 5.29 Historical Water Year 2001 - 2012 Thermalito Reservoir Storage

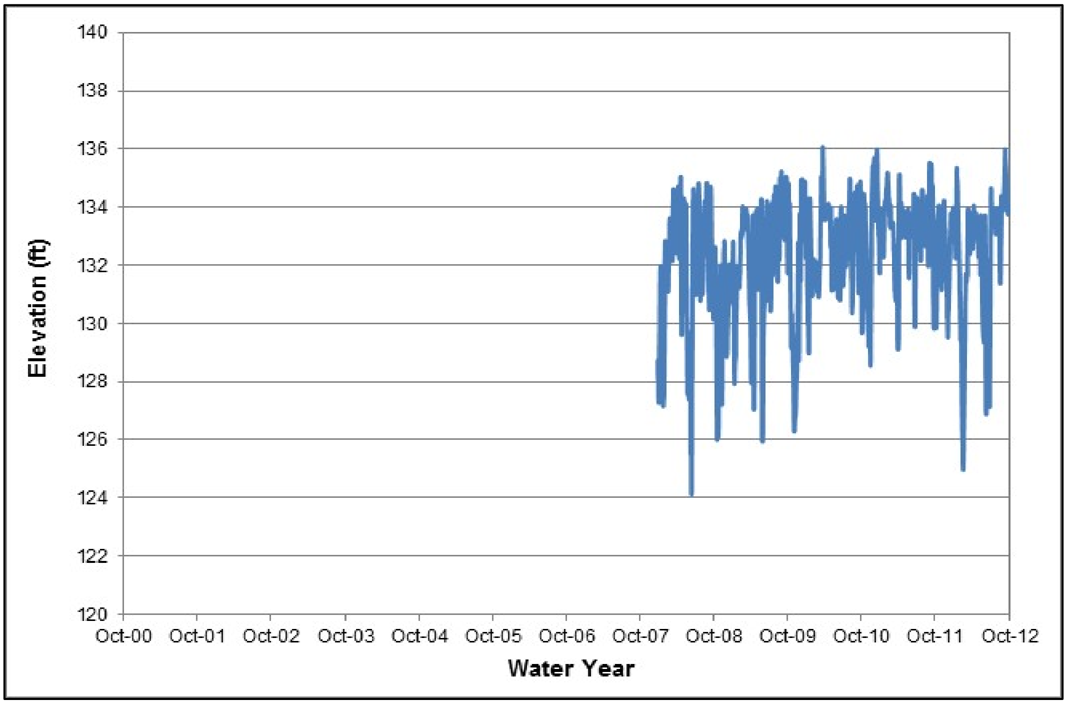

Figure 5.30 Historical Water Year 2008 - 2012 Thermalito Reservoir Elevation

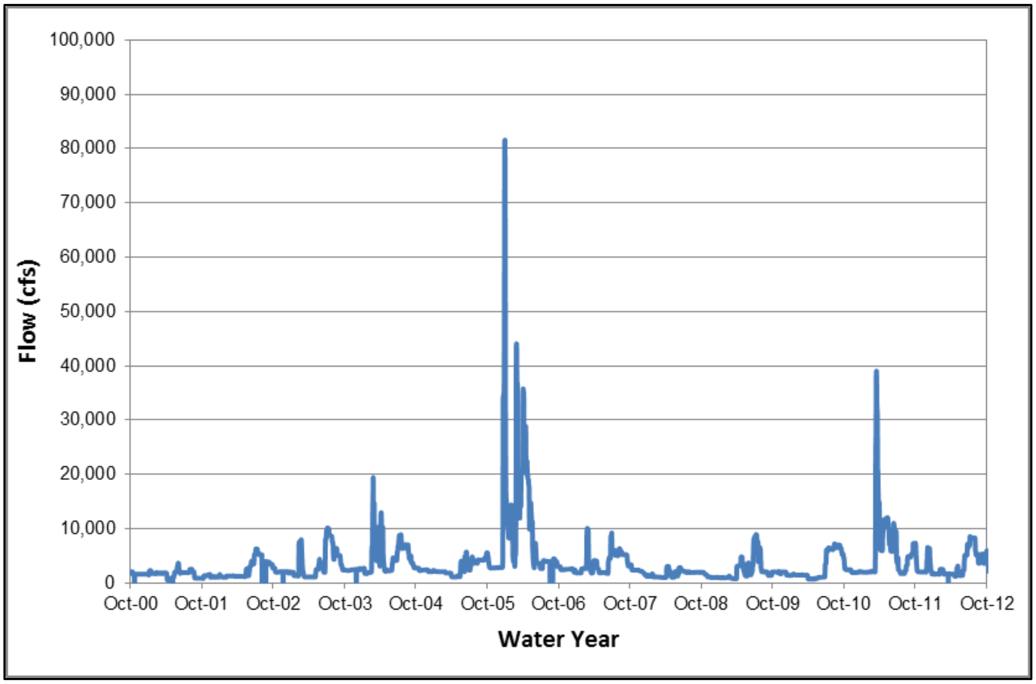

Figure 5.31 Historical Water Year 2001 - 2012 Feather River Mean Daily Flows near Gridley

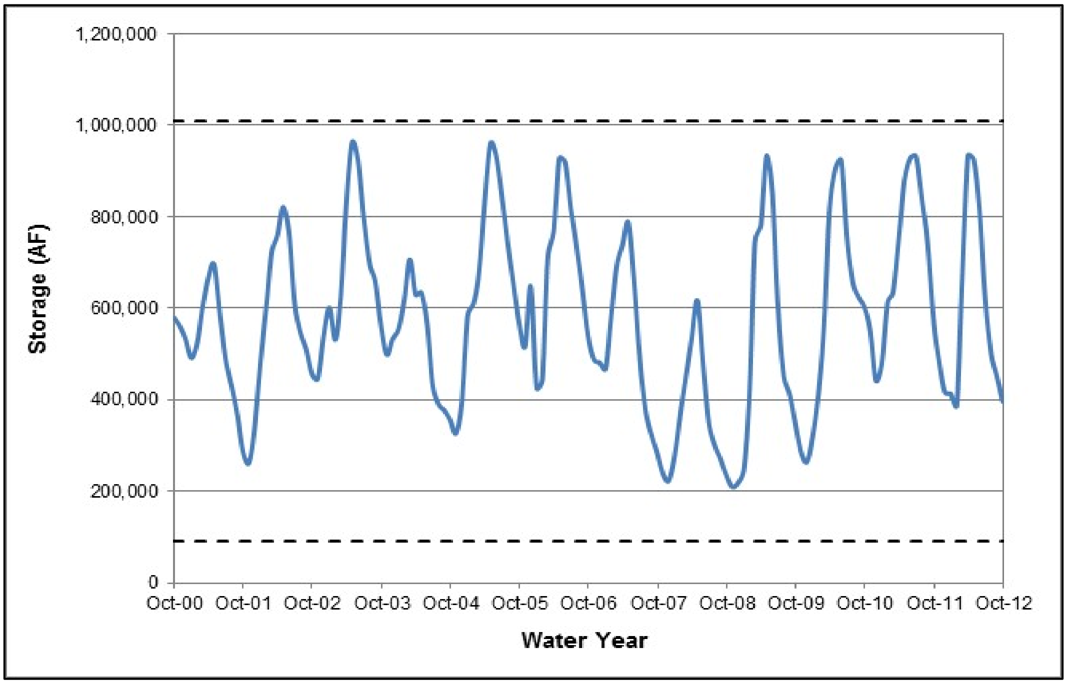

Figure 5.32 Historical Water Year 2001 - 2012 Folsom Lake Storage[9]

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[9] The minimum storage line of 90,000 AF was taken from CalSim II. The maximum storage line of 977,000 AF was taken from the California Data Exchange Center website http://cdec.water.ca.gov/misc/resinfo.html.

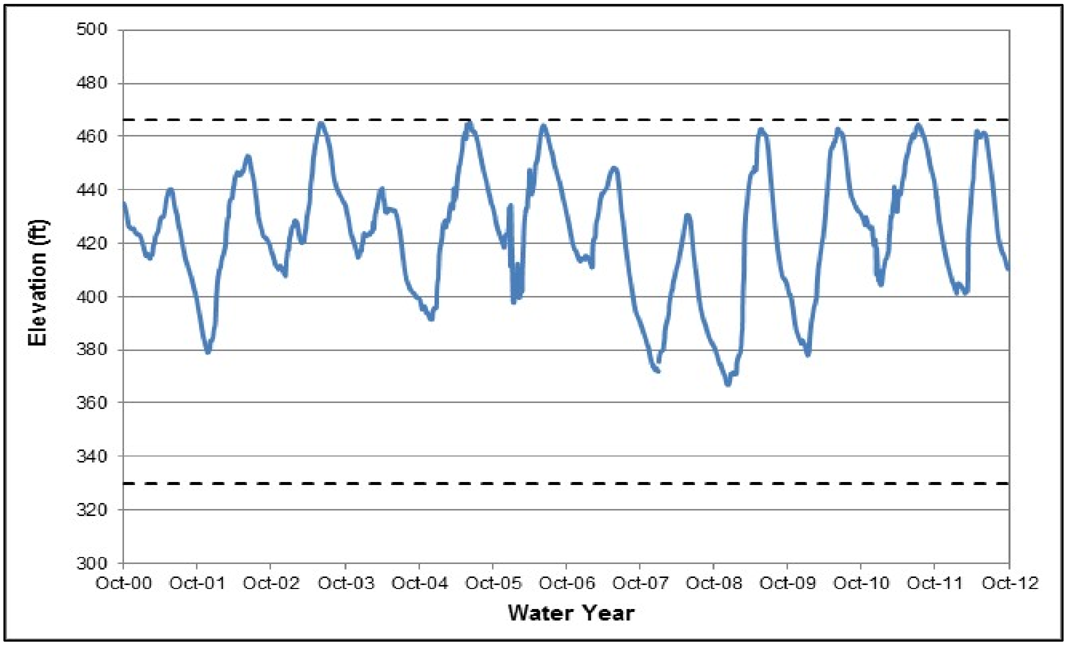

Figure 5.33 Historical Water Year 2001 - 2012 Folsom Lake Elevation[10]

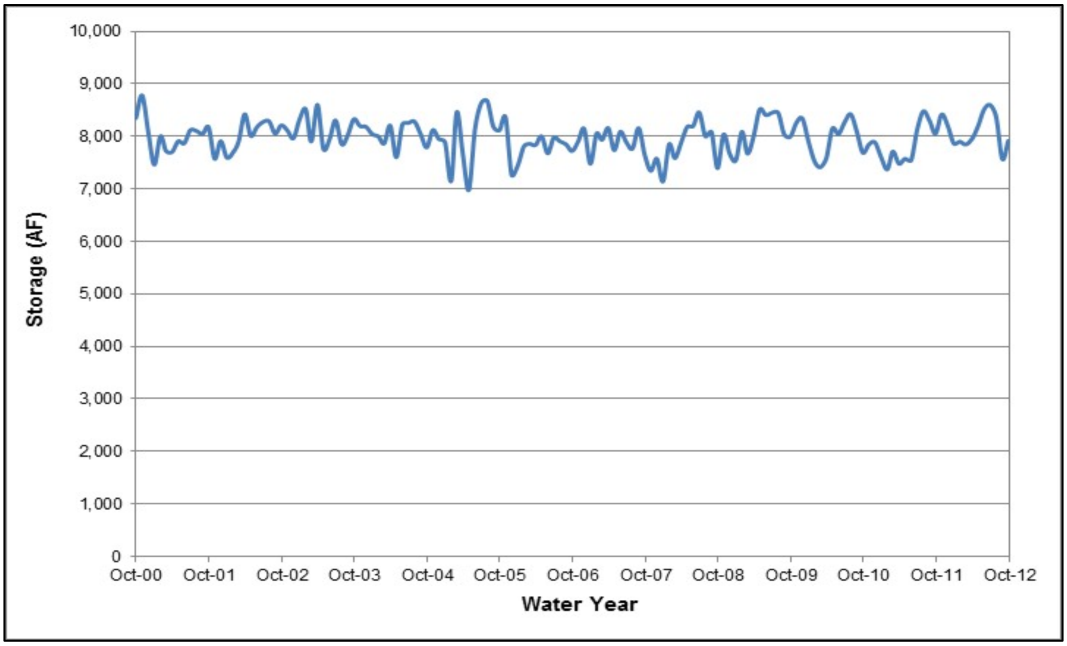

Figure 5.34 Historical Water Year 2001 - 2012 Lake Natoma Storage

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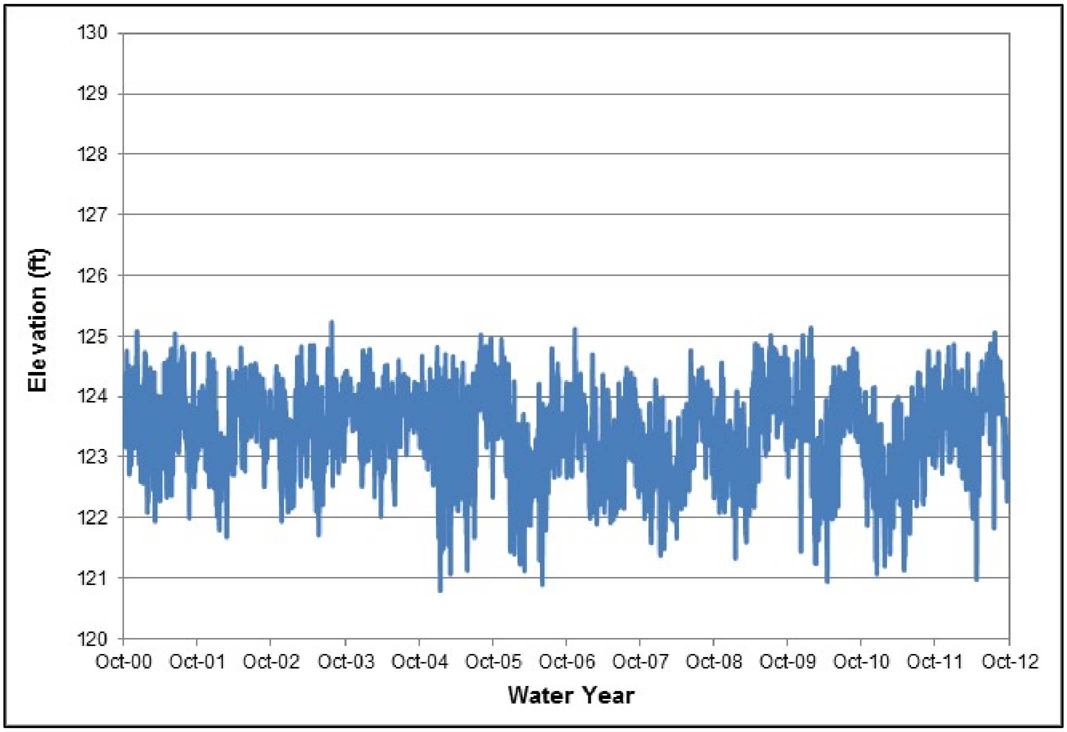
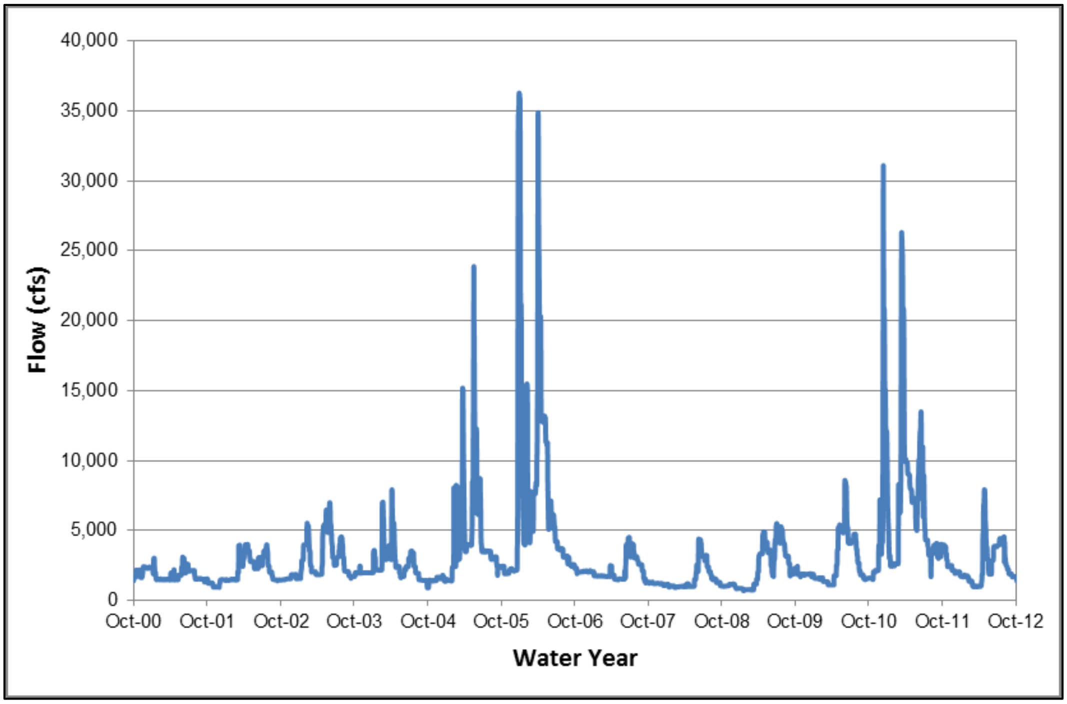
[10] The minimum elevation line of 330 ft was taken from CalSim II. The maximum elevation line of 466 ft was provided by Reclamation.

1 

2 **Figure 5.35 Historical Water Year 2001 - 2012 Lake Natoma Elevation**

3 

4 **Figure 5.36 Historical Water Year 2001 - 2012 American River Mean Daily Flows at**
5 **Fair Oaks**

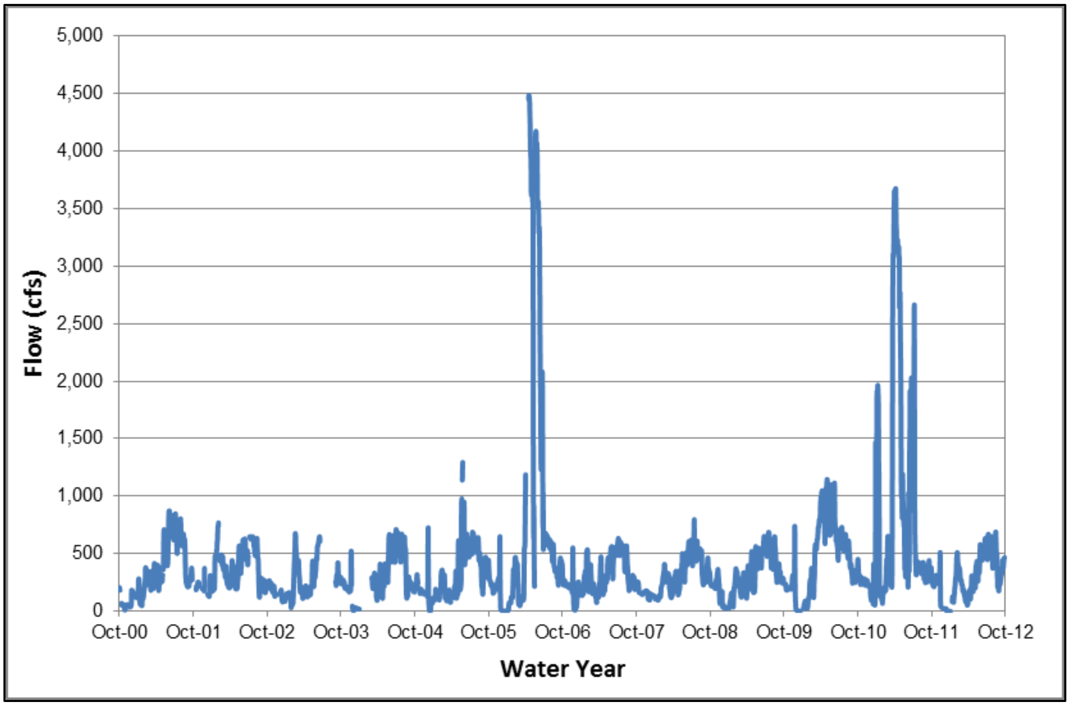


Figure 5.37 Historical Water Year 2001 - 2012 San Joaquin River Mean Daily Flows at Mendota

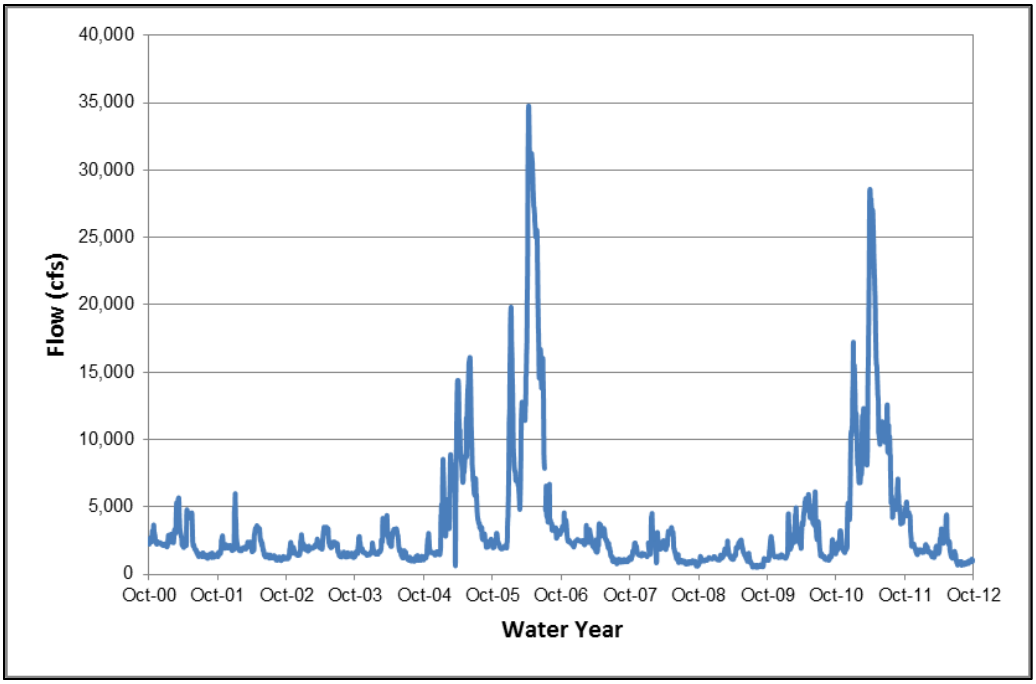


Figure 5.38 Historical Water Year 2001 - 2012 San Joaquin River Mean Daily Flows at Vernalis

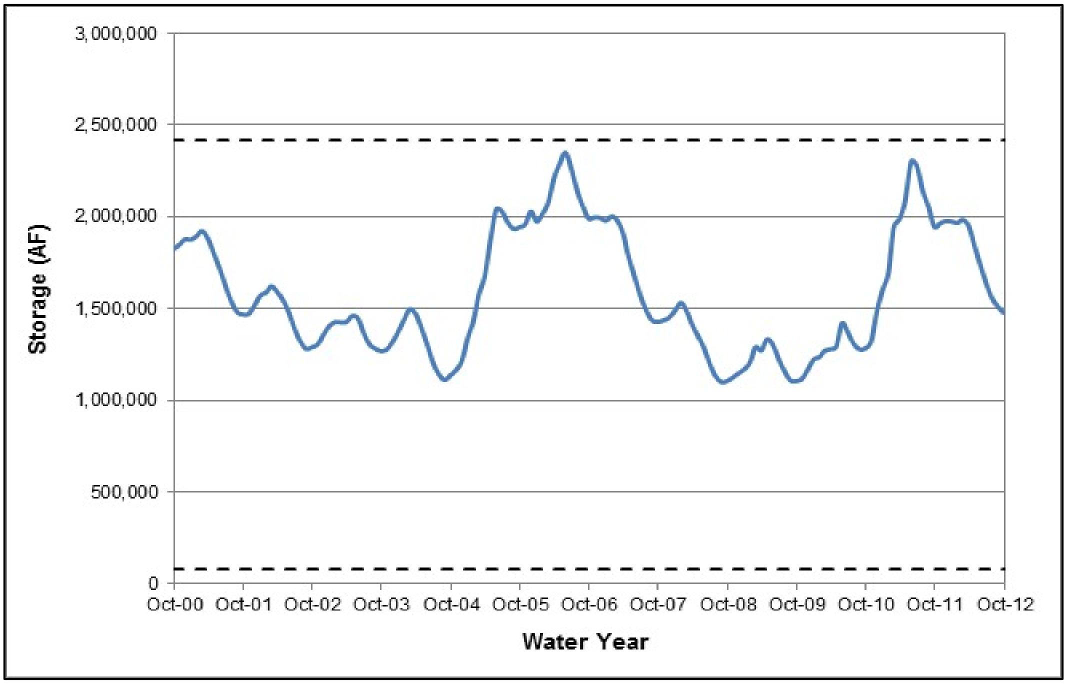


Figure 5.39 Historical Water Year 2001 - 2012 New Melones Reservoir Storage[11]

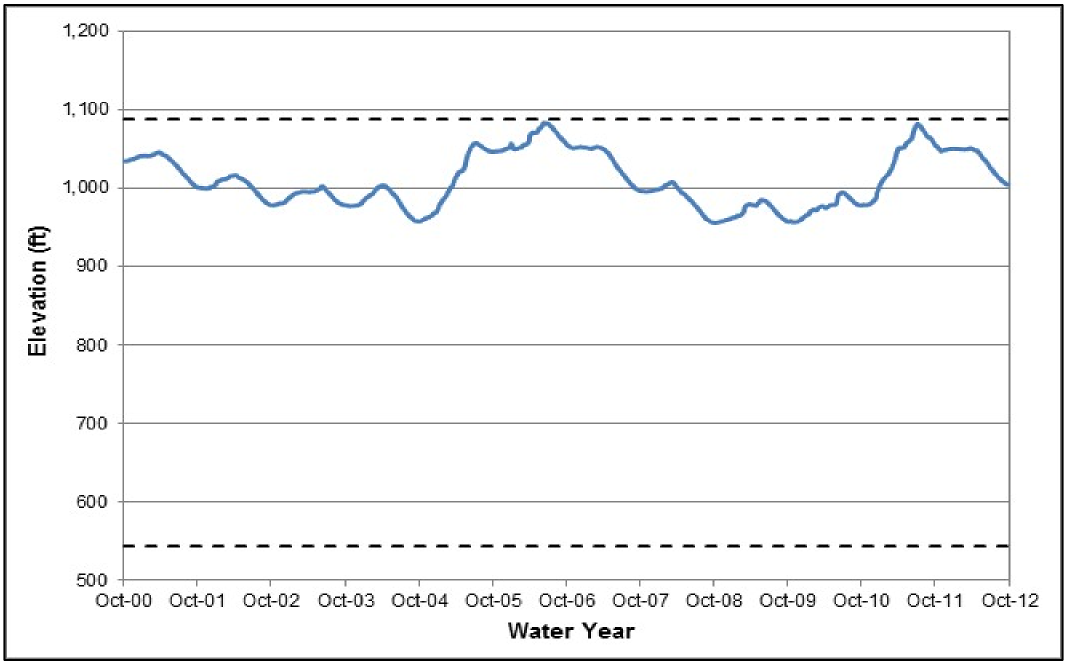


Figure 5.40 Historical Water Year 2001 - 2012 New Melones Reservoir Elevation[12]

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[11] The minimum storage line of 80,000 AF was taken from CalSim II. The maximum storage line of 2,400,000 AF was taken from the California Data Exchange Center website http://cdec.water.ca.gov/misc/resinfo.html.

[12] The dead pool elevation of 543 feet and normal pool elevation of 1,088 feet was taken from CalSim II.

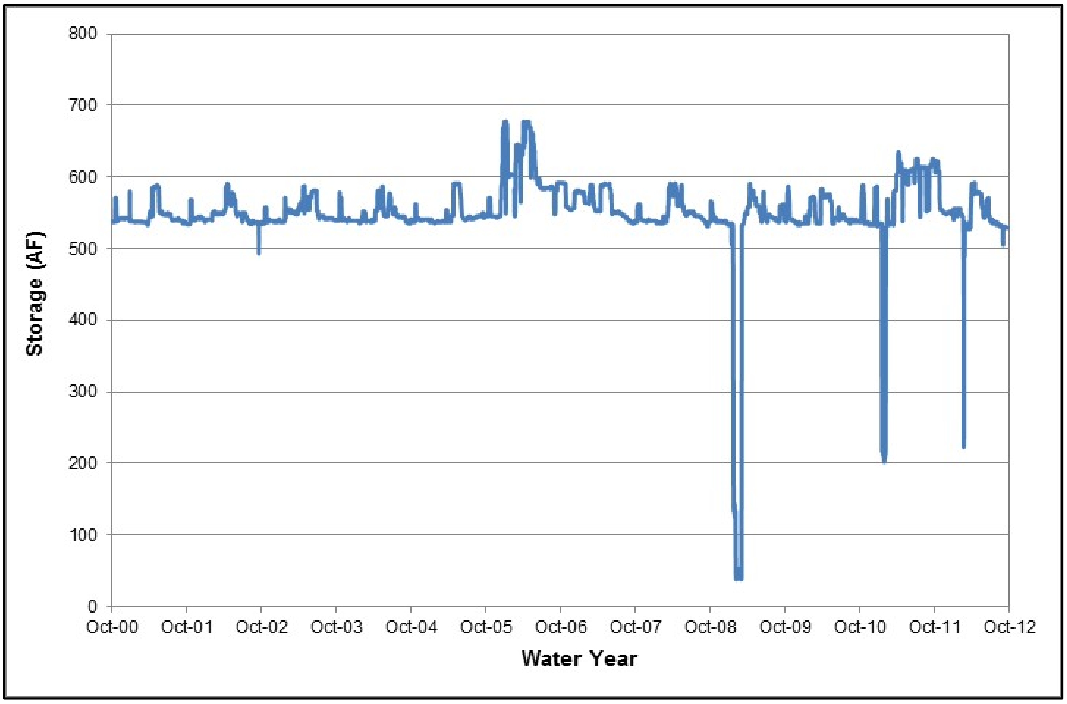

Figure 5.41 Historical Water Year 2001 - 2012 Goodwin Reservoir Storage

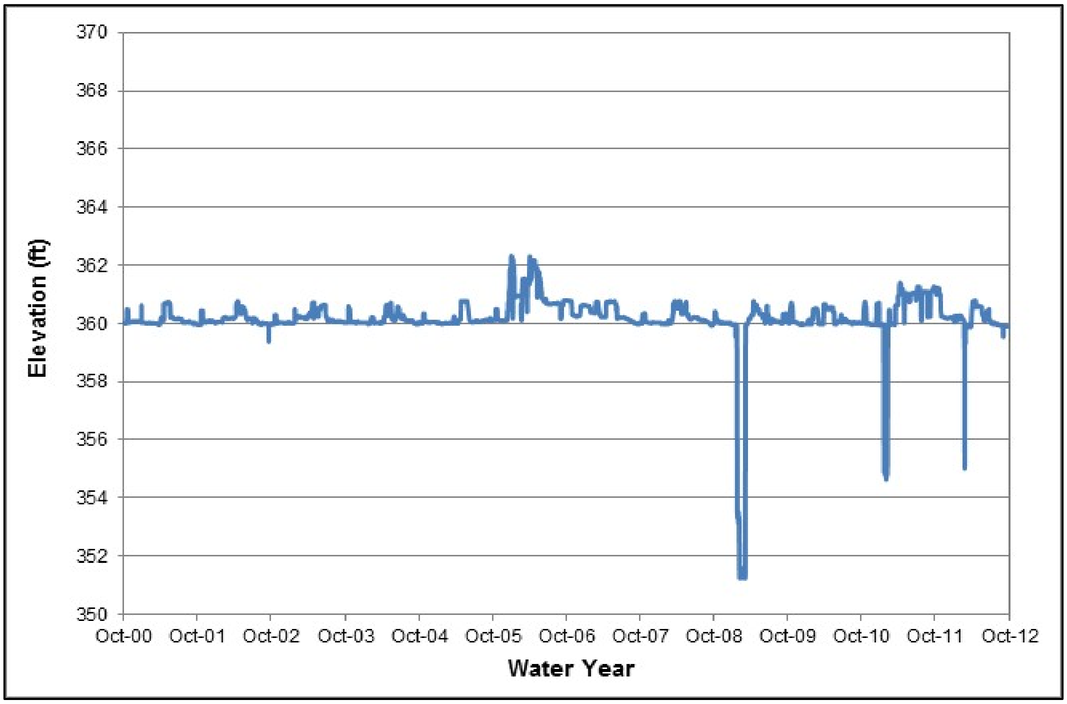

Figure 5.42 Historical Water Year 2001 - 2012 Goodwin Reservoir Elevation[13]

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[13] Erroneous data on 10/30/2002 was removed.

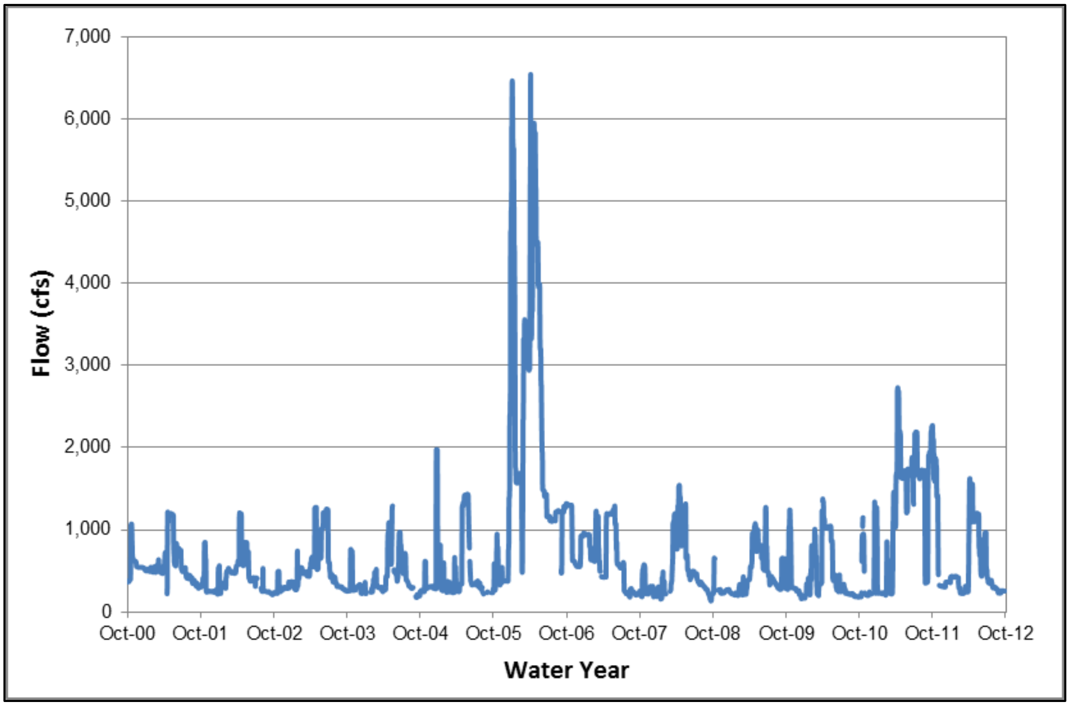

Figure 5.43 Historical Water Year 2001 - 2012 Stanislaus River Mean Daily Flows at Orange Blossom Bridge

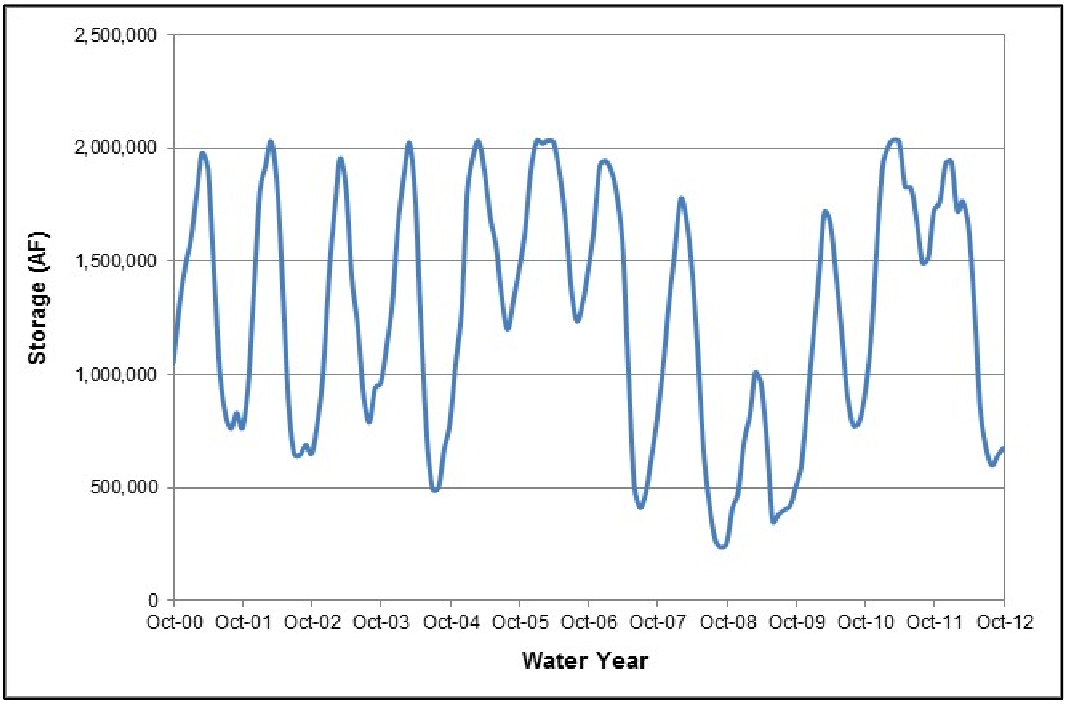

Figure 5.44 Historical Water Year 2001 - 2012 San Luis Reservoir Storage

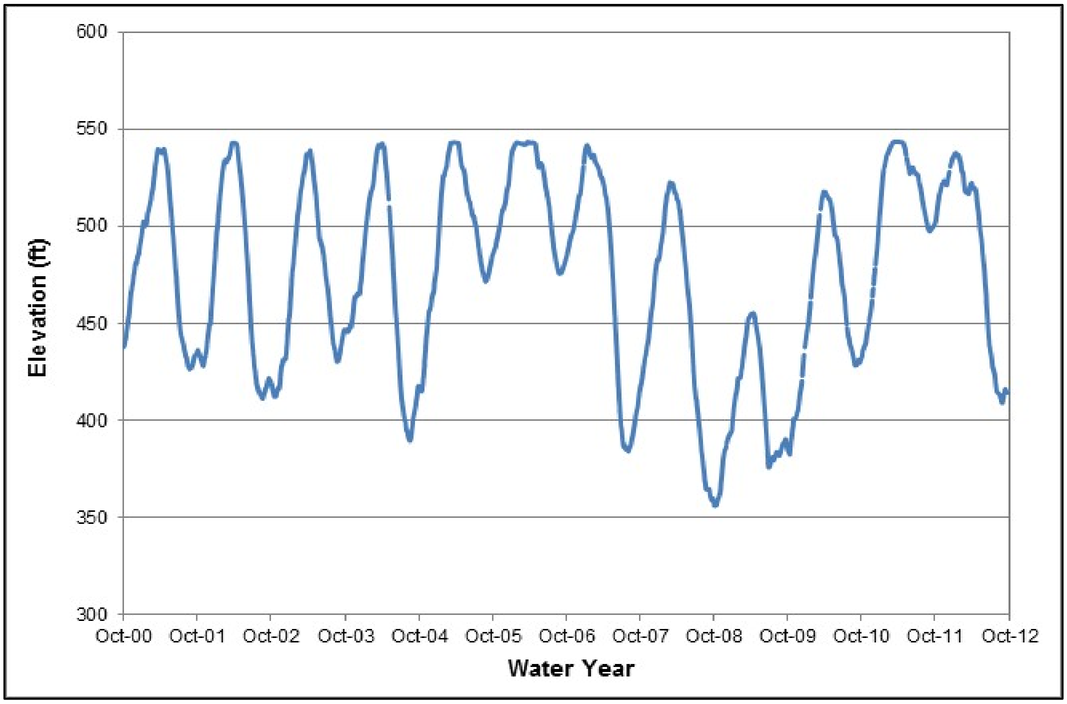

Figure 5.45 Historical Water Year 2001 - 2012 San Luis Reservoir Elevation[14]

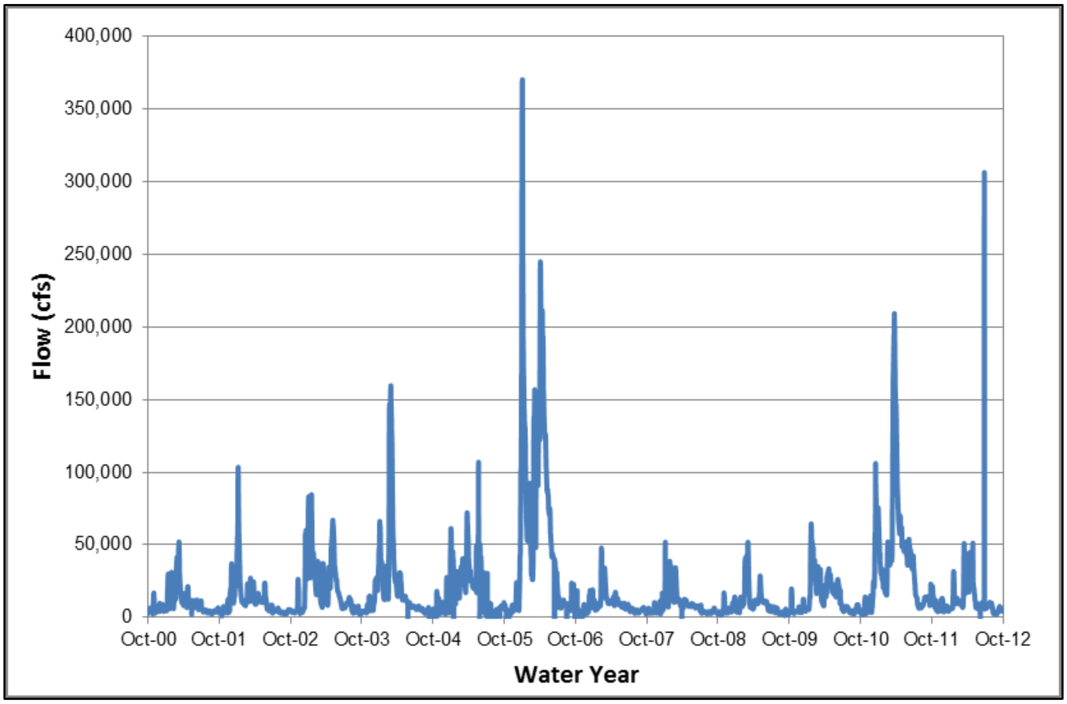

Figure 5.46 Historical Water Year 2001 - 2012 Delta Outflow Mean Daily Flows

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[14] Erroneous data on 10/13/2003, 9/18/2007, and 7/19/2010 was removed.

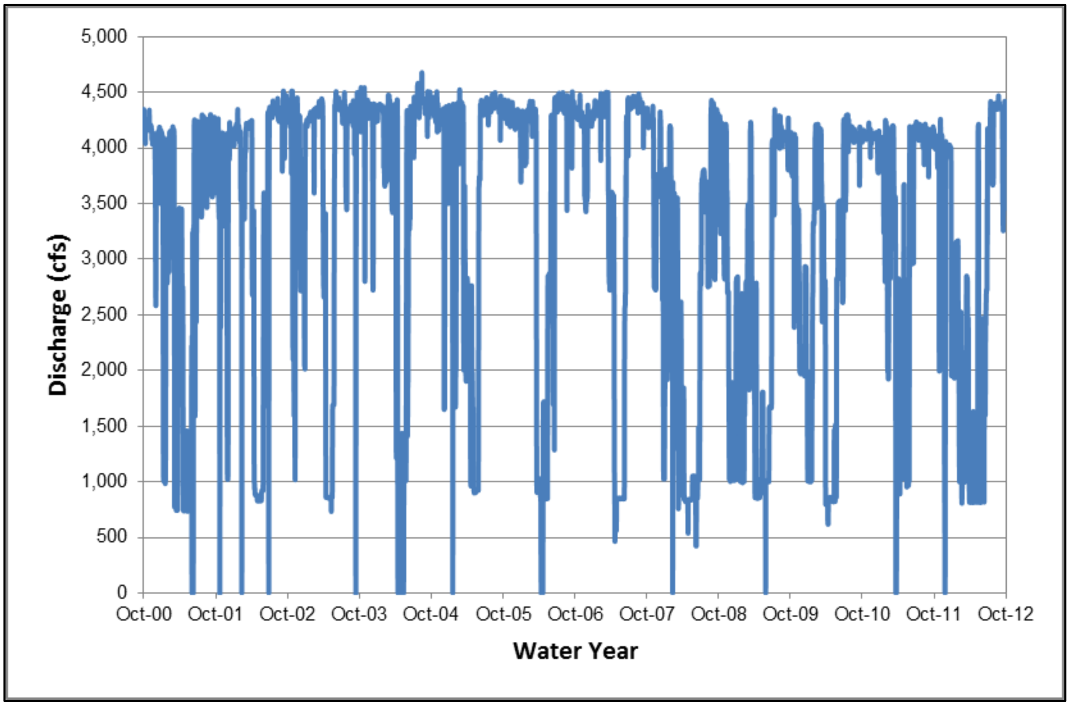

Figure 5.47 Historical Water Year 2001 - 2012 Jones Pumping Plant Mean Daily Flows

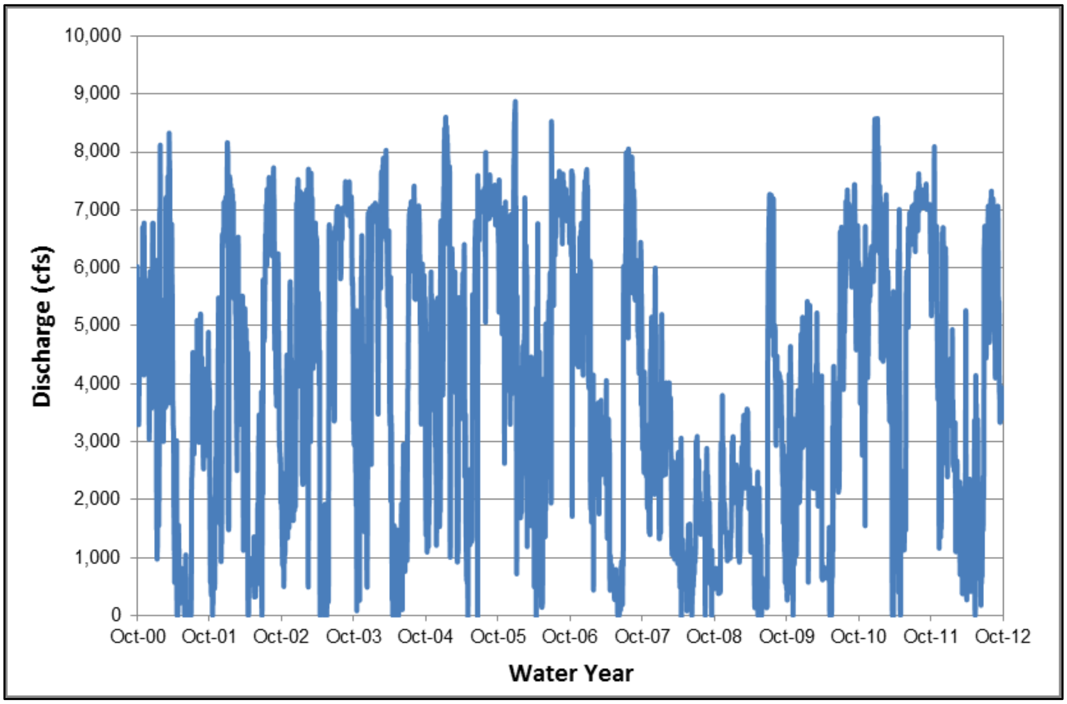

Figure 5.48 Historical Water Year 2001 - 2012 Banks Pumping Plant Mean Daily Flows

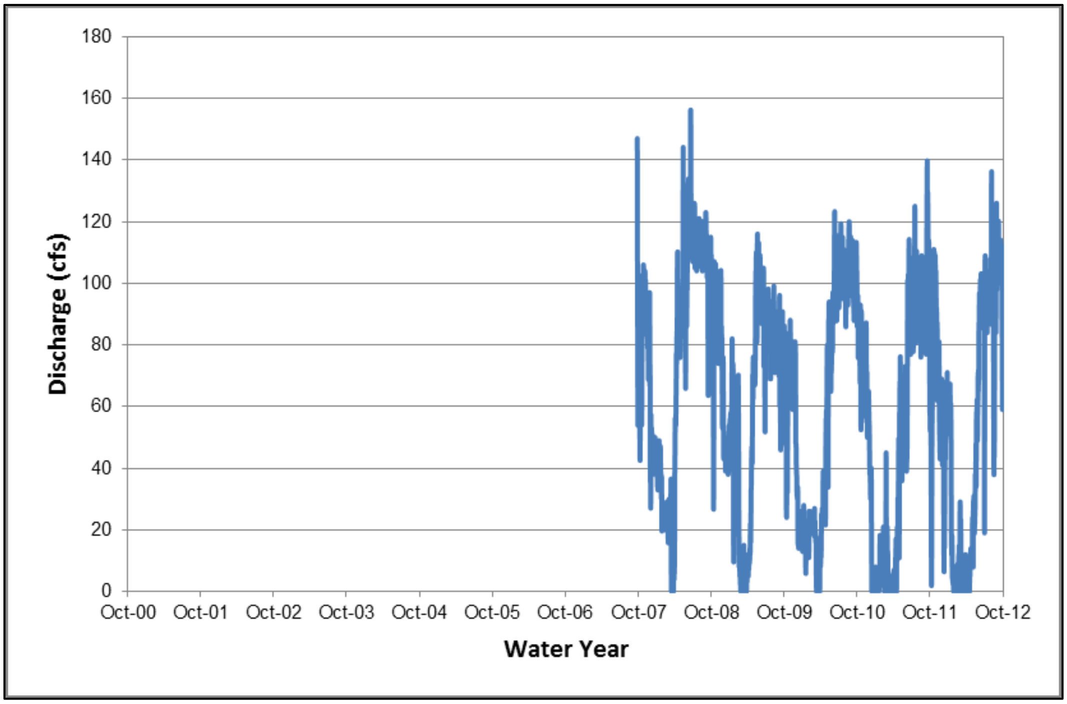

Figure 5.49 Historical Water Year 2008 - 2012 Barker Slough Pumping Plant Mean Daily Flows

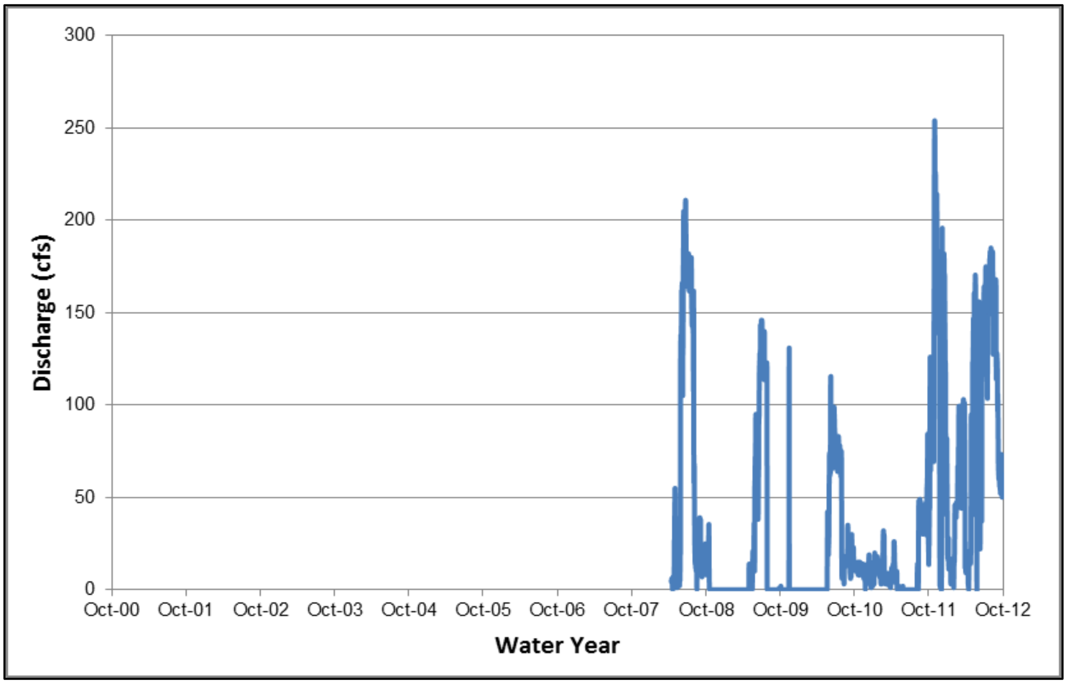

Figure 5.50 Water Year 2008 – 2012 Contra Costa Canal Rock Slough Intake Mean Daily Flows

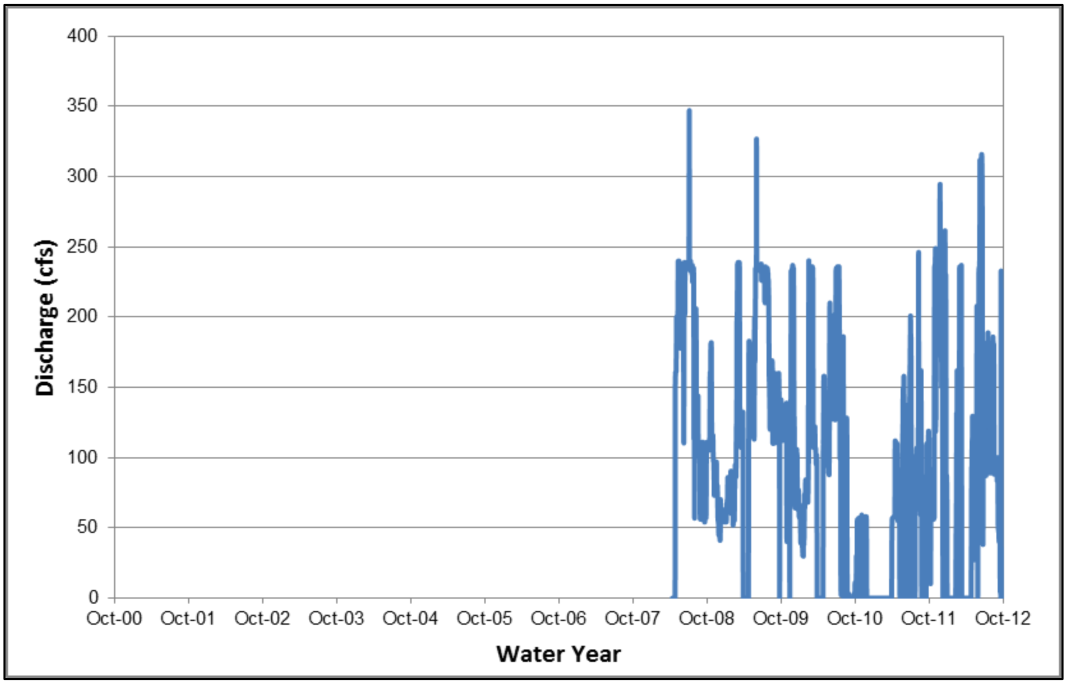

Figure 5.51 Historical Water Year 2008 - 2012 Contra Costa Water District Old River Intake Mean Daily Flows

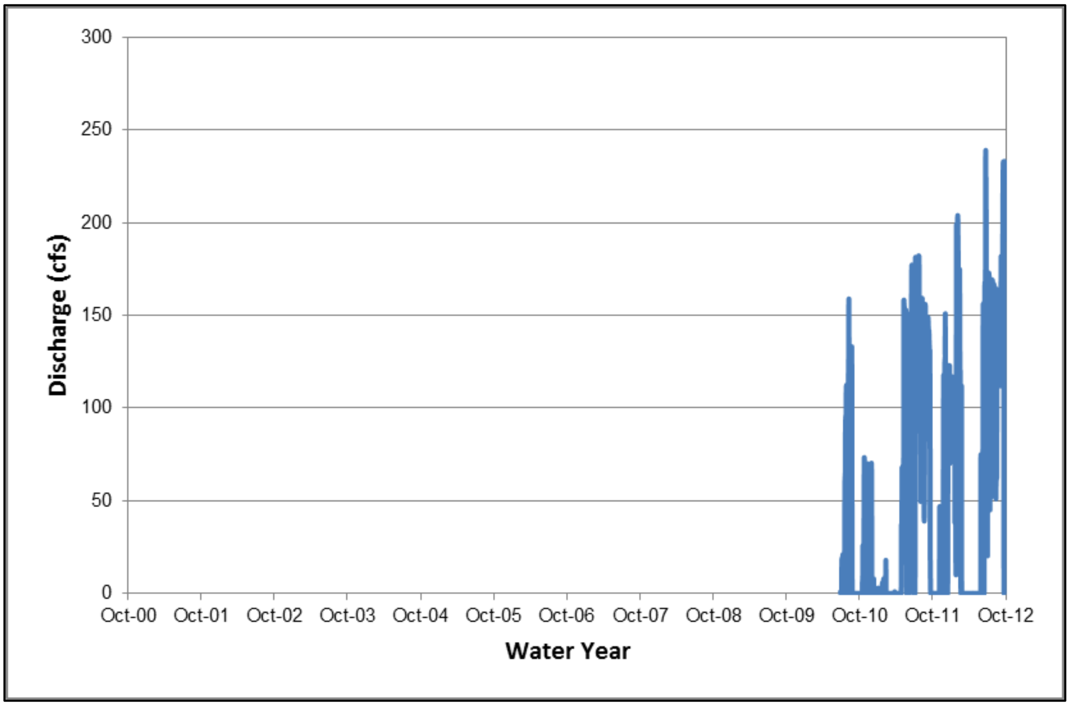

Figure 5.52 Historical Water Year 2010 - 2012 Contra Costa Water District Middle River Intake Mean Daily Flows

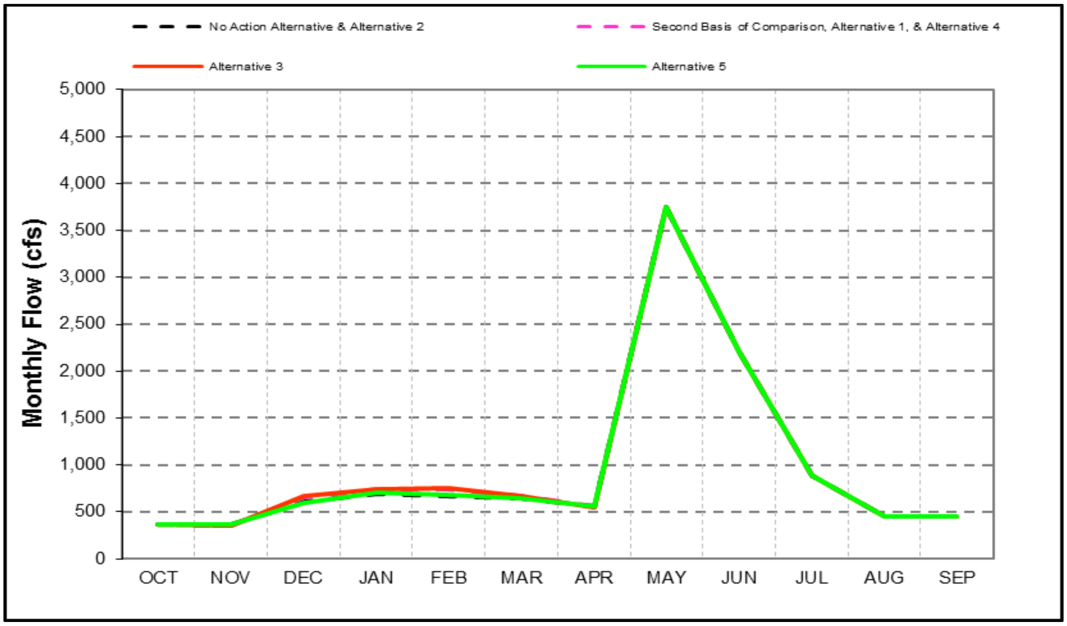

Figure 5.53 Trinity River below Lewiston Reservoir, Long-Term Average Flow[15]

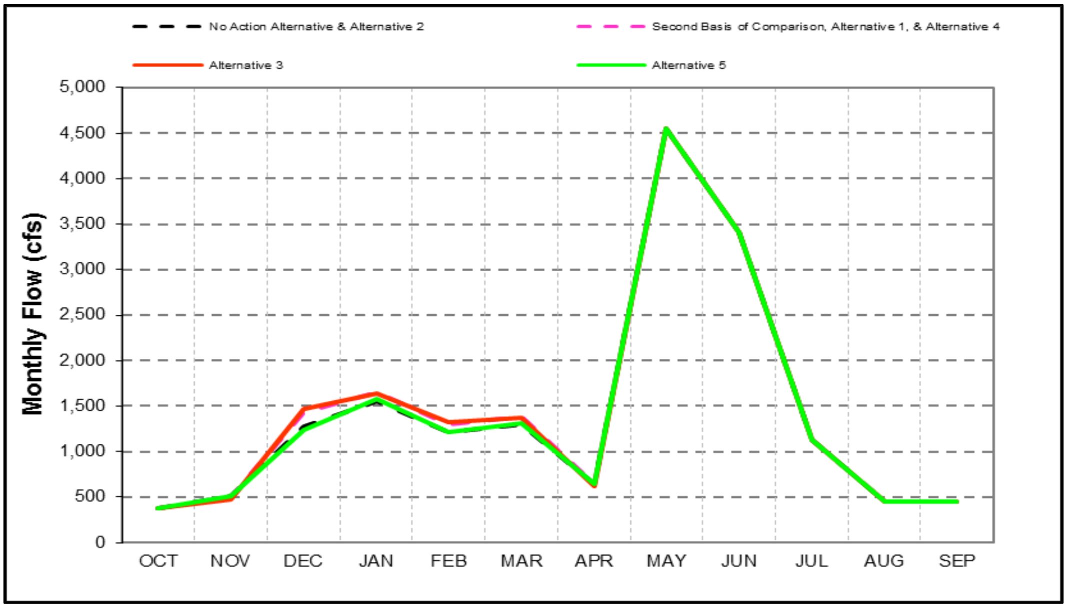

Figure 5.54 Trinity River below Lewiston Reservoir, Wet Year Long-Term Average Flow[15,16]

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[15] Based on the 82-year simulation period; Notes: 1) All alternatives are simulated with projected hydrology and sea level at Year 2030 conditions. 2) Model results for Alternatives 1, 4, and Second Basis of Comparison are the same, therefore Alternatives 1 and 4 results are not presented. Qualitative differences, if applicable, are discussed in the text. 3) Model results for Alternative 2 and No Action Alternative are the same, therefore Alternative 2 results are not presented. Qualitative differences, if applicable, are discussed in the text.

[16] Wet-Year and Dry-Year as defined by the Sacramento 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999), projected to year 2030

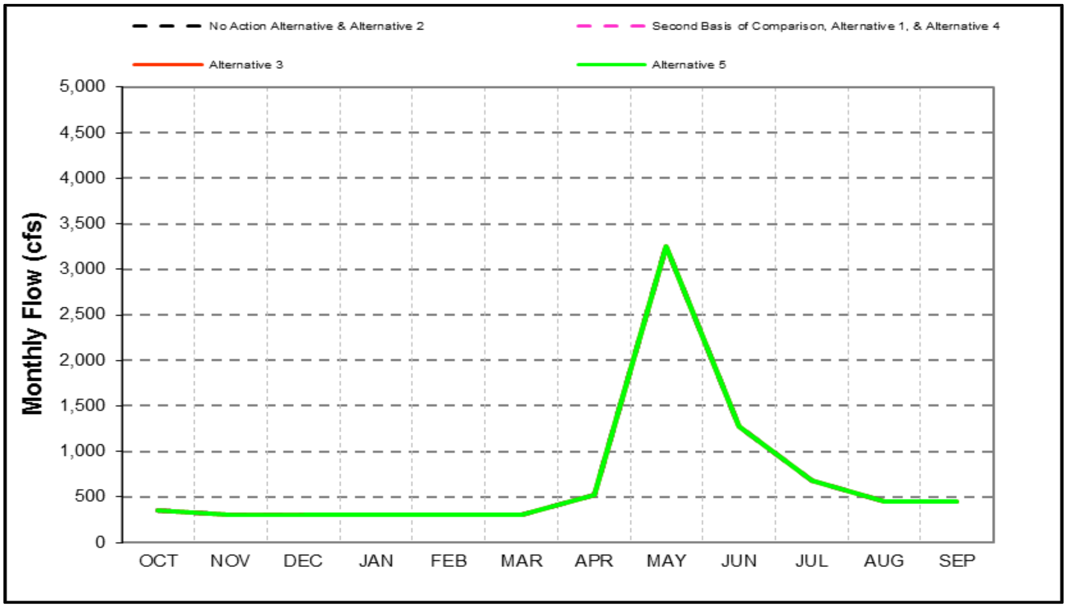

Figure 5.55 Trinity River below Lewiston Reservoir, Dry Year Long-Term Average Flow[15,16]

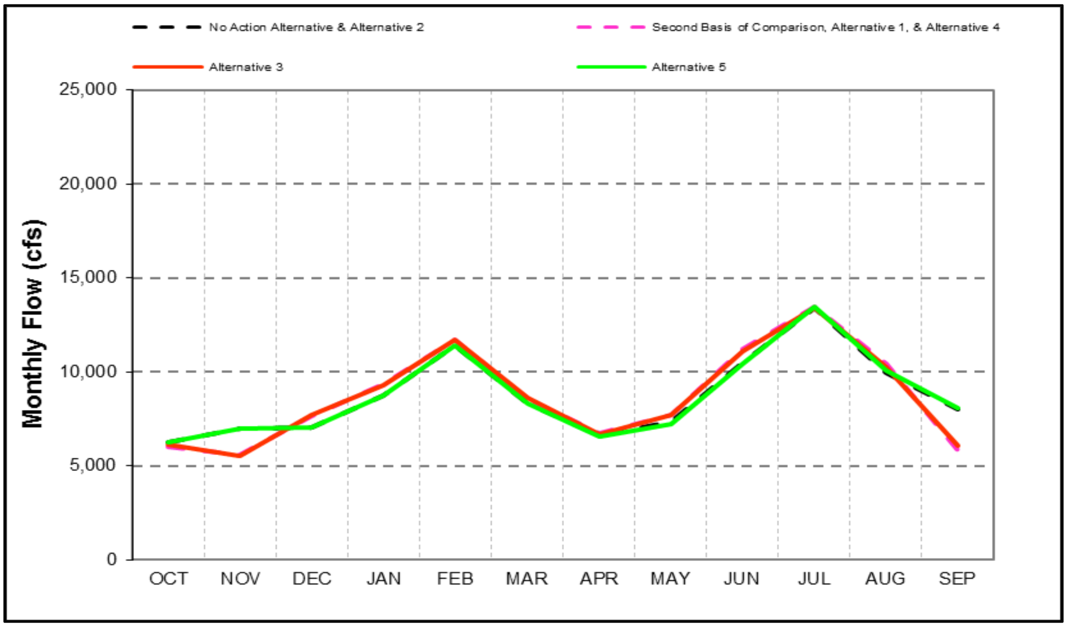

Figure 5.56 Sacramento River downstream of Keswick Reservoir, Long-Term Average Flow[15]

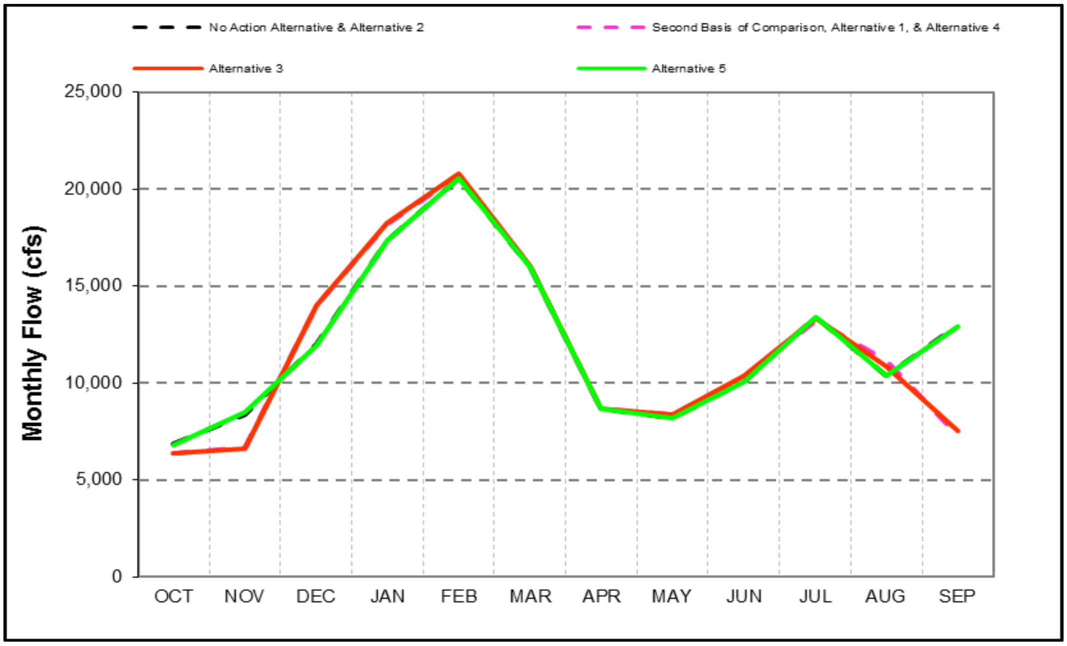

Figure 5.57 Sacramento River downstream of Keswick Reservoir, Wet Year Long-Term Average Flow[15,16]

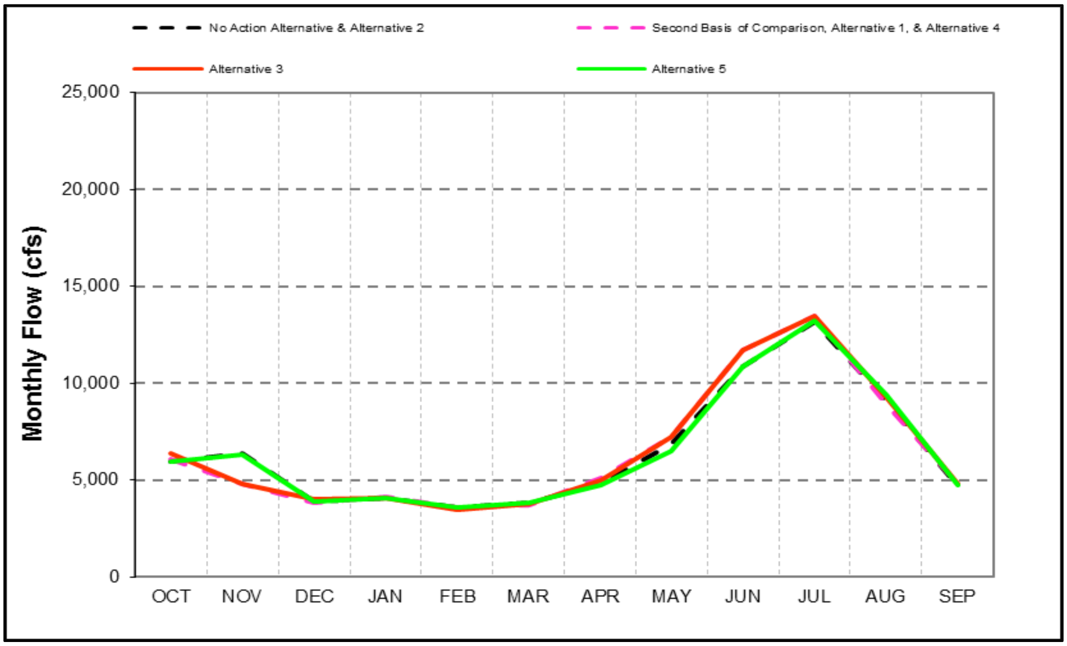

Figure 5.58 Sacramento River downstream of Keswick Reservoir, Dry Year Long-Term Average Flow[15,16]

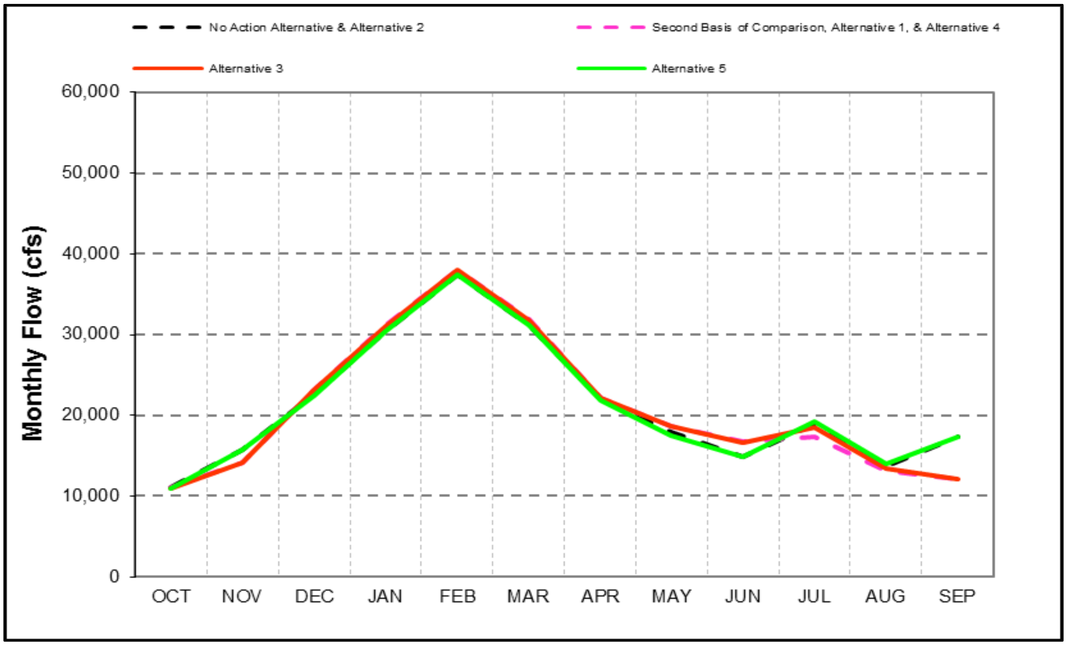

Figure 5.59 Sacramento River at Freeport, Long-Term Average Flow[15]

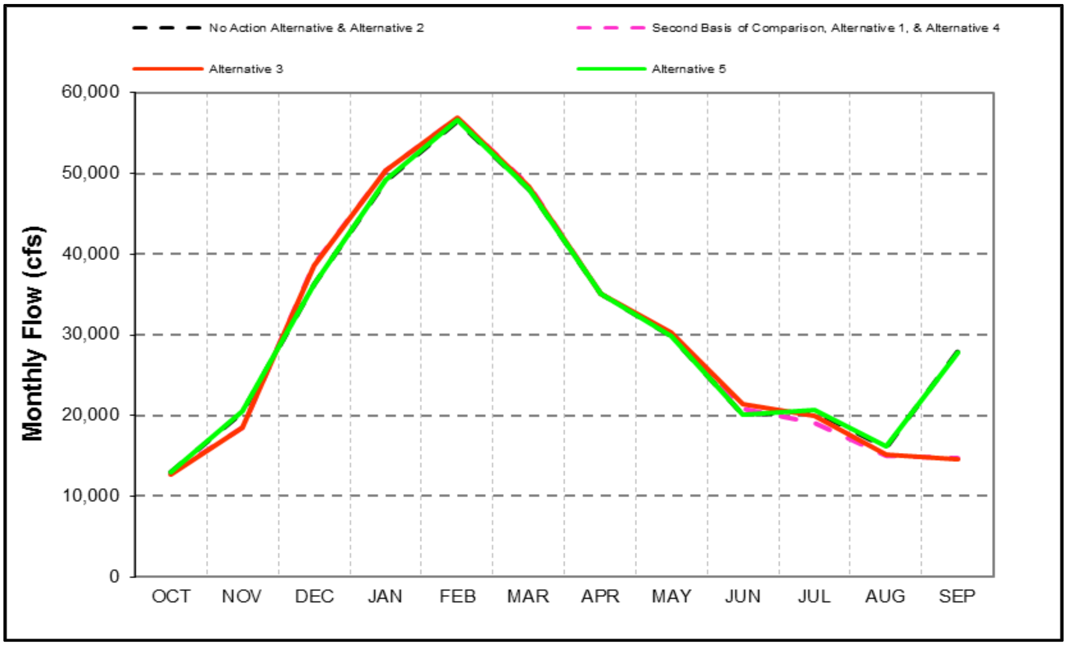

Figure 5.60 Sacramento River at Freeport, Wet Year Long-Term Average Flow[15,16]

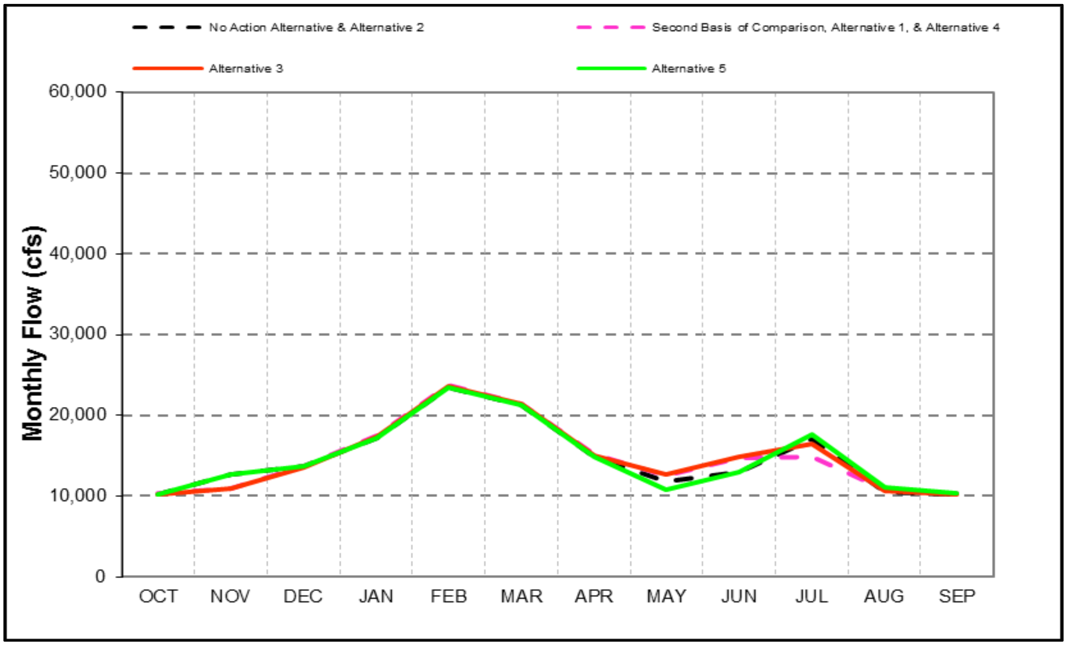

Figure 5.61 Sacramento River at Freeport, Dry Year Long-Term Average Flow[15,16]

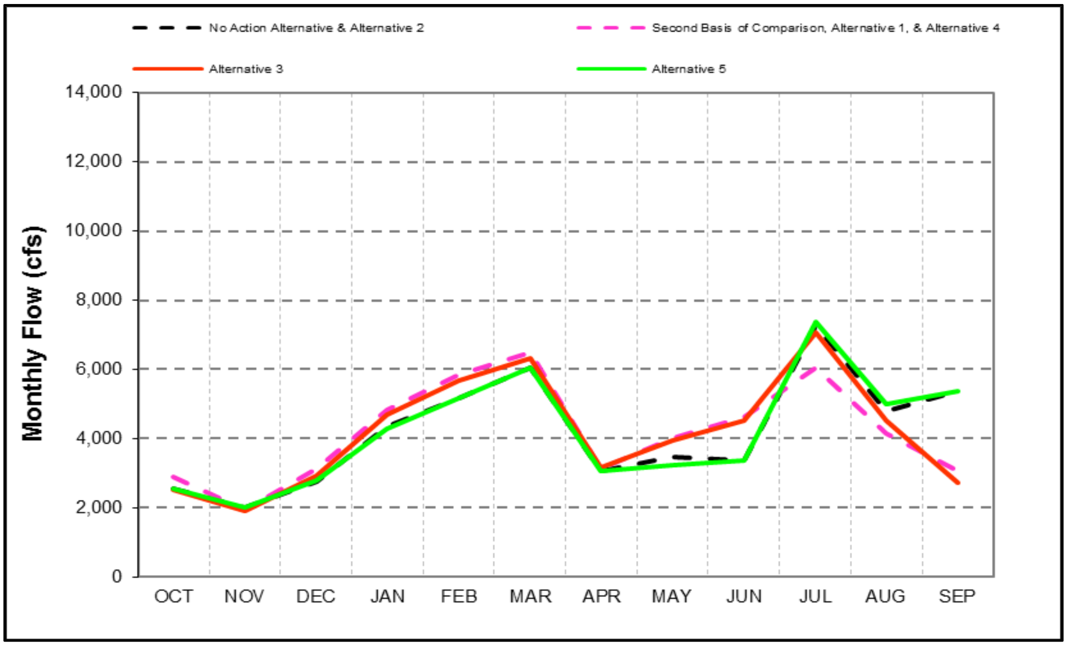

Figure 5.62 Feather River downstream of Thermalito, Long-Term Average Flow[15]

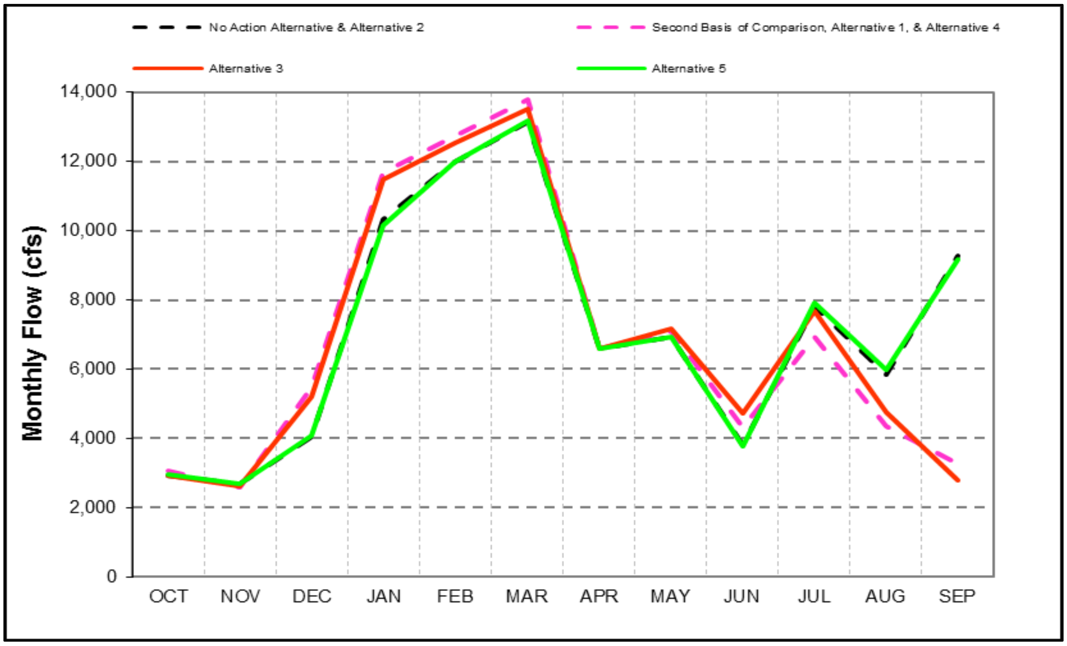

Figure 5.63 Feather River downstream of Thermalito, Wet Year Long-Term Average Flow[15,16]

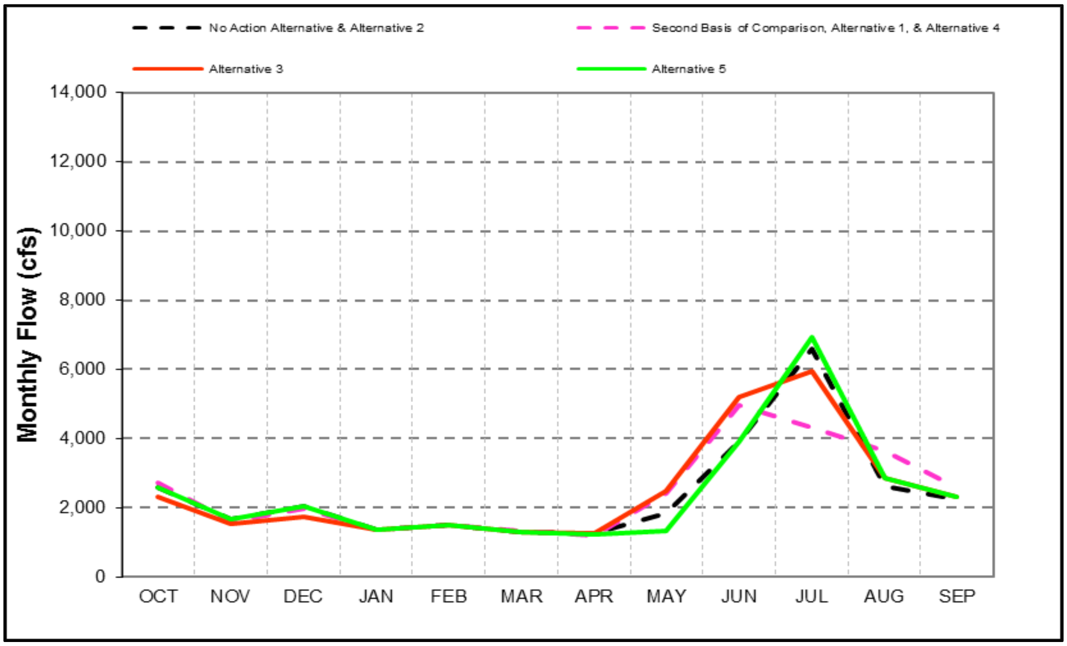

Figure 5.64 Feather River downstream of Thermalito, Dry Year Long-Term Average Flow[15,16]

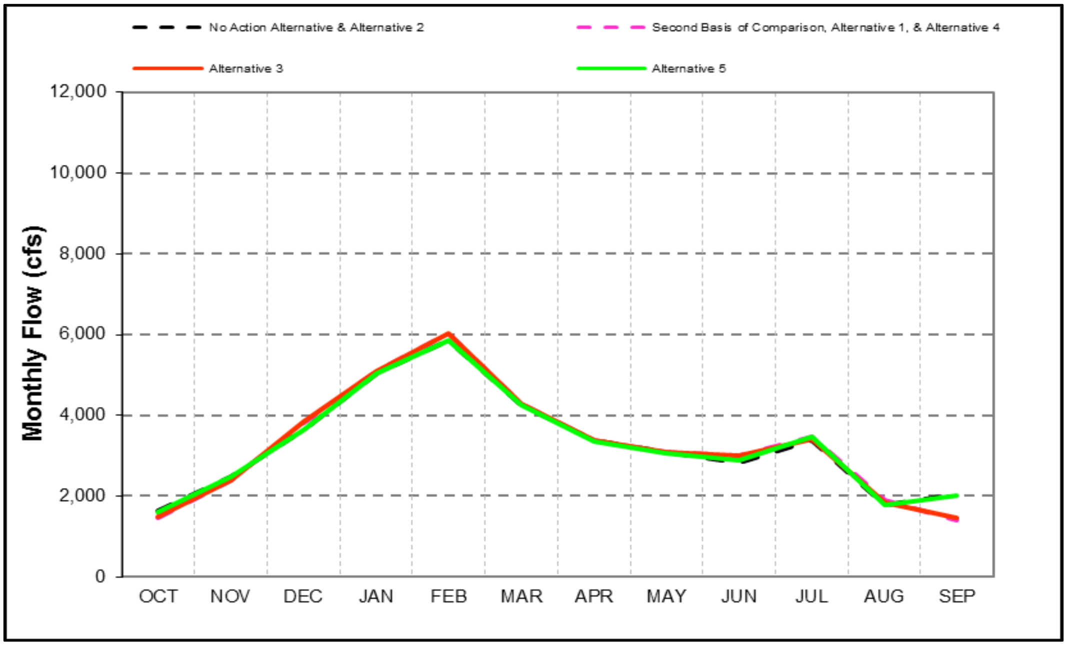

Figure 5.65 American River downstream of Nimbus Dam, Long-Term Average Flow[15]

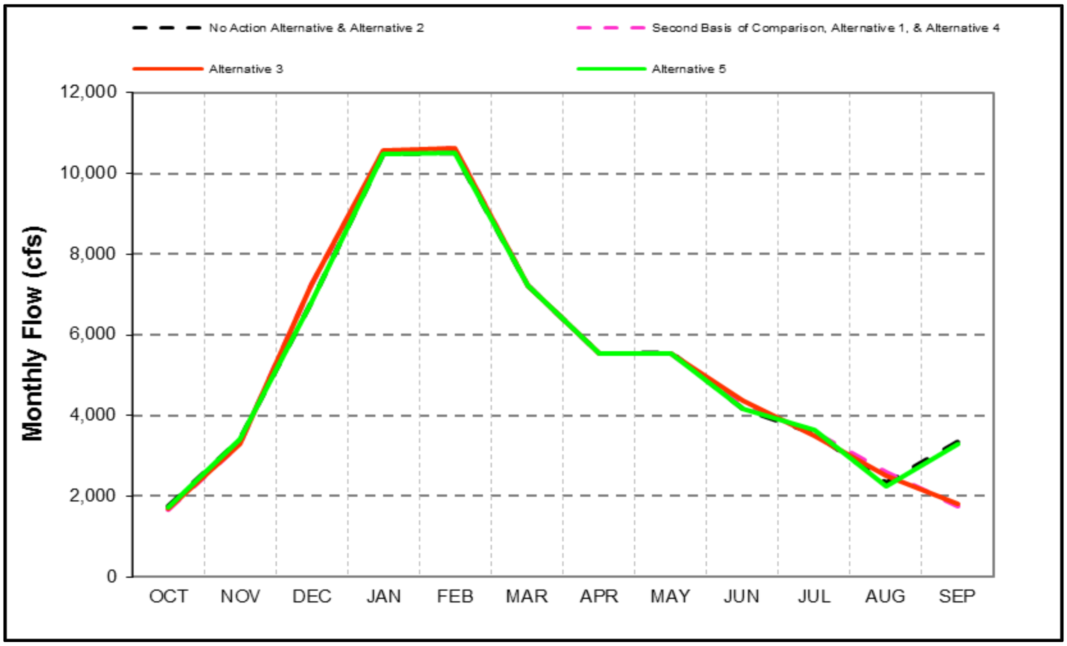

Figure 5.66 American River downstream of Nimbus Dam, Wet Year Long-Term Average Flow[15,16]

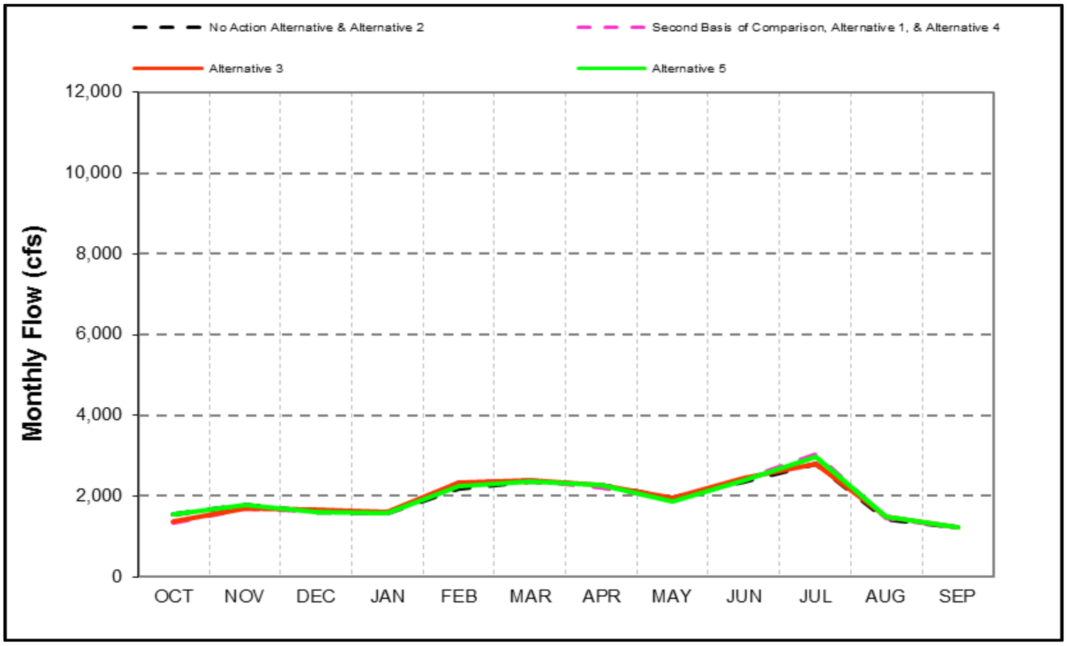

Figure 5.67 American River downstream of Nimbus Dam, Dry Year Long-Term Average Flow[15,16]

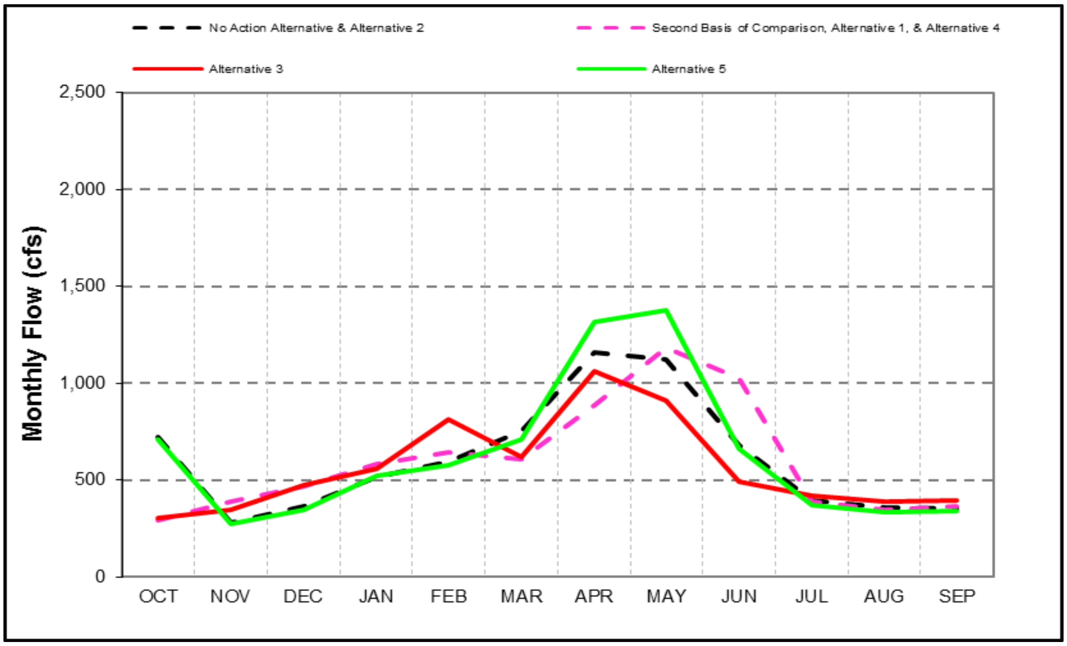

Figure 5.68 Stanislaus River below Goodwin, Long-Term Average Flow[15]

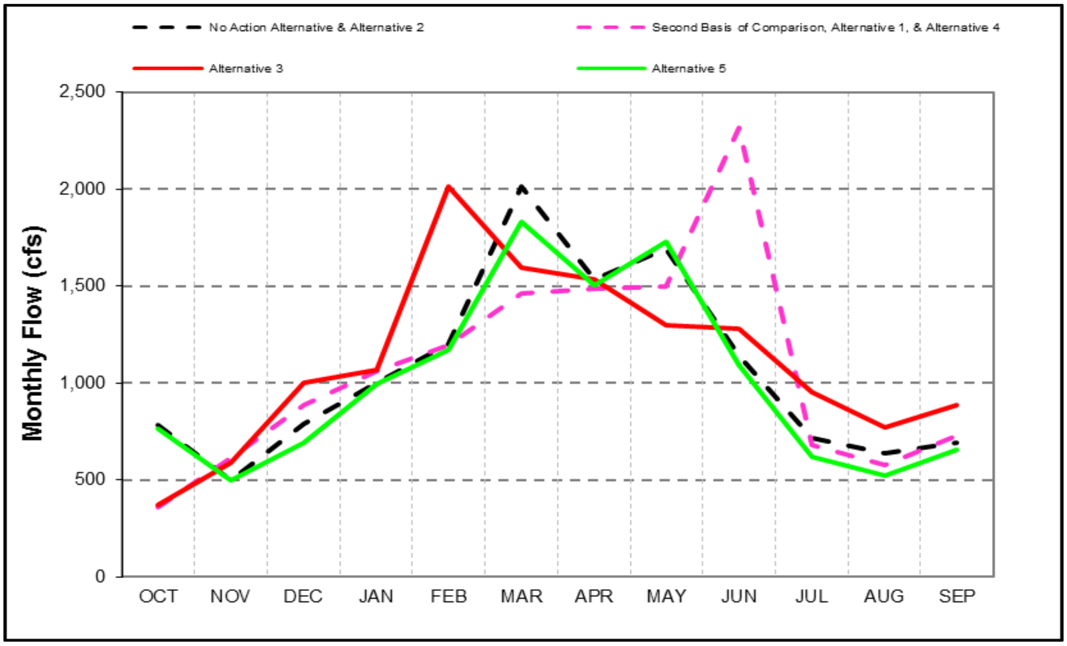

Figure 5.69 Stanislaus River below Goodwin, Wet Year Long-Term Average Flow[15,16]

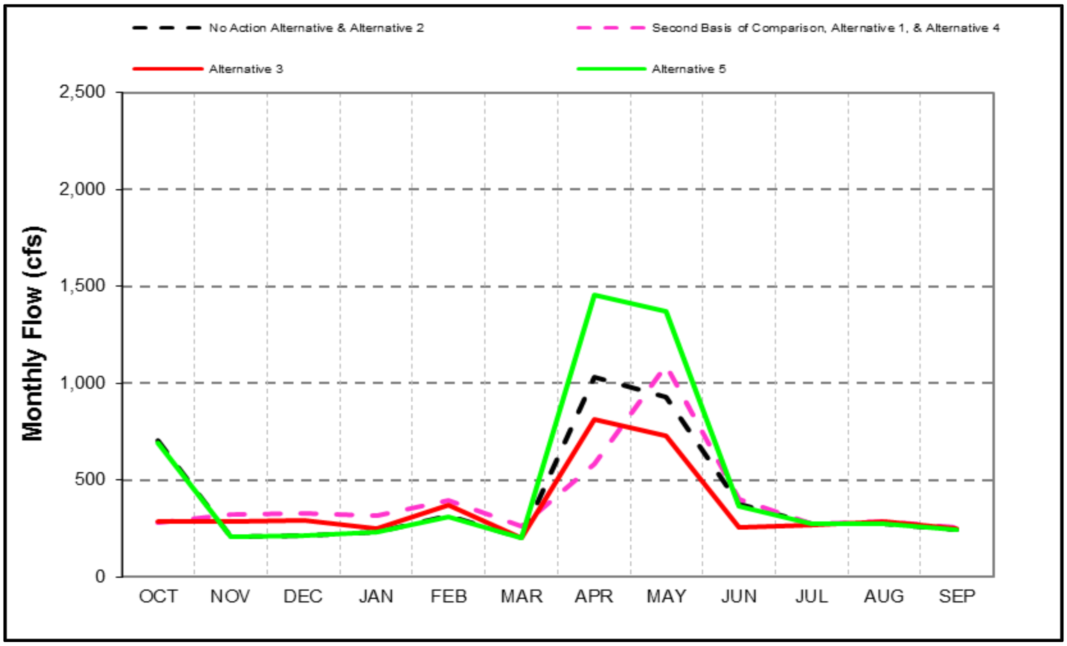

Figure 5.70 Stanislaus River below Goodwin, Dry Year Long-Term Average Flow[15,16]

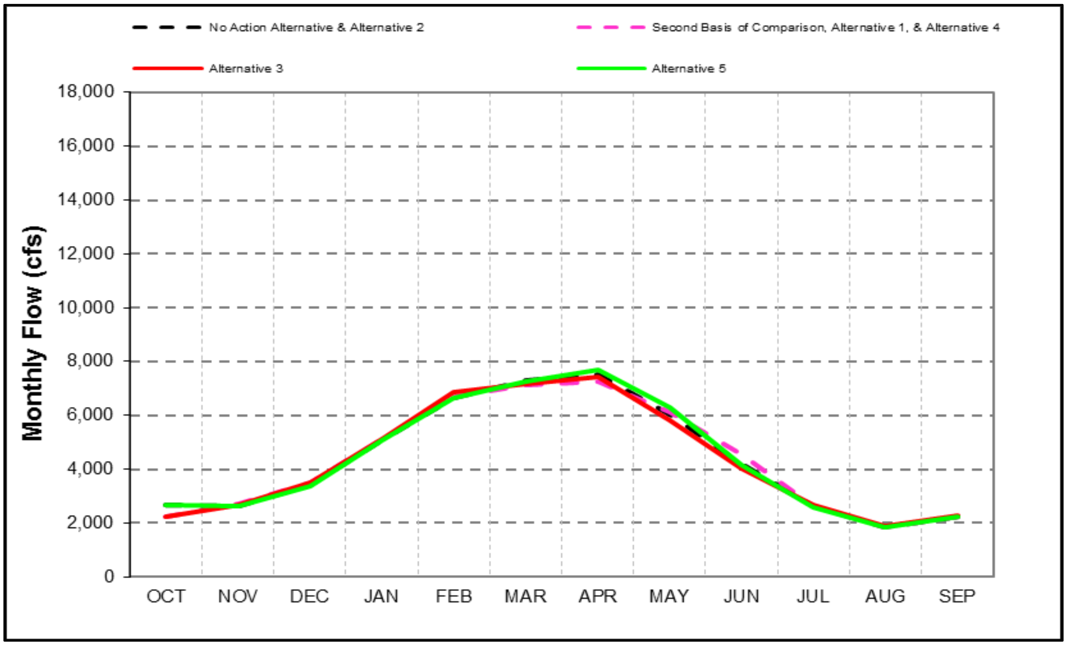

Figure 5.71 San Joaquin River at Vernalis, Long-Term Average Flow[15]

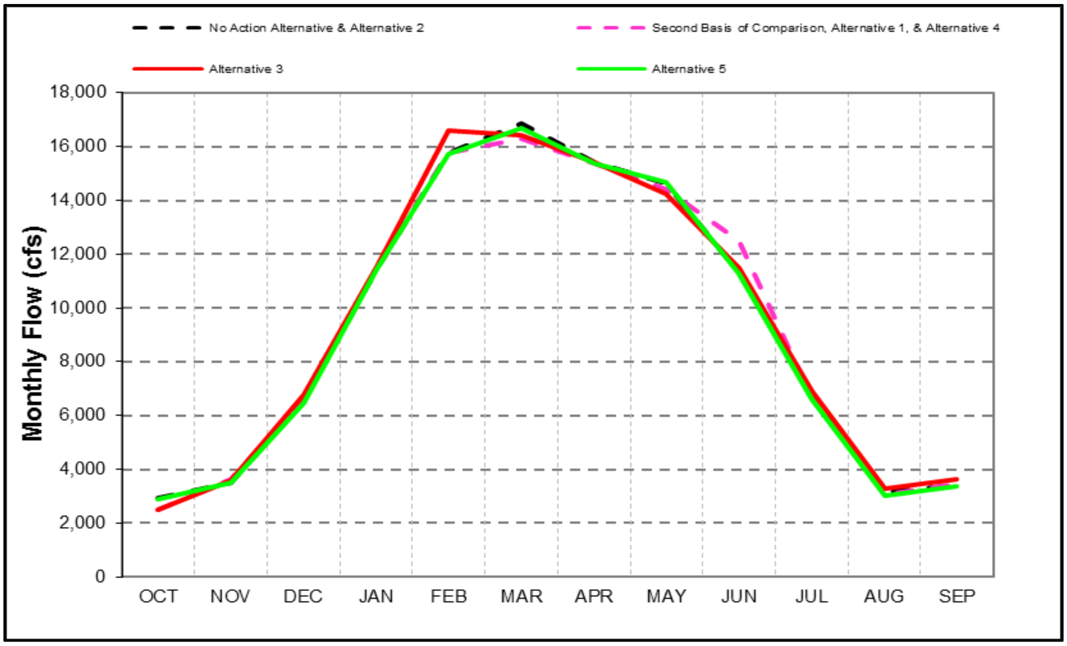

Figure 5.72 San Joaquin River at Vernalis, Wet Year Long-Term Average Flow[15,16]

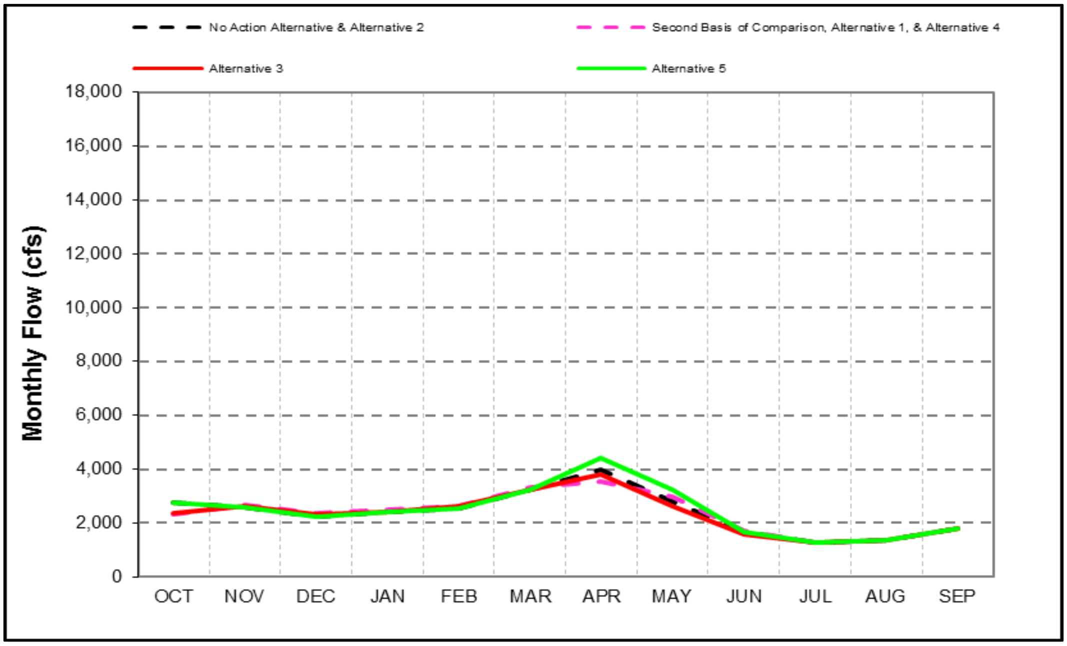

Figure 5.73 San Joaquin River at Vernalis, Dry Year Long-Term Average Flow[15,16]

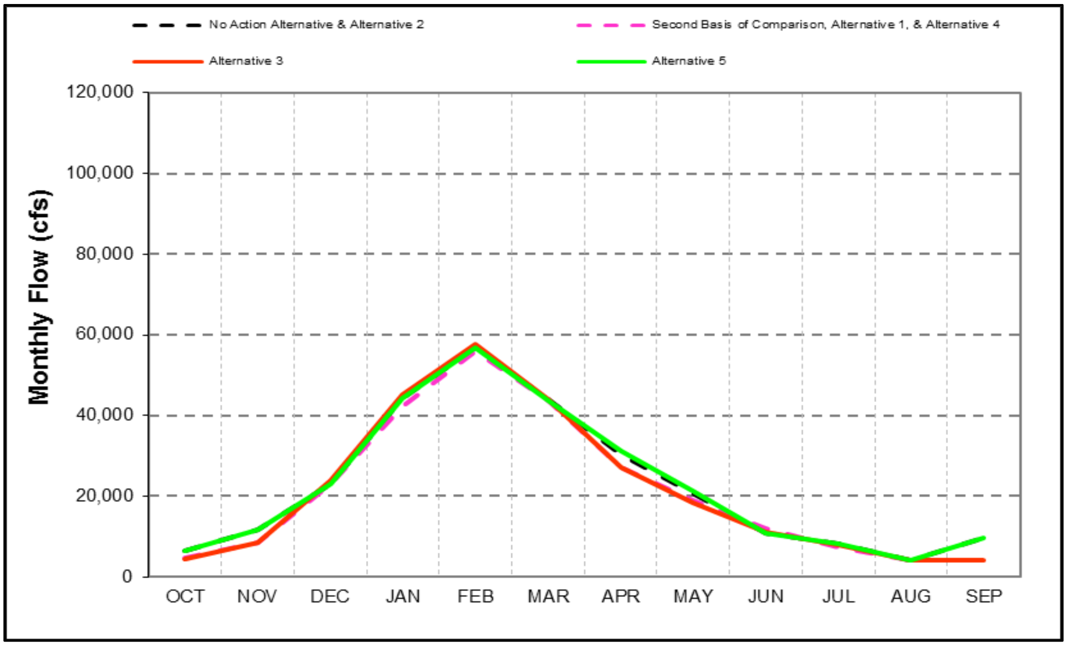

Figure 5.74 Sacramento/San Joaquin River Delta Outflow, Long-Term Average Flow[15]

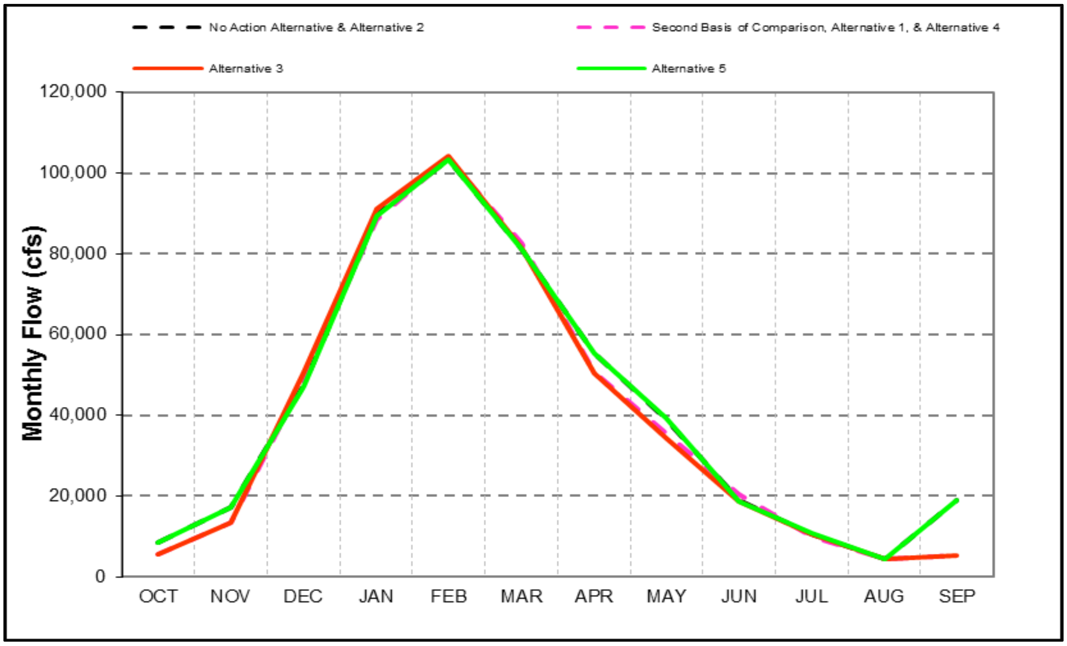

Figure 5.75 Sacramento/San Joaquin River Delta Outflow, Wet Year Long-Term Average Flow[15]

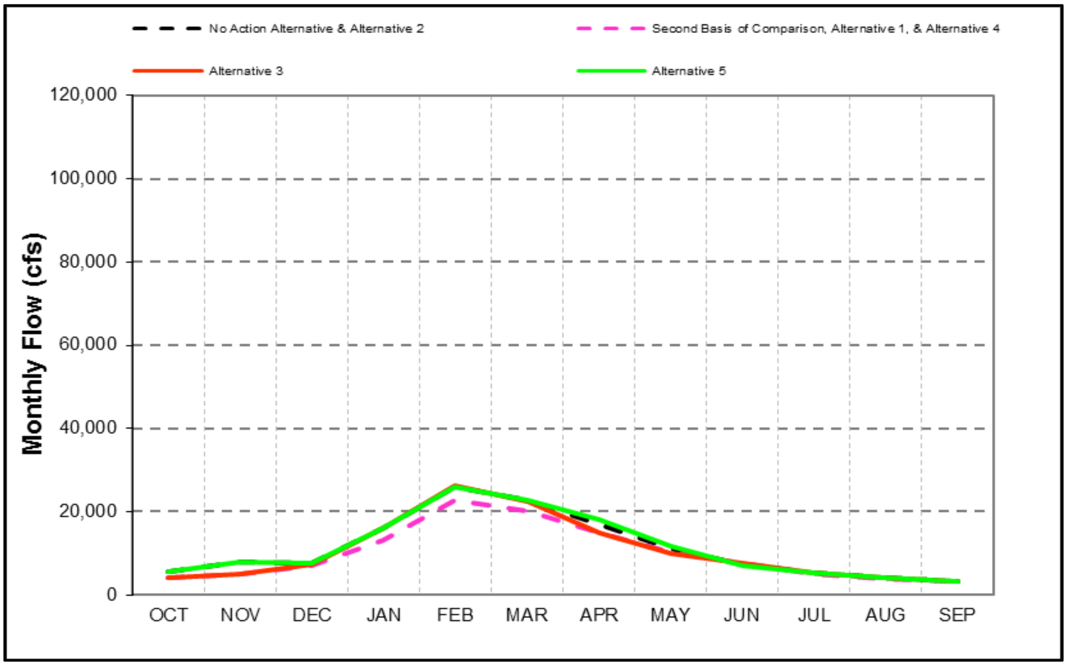

Figure 5.76 Sacramento/San Joaquin River Delta Outflow, Dry Year Long-Term Average Flow[15]

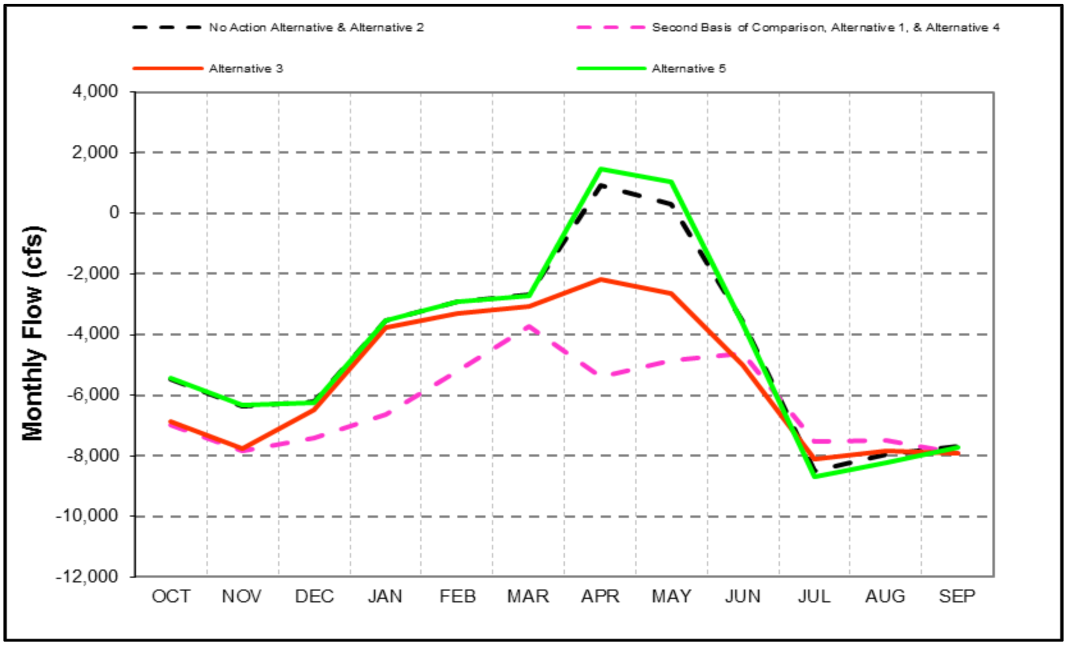

Figure 5.77 Old and Middle River, Long-Term Average Flow[15]

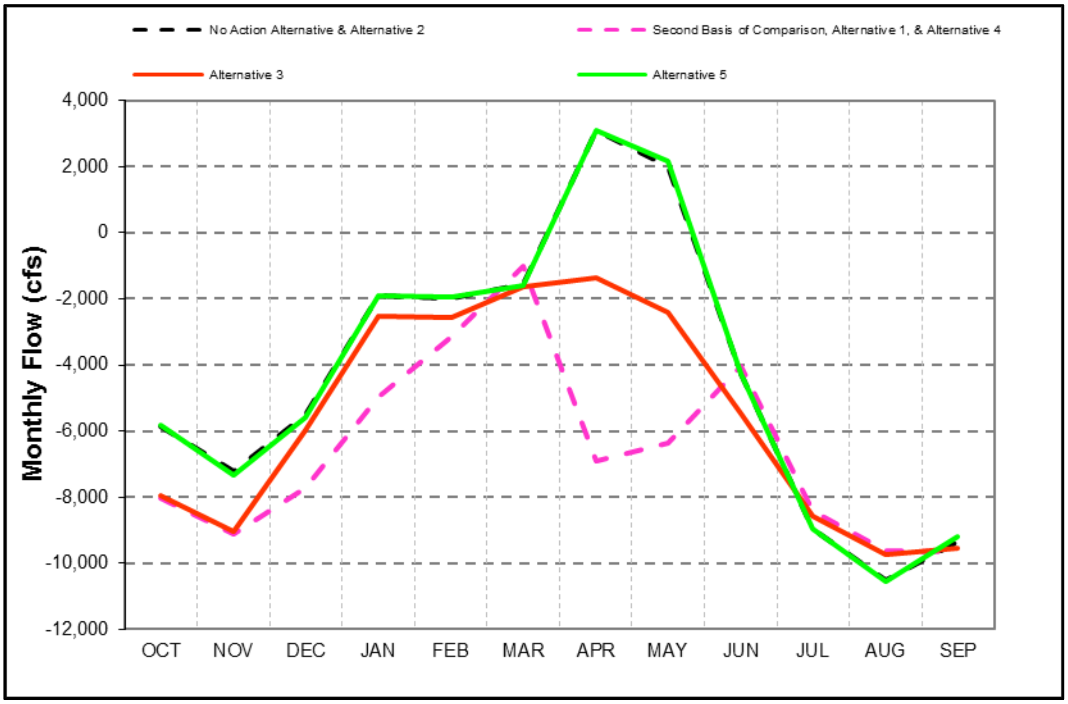

Figure 5.78 Old and Middle River, Wet Year Long-Term Average Flow[15, 16]

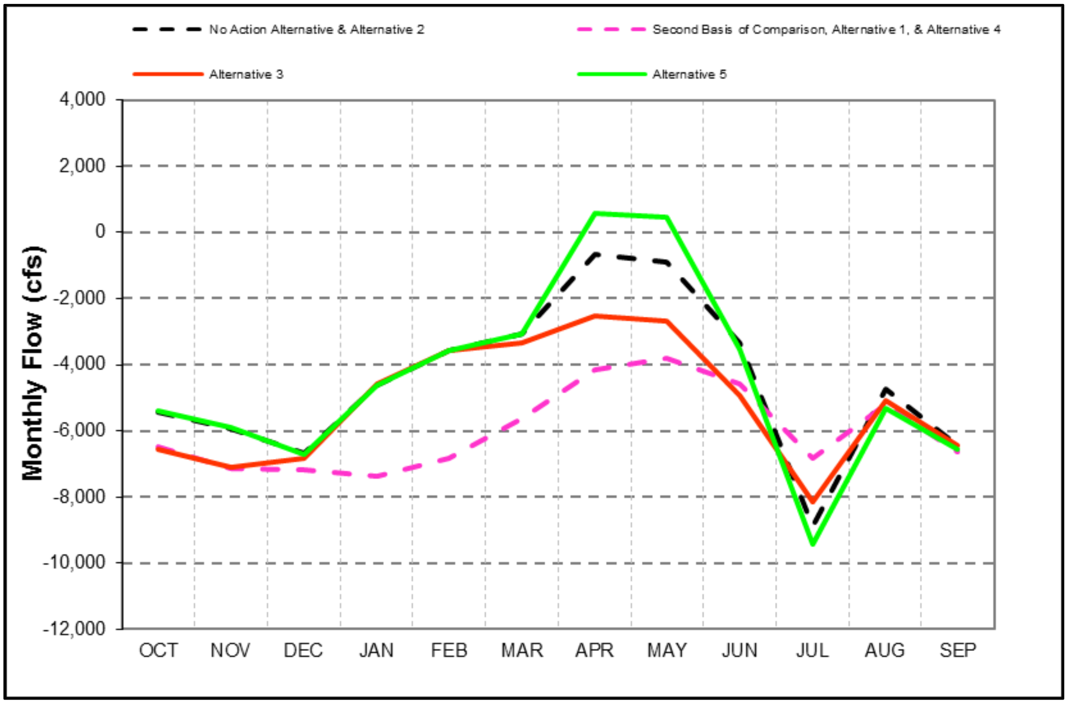

Figure 5.79 Old and Middle River, Dry Year Long-Term Average Flow[15, 16]

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Chapter 6

Surface Water Quality

6.1 Introduction

This chapter describes Surface Water Quality in the study area; and potential changes that could occur as a result of implementing the alternatives evaluated in this Environmental Impact Statement (EIS). Implementation of the alternatives could affect these resources through potential changes in operation of the Central Valley Project (CVP) and State Water Project (SWP) and ecosystem restoration.

6.2 Regulatory Environment and Compliance Requirements

Potential actions that could be implemented under the alternatives evaluated in this EIS could affect surface water resources impacted by changes in the operations of CVP or SWP reservoirs and in the vicinity of and lands served by CVP and SWP water supplies. Actions located on public agency lands; or implemented, funded, or approved by Federal and state agencies would need to be compliant with appropriate Federal and state agency policies and regulations, as summarized in Chapter 4, Approach to Environmental Analyses.

Several of the Federal and state laws and regulations that provide quantitative criteria to determine compliance also are summarized in this subsection of this chapter to provide context for information provided in the remaining sections of this chapter.

6.2.1 Federal Water Pollution Control Act Amendments of 1972 (Clean Water Act)

The Federal Water Pollution Control Act Amendments of 1972, also known as the Clean Water Act (CWA), established the institutional structure for the U.S. Environmental Protection Agency (USEPA) to regulate discharges of pollutants into the waters of the United States, establish water quality standards, conduct planning studies, and provide funding for specific grant projects. The CWA was further amended through the CWA of 1977 and the Water Quality Act of 1987. The California State Water Resources Control Board (SWRCB) has been designated by the USEPA to develop and enforce water quality objectives and implementation plans in California, as described below under State Policies and Regulations.

The California RWQCBs have adopted, and the SWRCB has approved, water quality control plans (basin plans) for each watershed basin in the State. The basin plans designate the beneficial uses of waters within each watershed basin, and water quality objectives designed to protect those uses pursuant to

Section 303 of the CWA. The beneficial uses together with the water quality objectives that are contained in the basin plans constitute State water quality standards.

Under the CWA section 303(d), the USEPA identifies and ranks water bodies for which existing pollution controls are insufficient to attain or maintain water quality standards based upon information prepared by all states, territories, and authorized Indian tribes (referred to collectively as "states" in the CWA). This list of impaired waters for each state comprises the state's 303(d) list. Each state must establish priority rankings and develop Total Maximum Daily Load (TMDL) values for all impaired waters. TMDLs calculate the greatest pollutant load that a water body can receive and still meet water quality standards and designated beneficial uses.

Section 305(b) of the CWA requires every state to submit a biennial water quality assessment of all state waters. These state-wide reports serve as the basis for USEPA's national Water Quality Inventory Report to Congress. Each water body is assessed regarding its ability to support the most common beneficial uses: aquatic life, drinking water supply, fish consumption, non-contact recreation, shell fishing, and swimming; also known as core beneficial uses (SWRCB 2010a).The USEPA requires states to integrate the 303(d) and 305(b) reports. For California, this report is called the California 303(d)/305(b) Integrated Report, and is prepared by the SWRCB using Integrated Reports submitted by each RWQCB (SWRCB 2010a). The 303(d) and 305(b) processes are further explained below under State Policies and Regulations.

The California Environmental Protection Agency, SWRCB, and RWQCBs have identified numerous water bodies within the project area that do not comply with applicable water quality standards and either adopted or are developing TMDLs, shown below in Table 6.1.

Table 6.1 Constituents of Concern per the 303(d) list within the Study Area

Region	Waterbody	Constituent of Concern	TMDL Status[1]
Trinity and Lower Klamath Rivers	Trinity Lake (was Claire Engle Lake)	Mercury	Expected: 2019
	Trinity River HU, Lower Trinity HA; Trinity River HU, Middle HA; Trinity River HU, South Fork HA; Trinity River, Upper HA; Trinity River HU, Upper HA, Trinity River, East Fork	Sedimentation/Siltation, Temperature[2], Mercury[3]	Approved: 2001
	Klamath River HU, Lower HA, Klamath Glen HAS	Nutrients, Organic, Enrichment/Low Dissolved Oxygen, Water Temperature	Approved: 2010
		Sedimentation/Siltation	Expected: 2025

Region	Waterbody	Constituent of Concern	TMDL Status[1]
Sacramento River Basin	Shasta Lake (where West Squaw Creek Enters); Keswick Reservoir (portion downstream from Spring Creek); Spring Creek, Lower (Iron Mountain Mine to Keswick Reservoir)	Acid Mine Drainage[4], Cadmium, Copper, Zinc	Expected: 2020
	Shasta Lake; Whiskeytown Lake (areas near Oak Bottom, Brandy Creek Campgrounds and Whiskeytown); Clear Creek (below Whiskeytown Lake, Shasta County)	Mercury	Expected: 2021
	Sacramento River (Keswick Dam to the Delta)[5]	Unknown Toxicity	Expected: 2019
		Chlordane[6], DDT, Mercury[7], PCBs, Dieldrin[8]	Expected: 2021
	Colusa Basin Drain	Diazinon	Expected: 2008
		Malathion	Expected: 2010
		Azinphos-methyl (Guthion), Group A Pesticides, Unknown Toxicity	Expected: 2019
		DDT, Dieldrin, E. coli, Low Dissolved Oxygen, Mercury, Carbofuran	Expected: 2021
	Oroville Lake; Feather River, Lower (Lake Oroville Dam to Confluence with Sacramento River), Yuba River, Lower[9]	Group A Pesticides	Expected: 2011
		Chlorpyrifos, Unknown Toxicity	Expected: 2019
		Mercury, PCBs	Expected: 2021
	Folsom Lake; Natoma, Lake; American River, Lower (Nimbus Dam to confluence with Sacramento River)[10]	Mercury	Expected: 2019
		Unknown Toxicity, PCBs	Expected: 2021
	Cache Creek, Lower (Clear Lake Dam to Cache Creek Settling Basin near Yolo Bypass)	Mercury	Approved: 2007
		Unknown Toxicity	Expected: 2019
		Boron	Expected: 2021
San Joaquin River and Tulare Basins	Mendota Pool; Panoche Creek (Silver Creek to Belmont Avenue)	Mercury[11]	Expected: 2021
		Selenium	Expected: 2019
		Sediment Toxicity[12]	Expected: 2021
		Sedimentation/Siltation[12]	Expected: 2007

Region	Waterbody	Constituent of Concern	TMDL Status[1]
	Agatha Canal (Merced County); Grasslands Marshes; Mud Slough, North (downstream of San Luis Drain); Salt Slough (upstream from confluence with San Joaquin River)[13]	Selenium[14]	Approved: 2002
		Chlorpyrifos	Approved: 2008
		Boron, Electrical Conductivity, Pesticides, Unknown Toxicity[15]	Expected: 2019
		Escherichia coli, Mercury, pH, Prometryn	Expected: 2021
	San Luis Reservoir	Mercury	Expected: 2021
	O'Neil Forebay		Expected: 2012
	Millerton Lake; San Joaquin River (Friant Dam to Stanislaus River)[16]	Selenium[17, 18]	Approved: 2002
		Chlorpyrifos, Diazinon[19]	Approved: 2007
		DDE20, DDT, Group A Pesticides	Expected: 2011
			Expected: 2012
		Boron[21], Invasive Species[23], Unknown Toxicity	Expected: 2019
		Arsenic[24], Electrical Conductivity[18, 22], Mercury[18], Water Temperature[26]	Expected: 2021
		alpha.-BHC[20], Escherichia coli[18, 25],	Expected: 2022
	San Joaquin River (Stanislaus River to Delta Boundary)	Chlorpyrifos, Electrical Conductivity	Approved: 2007
		DDE, DDT, Group A Pesticides	Expected: 2011
		Mercury	Expected: 2012
		Toxaphene, Unknown Toxicity	Expected: 2019
		Diuron, Escherichia coli, Water Temperature	Expected: 2021
	Merced River, Lower; Tuolumne River, Lower; New Melones Reservoir; Tulloch Reservoir; Stanislaus River, Lower[27]	Diazinon	Expected: 2010
		Group A Pesticides	Expected: 2011
		Chlorpyrifos, Mercury, Water Temperature	Expected: 2021
		Unknown Toxicity	Expected: 2022
		Invasive Species	Expected: 2019

Region	Waterbody	Constituent of Concern	TMDL Status[1]
	Cosumnes River, Lower (below Michigan Bar; partly in Delta Waterways, eastern portion)	Escherichia coli, Sediment Toxicity	Expected: 2021
	Mokelumne River, Lower (in Delta Waterways, eastern portion)	Copper, Zinc	Expected: 2020
		Chlorpyrifos, Mercury, Dissolved Oxygen, Unknown Toxicity	Expected: 2021
	Calaveras River, Lower (from Stockton Diverting Canal to the San Joaquin River; partly in Delta waterways, eastern portion)	Chlorpyrifos, Diazinon	Approved: 2007
		Pathogens	Approved: 2008
		Organic Enrichment/Low Dissolved Oxygen	Expected: 2012
		Mercury	Expected: 2021
	Kings River, Lower (Island Weir to Stinson and Empire Weirs); Kings River, Lower (Pine Flat Reservoir to Island Weir); Kaweah River (below Terminus Dam, Tulare County); Kaweah River, Lower (includes St Johns River)[28]	Electrical Conductivity, Molybdenum, Toxaphene	Expected: 2015
		Chlorpyrifos[29], pH[30], Unknown Toxicity	Expected: 2021
Sacramento-San Joaquin River Delta	Sacramento San Joaquin Delta	Mercury	Approved: 2008
		PCBs	Expected: 2008
		Selenium	Expected: 2010
		Chlordane, DDT, Dieldrin	Expected: 2013
		Dioxin compounds, Furan Compounds, Invasive Species	Expected: 2019
	Delta waterways (central, eastern, northern, northwestern, western portion, southern portions, export area, and Stockton Ship Channel)	Chlorpyrifos[31], Diazinon, Organic Enrichment/Low Dissolved Oxygen[32]	Approved: 2007
		Pathogens[32]	Expected: 2008
		Mercury	Expected: 2009
		Chlordane[33], DDT, Dieldrin[33], Group A Pesticides	Expected: 2011
		Dioxin[32], Electrical Conductivity[34], Furan Compounds[32], Invasive Species, PCBs[35], Unknown Toxicity	Expected: 2019

Region	Waterbody	Constituent of Concern	TMDL Status[1]
Suisun Bay and Suisun Marsh	Suisun Bay	Mercury	Approved: 2008
		PCBs	Expected: 2008
		Selenium	Expected: 2010
		Chlordane, DDT, Dieldrin	Expected: 2013
		Dioxin compounds, Furan Compounds, Invasive Species	Expected: 2019
	Suisun Marsh Wetlands	Mercury, Nutrients, Organic Enrichment/Low Dissolved Oxygen, Salinity/TDS/Chlorides	Expected: 2013
San Francisco Bay Region	Carquinez Strait and San Pablo Bay	Mercury	Approved: 2008
		PCBs	Expected: 2008
		Selenium	Expected: 2010
		Chlordane, DDT, Dieldrin	Expected: 2013
		Dioxin compounds, Furan Compounds, Invasive Species	Expected: 2019

Source: SWRCB 2011A

Notes:

1 TMDL status is either expected to be completed or approved by USEPA in the year specified

2 Water temperature is only a constituent of concern for the South Fork Trinity River and a TMDL is expected to be completed in 2019.

3 Mercury is only a constituent of concern for the East Fork Trinity River in the upper hydrologic area and a TMDL is expected to be completed in 2019.

4 Acid Mine Drainage is a constituent of concern at Spring Creek only

5 Chlordane, DDT, PCBs, Dieldrin not constituents of concern for Sacramento River (Keswick Dam to Red Bluff)

6 Chlordane not a constituent of concern for Sacramento River (Red Bluff to Knights Landing)

7 Mercury not a constituent of concern for Sacramento River (Keswick Dam to Cottonwood Creek). Mercury TMDL is expected to be complete in 2012 for Sacramento River (Knights Landing to the Delta)

8 Dieldrin TMDL for Sacramento from Knights Landing to the Delta is expected to be completed in 2022.

9 Mercury is the only constituent of concern for Yuba River and a TMDL is expected to be complete in 2021. Mercury TMDL expected to be complete in 2021 for Feather River, Lower (Lake Oroville Dam to Confluence with Sacramento River). Mercury and PCBs are the only constituents of concern for Lake Oroville and TMDLs are expected to be complete in 2021 for both constituents.

10 Mercury is the only constituent of concern for Folsom Lake and Lake Natoma. Mercury TMDL is expected to be completed in 2010 for American River, Lower (Nimbus Dam to confluence with Sacramento River)

11 Mercury TMDL for Panoche Creek (Silver Creek to Belmont Avenue) expected to be complete in 2020.

12 Not a constituent of concern for Mendota Pool

13 pH and selenium are the only constituents of concern for Agatha Canal (Merced County). Electrical conductivity and Selenium are the only constituents of concern for Grasslands Marshes. Boron, Electrical Conductivity, Pesticides, Selenium, and Unknown Toxicity are the only constituents of concern for Mud Slough, North (downstream of San Luis Drain). pH, selenium, and pesticides are not constituents of concern for Salt Slough (upstream from confluence with San Joaquin River)

14 The CVRWQCB completed a TMDL for selenium in the lower San Joaquin River (downstream of the Merced River) in 2001 and Salt Slough in 1997/1999, and USEPA approved this in 2002.

15 The unknown toxicity TMDL for Mud Slough (downstream of San Luis Drain) is expected to be written and complete in 2021.

16 Mercury is the only constituent of concern for Millerton Lake and a TMDL is expected to be complete in 2019.

17 Selenium is only a constituent of concern in San Joaquin River (Mud Slough to Merced River)

18 Electrical conductivity, Escherichia coli, mercury and selenium are not constituents of concern for San Joaquin River (Mendota Pool to Bear Creek). The Electrical Conductivity TMDL for San Joaquin River (Bear Creek to Merced River) is expected to be written and complete in 2019. The Mercury TMDL for San Joaquin River (Bear Creek to Stanislaus River) is expected to be written and complete in 2012.

19 Diazinon not a constituent of concern for San Joaquin River (Bear Creek to Mud Slough and Merced River to Tuolumne River)

20 DDE and alpha.-BHC is only a constituent of concern in San Joaquin River (Merced River to Tuolumne River)

21 The Boron TMDL for San Joaquin River (Merced to Tuolumne River) was approved by the USEPA in 2007. Boron is not a constituent of concern for the San Joaquin River (Tuolumne River to Stanislaus River).

22 The Electrical Conductivity TMDL for San Joaquin River (Tuolumne River to Stanislaus River) is expected to be written and complete in 2021.

23 Invasive species only a constituent of concern for the San Joaquin River (Friant Dam to Mendota Pool).

24 Arsenic not a constituent of concern in San Joaquin River except Bear Creek to Mud Slough.

25 Escherichia coli is not a constituent of concern for San Joaquin River (Mendota Pool to Bear Creek and Merced River to Stanislaus River). The Escherichia coli TMDL for San Joaquin River (Bear Creek to Mud Slough) is expected to be written and complete in 2021.

26 Water temperature is only a constituent of concern for San Joaquin River (Merced River to Stanislaus River)

27 Mercury is the only constituent of concern for New Melones Reservoir and Tulloch Reservoir. The diazinon TMDL for lower Merced River and lower Stanislaus River is expected to be complete in 2008. The Chlorpyrifos TMDL for the lower Merced River is expected to be complete in 2008. The Mercury TMDL for lower Merced River is expected to be complete in 2019 and lower Stanislaus River TMDL is expected to be complete in 2020. The Unknown Toxicity TMDL for lower Stanislaus River is expected to be complete in 2019 and lower Merced River is expected in 2021.

28 The only constituents of concern for Kings River, Lower (Island Weir to Stinson and Empire Weirs) are electrical conductivity, toxaphene, molybdenum.

29 Chlorpyrifos is only a constituent of concern for Kings River, Lower (Pine Flat Reservoir to Island Weir).

30 pH is only a constituent of concern for Kaweah River (below Terminus Dam, Tulare County).

31 Chlorpyrifos TMDL for Delta waterways (central portion) expected to be complete in 2019. Chlorpyrifos TMDL for Delta waterways (western portion) expected to be complete in 2006.

32 Not a constituent of concern for Delta waterways except for Stockton Ship Channel.

33 Not a constituent of concern for Delta waterways except for northern portion.

34 Not a constituent of concern for Delta waterways (central, northern, eastern portions, and Stockton Ship Channel)

35 Not a constituent of concern for Delta waterways except for the northern portion and the Stockton Ship Channel.

National Toxics Rule (NTR) was established by USEPA in accordance with CWA section 303 to provide ambient water quality criteria for priority toxic pollutants to protect aquatic life and human health.

The Secretary of the Interior established the first antidegradation policy in 1968. In 1975, USEPA included the antidegradation requirements in the Water Quality Standards Regulation (40 Code of Federal Regulations [CFR] 130.17, 40 CFR 55340-41). The requirements were included in the 1987 CWA amendment in section 303(d)(4(B)). The Federal antidegradation policy requires states to develop regulations to allow increases in pollutant loadings or changes in surface water quality only if: 1) existing surface water uses are maintained and protected, and established water quality requirements are met; 2) if water quality requirements cannot be maintained by a project, water quality must be maintained to fully protect “fishable/swimmable” uses and other existing uses; and 3) for Outstanding National Resource Waters water quality criteria where “States may allow some limited activities which result in temporary and short-term changes in water quality” (Water Quality Standards Regulations) but would not impact existing uses or special use of these waters.

6.2.2 Major California Water Quality Regulations

The Porter Cologne Water Quality Control Act (Porter-Cologne Act) established the SWRCB and divided the state into nine regions, each overseen by a RWQCB. The nine RWQCBs have the primary responsibility for the coordination and control of water quality within their respective jurisdictional boundaries. The SWRCB and the RWQCBs have been delegated Federal authority to implement the requirements of the Federal CWA in California. The RWQCBs that have jurisdiction over the water bodies in the project area are the NCRWQCB, CVRWQCB, SFB RWQCB, Central Coast RWQCB, Los Angeles RWQCB, Santa Ana RWQCB, San Diego RWQCB, Lahontan RWQCB, and Colorado River RWQCB. The Porter-Cologne Act requires the RWQCBs to prepare and periodically update basin plans. Basin plans establish beneficial uses of water, water quality objectives, and implementation programs for achieving the objectives.

The State of California has adopted several water quality policies that are similar to federal water quality policies, including the California Toxics Rule (CTR) and the Policy for Implementing Toxic Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (State Implementation Policy).

The CTR is applicable to all State waters, as are the USEPA advisory National Recommended Water Quality Criteria. Fresh water criteria apply to waters of salinity less than 1 parts per thousand 95 percent or more of the time, seawater criteria are for water greater than 10 parts per thousand 95 percent or more of the time, and estuarine waters use the more stringent of the two possible criteria, in absence of estuary-specific criteria.

The State Implementation Policy for water quality control, adopted in 2000, applies to discharges of toxic pollutants into the inland surface waters, enclosed bays, and estuaries of California subject to regulation under the Porter-Cologne Act and the Federal CWA. This policy establishes:

- Implementation provisions for priority pollutant criteria promulgated by the USEPA through the NTR and the CTR, and for priority pollutant objectives established by RWQCBs in their basin plans;
- Monitoring requirements for 2,3,7,8-tetrachlorodibenzodioxin (TCDD) equivalents; and
- Chronic toxicity control provisions.

6.2.2.1 Basin Plans

The RWQCBs are required to formulate and adopt basin plans for all areas under their jurisdiction under the Porter-Cologne Act. Each basin plan must contain water quality objectives to ensure the reasonable protection of beneficial uses, as well as a program of implementation for achieving water quality objectives with the basin plans.

Section 13050(f) of the Porter-Cologne Act lists the beneficial uses of the waters of the state that may be protected against water quality degradation, which include but are not limited to: domestic, municipal, agricultural, and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, and wildlife and other aquatic resources or preserves. Basin plans must designate and protect beneficial uses in the region. A uniform list of beneficial uses is defined by the SWRCB, however each RWQCB may identify additional beneficial uses specific to local water bodies.

Basin plans must adopt water quality standards to protect public health or welfare, enhance the quality of water, and serve the purposes of the CWA. These water quality standards include: designated beneficial uses; water quality objectives to protect the beneficial uses; implementation of the Federal and State policies for antidegradation; and general policies for application and implementation.

The basin plans are subject to modification, considering applicable laws, policies, technologies, water quality conditions and priorities. Basin plans must be assessed every three years for the appropriateness of existing standards and evaluation and prioritization of basin planning issues. In California however, water bodies are assessed every two years for CWA 303(d) and 305(b) requirements. Revisions are accomplished through Basin Plan amendments. Once a Basin Plan amendment is adopted in noticed public hearings, it must be approved by the SWRCB, Office of Administrative Law and in some cases, the USEPA.

6.2.2.1.1 California 303(d)/305(b) Integrated Reports

The California 303(d)/305(b) Integrated Report is updated biennially for inclusion in the USEPA's national Water Quality Inventory Report to Congress. The report is composed of the current California 303(d) list, and all current listing decisions for contaminants in impaired water bodies. The statewide report is the compilation of 303(d)/305(b) Integrated Reports submitted by each RWQCB. The final California 303(d) list must be submitted to and approved by the USEPA before it becomes effective.

The most recent statewide report is the 2010 California 305(b)/303(d) Integrated Report, accompanied by the 2010 Staff Report, which outlines the process by which water bodies were assessed for impairment and by which listing decisions were made. Each successive 303(d) list updates the previous approved 303(d) list, in this case the 2006 Section 303(d) list. The updates are made by each RWQCB in accordance with the Water Quality Control Policy for Developing California's CWA Section 303(d) list ("Listing Policy").

For the 2010 Integrated Report, the data assessed included the 2006 California CWA Section 303(d) list and its supporting data and information, applicable Surface Water Ambient Monitoring Program (SWAMP) data from 2000 to 2007, data from several local monitoring programs, and data provided during public solicitation. Data incorporated into the assessment were existing and readily available to RWQCB staff.

Data were assessed to identify the beneficial uses for each water body, and whether water quality criteria were being met. The core beneficial uses most commonly evaluated were aquatic life, drinking water supply, fish consumption, non-contact recreation, shell fishing, and swimming. The water quality criteria considered included water quality objectives set forth by RWQCB Basin Plans, criteria included in Statewide Basin Plans, the CTR, and maximum contaminant level MCLs. Narrative "Evaluation Guidelines" were designated for pollutants without numeric Basin Plan Objectives, MCLs or CTR criteria, as described in the Listing Policy.

The data and assessment results were summarized in LOEs for water body segment-contaminant combinations. The LOEs include specific information used to determine whether water quality standards are being met for the water body segment, including: affected beneficial uses; relevant pollutant; relevant water quality criteria; and detailed information regarding data samples and quality assurance information. Fact sheets were prepared that summarize the LOEs and the reasoning for inclusion or exclusion of the water body-pollutant combination from the 303(d) list. The fact sheets are stored in the Water Boards' California Water Quality Assessment (CalWQA) database.

Water body segment-contaminant combinations were categorized into one of three Beneficial Use Support Ratings: fully supporting (supporting), not supporting, and insufficient information. These Beneficial Use Support Ratings were used as the basis for categorizing the water bodies into Integrated Report categories.

For water bodies that are in need of a TMDL, the Listing Policy provides instruction for scheduling TMDL development, based on, among other factors, the significance of the water segment, the degree that water quality objectives are not met or that beneficial uses are threatened, and the potential threat to human health and the environment.

The 2010 California 305(b)/303(d) Integrated Report results in a significant increase in proposed 303(d) listings in comparison to previous years. This is likely the result of a large volume of water quality data available for the 2010 assessment, which was not available for the 2006 assessment. There are also more protective water quality standards for some water bodies, requiring their addition to the 303(d) list.

6.2.2.2 Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS)

In 2006, the CVRWQCB, the SWRCB, and stakeholders began a joint effort to address salinity and nitrate problems in California's Central Valley and adopt long-term solutions that will lead to enhanced water quality and economic sustainability. This effort is referred to as the CV-SALTS Initiative. The goal of CV-SALTS is to develop a comprehensive region-wide Salt and Nitrate Management Plan (SNMP) describing a water quality protection strategy that will be implemented through a mix of voluntary and regulatory efforts. The SNMP may include recommendations for numeric water quality objectives, beneficial use designation refinements, and/or other refinements, enhancements, or basin plan revisions. The SNMP will serve as the basis for amendments to the three water quality control plans that cover the Central Valley Region (Sacramento River and San Joaquin River Basin Plan, the Tulare Lake Basin Plan and the Sacramento/San Joaquin Rivers Bay-Delta Plan) and the San Francisco Bay Area Region Basin Plan. The Basin Plan Amendments (BPAs) will likely establish a comprehensive implementation plan to achieve water quality objectives for salinity (including nitrate) in the Region's surface waters and groundwater; and the SNMP may include recommendations for numeric water quality objectives, beneficial use designation refinements, and/or other refinements, enhancements, or Basin Plan revisions.

6.3 Affected Environment

This section describes surface water quality that could be potentially affected by the implementation of the alternatives considered in this EIS. Changes in water quality due to changes in CVP and SWP operations may occur in the Trinity River, Central Valley, San Francisco Bay Area, and Central Coast and Southern California regions. Changes to surface water bodies and water supplies are described in Chapter 5, Surface Water Resources and Water Supplies.

This chapter focuses on constituents of concerns that could be affected by changes in CVP and SWP water operations. The constituents of concern have been identified in the Final California 2010 Integrated Report (303(d) List/305(b) Report) as well as other water quality reports. This section provides descriptions of sources of constituents, water quality effects, water quality objectives and/or guidelines, and plans to improve water quality.

6.3.1 Beneficial Uses of Surface Waters in the Study Area

Water quality conditions throughout the study area are assessed and described by the RWQCB Basin Plans and Integrated Reports. Each region has specific beneficial uses, as summarized in Table 6.2 and water quality constituents of concern; however, several pollutants are prevalent throughout the study area. The origins and prevalence of these pollutants are discussed below.

Table 6.2 Designated Beneficial Uses within Project Study Area

Surface Water Body	Municipal and Domestic Supply (MUN)	Agricultural Supply (AGR)	Industrial Service Supply (IND)	Industrial Process Supply (PRO)	Groundwater Recharge (GWR)	Fresh water Replenishment (FRSH)	Navigation (NAV)	Hydropower Generation (POW)	Water Contact Recreation (REC-1)	Non-Contact Water Recreation (REC-2)	Commercial and Sport Fishing (COMM)	Warm Fresh water Habitat (WARM)	Cold Fresh water Habitat (COLD)	Wildlife Habitat (WILD)	Rare, Threatened, or Endangered Species (RARE)	Marine Habitat (MAR)	Migration of Aquatic Organisms (MIGR)	Spawning, Reproduction, and/or Early Development (SPWN)	Shellfish Harvesting (SHELL)	Estuarine Habitat (EST)	Aquaculture (AQUA)	Native American Culture (CUL)	Flood Peak Attenuation/ Flood Water Storage (FLD)	Wetland Habitat (WET)	Water Quality Enhancement (WQE)
Trinity and Lower Klamath Rivers																									
Lower Klamath River and Klamath Glen Hydrologic Subarea	E	E	P	P	E	E	E	P	E	E	E	E	E	E	E	E	E	E	E	E	P	E	–	–	–
Trinity Lake	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	–	P	E	–	–	P	–	–	–	–
Lewiston Reservoir	E	E	P	P	E	E	E	E	E	E	E	P	E	E	E	–	P	E	–	–	E	–	–	–	–
Middle Trinity River and Surrounding Hydrologic Area	E	E	E	P	E	E	E	P	E	E	E	–	E	E	E	–	E	E	–	–	E&P	–	–	–	–
Lower Trinity River and Surrounding Hydrologic Area[1]	E&P	E&P	E	E&P	E	E	E	E&P	E	E	E	–	E	E	E	–	E	E	P	–	E&P	E[2]	–	–	–
Sacramento River Basin																									

Surface Water Body	**Municipal and Domestic Supply (MUN)**	**Agricultural Supply (AGR)**	**Industrial Service Supply (IND)**	**Industrial Process Supply (PRO)**	**Groundwater Recharge (GWR)**	**Fresh water Replenishment (FRSH)**	**Navigation (NAV)**	**Hydropower Generation (POW)**	**Water Contact Recreation (REC-1)**	**Non-Contact Water Recreation (REC-2)**	**Commercial and Sport Fishing (COMM)**	**Warm Fresh water Habitat (WARM)**	**Cold Fresh water Habitat (COLD)**	**Wildlife Habitat (WILD)**	**Rare, Threatened, or Endangered Species (RARE)**	**Marine Habitat (MAR)**	**Migration of Aquatic Organisms (MIGR)**	**Spawning, Reproduction, and/or Early Development (SPWN)**	**Shellfish Harvesting (SHELL)**	**Estuarine Habitat (EST)**	**Aquaculture (AQUA)**	**Native American Culture (CUL)**	**Flood Peak Attenuation/ Flood Water Storage (FLD)**	**Wetland Habitat (WET)**	**Water Quality Enhancement (WQE)**
Shasta Lake	E	E	–	–	–	–	–	E	E	E	–	E^{4}	E^{4}	E	–	–	–	$E^{5,6}$	–	–	–	–	–	–	–
Sacramento River: Shasta Dam to Colusa Basin Drain	E	E	E	–	–	–	E	E	E^{3}	E	–	E^{4}	E^{4}	E	–	–	$E^{5,6}$	$E^{5,6}$	–	–	–	–	–	–	–
Colusa Basin Drain	–	E	–	–	–	–	–	–	E^{3}	–	–	E^{4}	P^{4}	E	–	–	E^{6}	E^{6}	–	–	–	–	–	–	–
Sacramento River: Colusa Basin Drain to Eye (“I”) Street Bridge	E	E	–	–	–	–	E	–	E^{3}	E	–	E^{4}	E^{4}	E	–	–	$E^{5,6}$	$E^{5,6}$	–	–	–	–	–	–	–
Whiskeytown Lake	E	E	–	–	–	–	–	E	E	E	–	E^{4}	E^{4}	E	–	–	–	E^{6}	–	–	–	–	–	–	–
Clear Creek below Whiskeytown Lake	E	E	–	–	–	–	–		E^{3}	E	–	E^{4}	E^{4}	E	–	–	E^{5}	$E^{5,6}$	–	–	–	–	–	–	–

Surface Water Body	Municipal and Domestic Supply (MUN)	Agricultural Supply (AGR)	Industrial Service Supply (IND)	Industrial Process Supply (PRO)	Groundwater Recharge (GWR)	Fresh water Replenishment (FRSH)	Navigation (NAV)	Hydropower Generation (POW)	Water Contact Recreation (REC-1)	Non-Contact Water Recreation (REC-2)	Commercial and Sport Fishing (COMM)	Warm Fresh water Habitat (WARM)	Cold Fresh water Habitat (COLD)	Wildlife Habitat (WILD)	Rare, Threatened, or Endangered Species (RARE)	Marine Habitat (MAR)	Migration of Aquatic Organisms (MIGR)	Spawning, Reproduction, and/or Early Development (SPWN)	Shellfish Harvesting (SHELL)	Estuarine Habitat (EST)	Aquaculture (AQUA)	Native American Culture (CUL)	Flood Peak Attenuation/ Flood Water Storage (FLD)	Wetland Habitat (WET)	Water Quality Enhancement (WQE)
Feather River below Lake Oroville (Fish Barrier Dam to Sacramento River)	E	E	–	–	–	–	–	–	E^{3}	E	–	E^{4}	E^{4}	E	–	–	E^{5,6}	E^{5,6}	–	–	–	–	–	–	–
American River below Lake Natoma (Folsom Dam to Sacramento River)	E	E	E	–	–	–	–	E	E^{3}	E	–	E^{4}	E^{4}	E	–	–	E^{5,6}	E^{5,6}	–	–	–	–	–	–	–
Yolo Bypass[7]	–	E	–	–	–	–	–	–	E	E	–	E^{4}	P^{4}	E	–	–	E^{5,6}	E^{6}	–	–	–	–	–	–	–
Sacramento-San Joaquin River Delta																									
Sacramento-San Joaquin River Delta[7,8,9]	E	E	E	E	E	–	E	–	E	E	E	E^{4}	E^{4}	E	E	–	E^{5,6}	E^{6}	E	E	–	–	–	–	–
San Joaquin River and Tulare Basin																									
San Joaquin River: Friant Dam to Mendota Pool	E	E	–	E	–	–			E^{3}	E	–	E^{4}	E^{4}	E	–	–	E^{5,6}	E^{6}, P^{5}	–						

Surface Water Body	**Municipal and Domestic Supply (MUN)**	**Agricultural Supply (AGR)**	**Industrial Service Supply (IND)**	**Industrial Process Supply (PRO)**	**Groundwater Recharge (GWR)**	**Fresh water Replenishment (FRSH)**	**Navigation (NAV)**	**Hydropower Generation (POW)**	**Water Contact Recreation (REC-1)**	**Non-Contact Water Recreation (REC-2)**	**Commercial and Sport Fishing (COMM)**	**Warm Fresh water Habitat (WARM)**	**Cold Fresh water Habitat (COLD)**	**Wildlife Habitat (WILD)**	**Rare, Threatened, or Endangered Species (RARE)**	**Marine Habitat (MAR)**	**Migration of Aquatic Organisms (MIGR)**	**Spawning, Reproduction, and/or Early Development (SPWN)**	**Shellfish Harvesting (SHELL)**	**Estuarine Habitat (EST)**	**Aquaculture (AQUA)**	**Native American Culture (CUL)**	**Flood Peak Attenuation/ Flood Water Storage (FLD)**	**Wetland Habitat (WET)**	**Water Quality Enhancement (WQE)**
San Joaquin River: Mendota Dam to the Mouth of Merced River	P	E	–	E	–	–			E^{3}	E	–	E^{4}	–	E	–		$E^{5,6}$	E^{6}, P^{5}	–						
San Joaquin River: Mouth of Merced River to Vernalis	P	E	–	E	–				E^{3}	E	–	E^{4}	–	E	–		$E^{5,6}$	E^{6}	–	–	–	–	–	–	–
New Melones Reservoir	E	E	–	–	–	–	–	E	E	E	–	–	E^{4}	E	–	–	–	–	–	–	–	–	–	–	–
Tulloch Reservoir	P	E	–	–	–	–	–	E	E	E	–	E^{4}	–	E	–	–	–	–	–	–	–	–	–	–	–
Stanislaus River: Goodwin Dam to San Joaquin River	P	E	E	E	–	–	–	E	E^{3}	E	–	E^{4}	E^{4}	E	–	–	E^{5}	$E^{5,6}$	–	–	–	–	–	–	–
San Luis Reservoir	E	E	E	–	–	–	–	E	E	E	–	E^{4}	–	E	–	–	–	–	–	–	–	–	–	–	–
O'Neill Reservoir	E	E	–	–	–	–	–	–	E	E	–	E^{4}	–	–	–	–	–	–	–	–	–	–	–	–	–

Surface Water Body	**Municipal and Domestic Supply (MUN)**	**Agricultural Supply (AGR)**	**Industrial Service Supply (IND)**	**Industrial Process Supply (PRO)**	**Groundwater Recharge (GWR)**	**Fresh water Replenishment (FRSH)**	**Navigation (NAV)**	**Hydropower Generation (POW)**	**Water Contact Recreation (REC-1)**	**Non-Contact Water Recreation (REC-2)**	**Commercial and Sport Fishing (COMM)**	**Warm Fresh water Habitat (WARM)**	**Cold Fresh water Habitat (COLD)**	**Wildlife Habitat (WILD)**	**Rare, Threatened, or Endangered Species (RARE)**	**Marine Habitat (MAR)**	**Migration of Aquatic Organisms (MIGR)**	**Spawning, Reproduction, and/or Early Development (SPWN)**	**Shellfish Harvesting (SHELL)**	**Estuarine Habitat (EST)**	**Aquaculture (AQUA)**	**Native American Culture (CUL)**	**Flood Peak Attenuation/ Flood Water Storage (FLD)**	**Wetland Habitat (WET)**	**Water Quality Enhancement (WQE)**
California Aqueduct	E	E	E	E	–	–	–	E	E	E	–	–	–	E	–	–	–	–	–	–	–	–	–	–	–
Delta-Mendota Canal	E	E	–	–	–	–	–	–	E	E	–	E[4]	–	E	–	–	–	–	–	–	–	–	–	–	–

Sources: Central Valley RWQCB 2004, SWRCB 2006a, Hoopa Valley TEPA 2008, Central Valley RWQCB 2011, North Coast RWQCB 2011,

Notes:

E: Existing Beneficial Use; P: Potential Beneficial Use

1 Includes beneficial uses for the Trinity River within the Hoopa Valley Indian Reservation as designated by the Hoopa Valley Indian Reservation Water Quality Control Plan, which, in addition to beneficial uses shown, also designates the Lower Trinity River as a Wild and Scenic waterway, providing for scenic, fisheries, wildlife and recreational purposes.

2 Not all beneficial uses are present uniformly throughout this water body. They have been summarized to reflect beneficial uses present in multiple segments of the water body.

3 Canoeing and rafting included in REC-1 designation.

4 Resident does not include anadromous. Any Segments with both COLD and WARM beneficial use designations will be considered COLD water bodies for the application of water quality objectives.

5 Cold water protection for salmon and steelhead.

6 Warm water protection for striped bass, sturgeon, and shad.

7 Beneficial uses vary throughout the Delta and will be evaluated on a case-by-case basis. COMM is a designated beneficial use for the Sacramento San Joaquin Delta and Yolo Bypass waterways listed in Appendix 43 of the Basin Plan for the Sacramento River and San Joaquin River Basins and not any tributaries to the listed waterways or portions of the listed waterways outside of the legal Delta boundary unless specifically designated.

8 Delta beneficial uses are shown as designated by the Water Quality Control Plan for the Sacramento River Basin and the San Joaquin River Basin, and the Water Quality Control Plan for the San Francisco Bay/Sacramento San Joaquin Delta Estuary.

9 Per State Water Board Resolution No. 90-28, Marsh Creek and Marsh Creek Reservoir in Contra Costa County are assigned the following beneficial uses: REC-1 and REC-2 (potential uses), WARM, WILD and RARE. COMM is a designated beneficial use for Marsh Creek and its tributaries listed in Appendix 43 of the Basin Plan for the Sacramento River and San Joaquin River Basins within the legal Delta boundary.

6.3.1.1 Water Temperature

Water temperature is a concern in regions throughout California including the lower Klamath River, Trinity Lake, Sacramento River, and the San Joaquin River. These regions support warm and cold fresh water habitat and other aquatic beneficial uses. Water bodies in these areas must maintain water temperatures supportive of resident and seasonal fish species habitats, particularly for endangered species. Common narrative and numeric water quality objectives for water temperature in water bodies within the study area are specified in each of the basin plans for the North Coast, Central Valley, Tulare Lake and the San Francisco Bay regions (NCRWQCB 2011; CVRWQCB 2004, and 2011; SFB RWQCB 2013):

- The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such alteration in temperature does not adversely affect beneficial uses.
- At no time or place shall the temperature of cold or warm-intrastate waters be increased by more than 5° F above natural receiving water temperature.

Water quality objectives for water temperature within the project study area are also specified in the SWRCB *Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California (Statewide Temperature Plan).*

Further information on the measurement and enforcement of water quality objectives for temperature is included in the Statewide Temperature Plan (SWRCB 1998).

6.3.1.2 Salinity

Salinity, a measure of dissolved salts in water, is a concern in the tidally-influenced Delta as it can cause impacts on domestic supply, agriculture, industry, and wildlife (CALFED 2007). The impacts of salinity on the domestic supply of water in the Delta include aesthetic (skin or tooth discoloration), or cosmetic (taste, odor, or color) effects, and increasing the need to reduce salinity for M&I uses by blending which can lead to a reduction in the quantity of usable water. Salts, such as bromide, in drinking water can increase the formation of harmful byproducts (see the Bromide, Organics, and Pathogens section). Salinity in the Delta impacts agriculture by reducing crop yields and salinity in the soil can cause plant stress. Another salt ion, chloride, in high concentrations in municipal and industrial supply has been known to cause corrosion in canned goods because of residual salts in paper boxes or linerboard.

Some fish and wildlife are also affected by salinity concentrations in the Delta because certain levels of salinity are required during different life stages to survive. One measure of salinity in the western Delta is “X2.” X2 refers to the horizontal distance from the Golden Gate Bridge up the axis of the Delta estuary to where tidally averaged near-bottom salinity concentration of 2 parts of salt in 1,000 parts of water occurs. The X2 standard was established to improve shallow water estuarine habitat in the months of February through June and relates to the extent of salinity movement into the Delta (DWR, Reclamation, USFWS and NMFS 2013). The location of X2 is important to both aquatic life and water supply beneficial uses.

The CVP and SWP are operated to achieve salinity objectives in the Delta, as described in detail in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations.

The SWRCB D-1641 includes “spring X2” criteria that require operations of the CVP and SWP to include upstream reservoir releases from February through June to maintain freshwater and estuarine conditions in the western Delta to protect aquatic life. In addition, the 2008 U.S. Fish and Wildlife Service (USFWS) Biological Opinion (BO) also includes an additional Delta salinity requirement in September and October in wet and above normal water years (Fall X2), as described in Chapter 5, Surface Water Resources and Water Supplies.

6.3.1.3 Mercury

Mercury is a constituent of concern throughout California, both as total mercury and as biologically-formed methylmercury, which is more available for food chain exposure and toxicity. Mercury present in the Delta, its tributaries, Suisun Marsh, and San Francisco Bay is derived both from current processes and as a result of historical deposition. Most of the mercury present in these locations is the result of historical mining of mercury ore in the Coast Ranges (via Putah and Cache creeks to the Yolo Bypass) and the extensive use of elemental mercury to aid gold extraction processes in the Sierra Nevada (via Sacramento, San Joaquin, Cosumnes, and Mokelumne rivers) (Alpers et al. 2008; Wiener et al. 2003). Elemental mercury from historical gold mining processes appears to be more bioavailable than that from mercury ore tailings because mercury used in gold mining processes was purified before use (CVRWQCB 2010a). Additional sources of mercury include atmospheric deposition from both local and distant sources, and discharges from wastewater treatment plants (SWRCB 2014a).

Methylation of mercury is an important step in the entrance of mercury into food chain (USEPA 2001a). This transformation can occur in both sediment and the water column. Methylmercury is absorbed more quickly by aquatic organisms than inorganic mercury, and it biomagnifies (i.e., increases the concentration of methylmercury in predatory fish from eating smaller contaminated fish and invertebrates). The pH of water, the length of the aquatic food chain, water temperature, and dissolved organic material and sulfate are all factors that can contribute to the bioaccumulation of methylmercury in aquatic organisms. The proportion of an area that is wetlands, the soil type, and erosion can also contribute to the amount of mercury that is transported from soils to water bodies. These effects can be seen in the variability in bioaccumulated mercury in the Sacramento-San Joaquin River Delta.

Consumption of contaminated fish is the major pathway for human exposure to methylmercury (USEPA 2001a). Once consumed, methylmercury is almost completely absorbed into the blood and transported to all tissues, and is also transmitted to the fetus through the placenta. Neurotoxicity from methylmercury can result in mental retardation, cerebral palsy, deafness, blindness, and dysarthia in utero, and in sensory and motor impairments in adults. Cardiovascular and immunological effects from low-dose methylmercury exposure have also been reported.

In an effort to protect aquatic and human health, USEPA recommended maximum concentrations “without yielding unacceptable effects” in 2001 for acute exposure, identified as the criteria maximum concentration (CMC), and for chronic exposure, identified as the criterion continuous concentration (CCC) (USEPA 2001a and USEPA 2014a). Current state-wide water quality criteria for mercury were established in the CTR in 2000 (USEPA 2000a). Under these requirements, total recoverable mercury for the protection of human health was set as limits for consumption of water and organisms as well as consumption of organisms only, as summarized in Table 6.3. Mercury objectives are also included in some California RWQCB basin plans, as discussed in subsequent sections of this chapter. Where both a CTR criterion and a Basin Plan objective exist, the more stringent value applies (SWRCB 2006a).

Table 6.3 Water Quality Criteria for Mercury and Methylmercury (as Total Mercury)

NRWQC	For the protection of freshwater species		CMC = 1.4 µg/l
			CCC = 0.77 µg/l
	For the protection of saltwater species		CMC = 1.8 µg/l
			CCC = 0.94 µg/l
	For the protection of human health[1]		0.3 mg/kg [2]
CTR	For the protection of human health	Consumption of water + organism	0.050 µg/l
		Consumption of organism only	0.051 µg/l

Source: NRWQC (National Recommended Water Quality Criteria) - USEPA 2014a; CTR (California Toxic Rule) - USEPA 2000a, USEPA 2001b

Notes:

1 For the consumption of organisms only and based on a total consumption 0.0175 kg fish and shellfish per day.

2 Methylmercury in fish tissue (wet weight)

A review of the mercury human health criteria by USEPA in 2001 concluded that a fish tissue (including shellfish) residue water quality criterion for methylmercury is more appropriate than a water-column-based water quality criterion (USEPA 2001a). A fish tissue criterion directly addresses the dominant human exposure route for methylmercury, and thus is more closely tied to the CWA goal of protecting public health. The USEPA also strongly encourages States and authorized Tribes to develop local or regional water quality criteria if they will be more appropriate for the target population.

The SWRCB is considering adopting statewide objectives for methylmercury based on the USEPA criteria, which would apply to inland waters, enclosed bays, and estuaries (SWRCB 2006a). These objectives would be applicable to waters that are not listed as impaired or that do not require a TMDL. Potential elements include a methylmercury fish tissue objective, a total mercury water quality objective, a methylmercury water quality objective, or some combination of these. Implementation procedures related to the NPDES permitting process also may be included.

The CTR criterion may be implemented as a fish tissue-based objective (FTO), or it may be converted into an ambient methylmercury water quality objective (AWQO), the latter reflecting the USEPA's fish consumption rate of 0.0175 kg fish/day, or site-specific consumption rates that more accurately reflect local consumption patterns (SWRCB 2006a). A USFWS evaluation of the USEPA criterion for methylmercury concluded that the FTO of 0.3 mg methylmercury/kg fish would be insufficient to protect three species that may occur in the study area including California Least Tern, California Clapper Rail, and Bald Eagle evaluated in the study.

6.3.1.4 Selenium

Selenium is a constituent of concern in the project area because of its potential effects on water quality and on aquatic and terrestrial resources primarily in the San Joaquin Valley and the San Francisco Bay, as well as some locations in Southern California (SWRCB 2011a). Elevated concentrations of selenium in soil and waterways within the San Joaquin Valley, and to some extent in the San Francisco Bay, are due primarily to erosion of uplifted selenium-enriched Cretaceous and Tertiary marine sedimentary rock located at the base of the east-facing side of the Coastal Range (Presser and Piper 1998; Presser 1994). The selenium-enriched soil derived from the eroded rock has been transported to the western San Joaquin Valley through natural processes; selenium is mobilized from the soil by irrigation practices and transported to waterways receiving agricultural drainage (Presser and Ohlendorf 1987). Other sources of selenium to the western Delta and San Francisco Bay include several oil refineries located in the vicinity of Carquinez Strait and San Pablo Bay (Presser and Luoma 2013; SWRCB 2011a). The specific water bodies within these areas that may be affected by the project and are impaired by selenium, as specified on the California CWA Section 303(d) list, include the Panoche Creek (from Silver Creek to Belmont Avenue), Mendota Pool, Grasslands Marshes, San Joaquin River (from Mud Slough to Merced River), Sacramento-San Joaquin Delta, and Suisun Bay (SWRCB 2011a).

Adverse effects of selenium may occur as a result of either a selenium deficiency or excess in the diet (ATSDR 2003; Ohlendorf 2003); the latter is the primary concern in the case of the impaired water bodies on the 303(d) list. Because of the known effects of selenium bioaccumulation from water to aquatic organisms and to higher trophic levels in the food chain, the fresh water, estuarine and wildlife habitat; spawning, reproduction, and/or early development; and rare, threatened, or endangered species beneficial uses of the water bodies are the most sensitive receptors to selenium exposure. Thus, excessive exposure can lead to selenium toxicity or selenosis and result in death or deformities of fish embryos, fry, or larvae (Ohlendorf 2003, Janz et al. 2010). Consequently, regulatory agencies have established exposure criteria to protect the beneficial uses of the water bodies.

Agencies such as the Agency for Toxic Substances and Disease Registry (ATSDR), California Office of Environmental Health Hazard Assessment (OEHHA), USEPA, SWRCB, and RWQCBs have determined acceptable selenium exposure levels for humans and water bodies in California. The ATSDR has stated the minimum risk levels (MRLs) for selenium to be ingested over a one-year period is 0.005 mg/kg/day, with an uncertainty factor of 3 (ATSDR 2013a). The 0.005 mg/kg/day value is also used by OEHHA to develop guidelines for consuming fish (OEHHA 2008). USEPA has set 50 µg/l as the maximum MCL for selenium in drinking water and OEHHA has set a more stringent draft public health goal (PHG) of 30 µg/l for selenium in drinking water (USEPA 2009a; OEHHA 2010). USEPA has also specified through the California Toxics Rule that the water quality criteria for aquatic life in all of California's fresh water bodies except for the San Joaquin River from Merced River to Vernalis are 20 µg/l for short-term (1-hour average) and 5 µg/l for long-term (4-day average) exposure (USEPA 2000a). For the San Joaquin River from Merced River to Vernalis, the short-term exposure is 12 µg/l and long-term limit is 5 µg/l, as stated in the Sacramento-San Joaquin River Basin Plan (CVRWQCB 2011). The water quality criteria for aquatic life in all of California's water bodies is 5 µg/l (4-day average exposure) and 20 µg/l (1-hour exposure) (USEPA 2014a).

The USEPA, Reclamation, the SWRCB, and the RWQCBs have created plans to reduce the toxic levels of selenium in California's impaired water bodies. The USEPA's Action Plan consists of recommendations to restore water quality and to protect aquatic species in the San Francisco Bay and Sacramento-San Joaquin Delta, which include strengthening selenium water quality criteria to reduce long-term exposure of sensitive aquatic and terrestrial species to selenium (USEPA 2012a). Grasslands Marshes, located in the San Joaquin Valley, include an area contaminated with selenium from agricultural irrigation and drainage practices when the marshes were irrigated with a blend of subsurface agricultural drainage water and higher-quality water. Reclamation's Grasslands Bypass Project reroutes the discharge of selenium-laden subsurface agriculture water from upstream agricultural dischargers that formerly passed through the Grassland Water District and nearby wildlife refuges and wetlands to Mud Slough by conveying it through a portion of the San Luis Drain. The project began in 1996 and has since reduced the selenium load discharged from the Grassland Drainage Area from 9,600 lbs to 2,200 lbs in 2011 (GBPOC 2013). Both the USEPA Action Plan and the Grasslands Bypass Project reduce selenium levels in waterways to meet the water quality objective targeted for December 2019. The CVRWQCB released a draft waste discharge requirement in May 2014 that suggests a performance goal of 15 µg/l (monthly mean) and water quality objective of 5 µg/l (4-day average) for Mud Slough (north) and the San Joaquin

River (CVRWQCB 2014a). This water quality objective for a 4-day average selenium concentration is consistent with the TMDL for the lower San Joaquin River (CVRWQCB 2001). The USEPA also released draft water quality criteria for the protection of freshwater aquatic life from toxic effects of selenium, shown in Table 6.4 (USEPA 2014b).

Table 6.4 Draft Water Quality Criteria for Selenium

Media Type	**Fish Tissue**	**–**	**Water Column**[3]	**–**
Criterion Element	Egg/Ovary[1]	Fish Whole-Body or Muscle[2]	Monthly Average Exposure	Intermittent Exposure[4]
Magnitude	15.2 mg/kg	8.1 mg/kg whole body or 11.8 mg/kg muscle (skinless, boneless filet)	1.3 µg/l in lentic aquatic systems 4.8 µg/l in lotic aquatic systems	$WQC_{int} = \frac{WQC_{30-day} - C_{bkgrnd}(1 - f_{in}}{f_{int}}$
Duration	Instantaneous measurement[5]	Instantaneous measurement[5]	30 days	Number of days/month with an elevated concentration

Source: USEPA 2014b

1 Overrides any whole-body, muscle, or water column elements when fish egg/vary concentrations are measured.

2 Overrides any water column element when both fish tissue and water concentrations are measured,

3 Water column values are based on dissolved total selenium in water

4 Where WQC_{30-day} is the water column monthly element, for either a lentic or lotic system, as appropriate. C_{bkgrnd} is the average background selenium concentration, and f_{int} is the fraction of any 30-day period during which elevated selenium concentrations occur, with f_{int} assigned a value ≥0.033 (corresponding to 1 day).

5 Instantaneous measurement. Fish tissue data provide point measurements that reflect integrative accumulation of selenium over time and space in the fish at a given site. Selenium concentrations in fish tissue are expected to change only gradually over time in response to environmental fluctuations.

6.3.1.5 Nutrients

Nutrients are a constituent of concern in the lower Klamath River hydrologic area (Klamath Glen HSA) and the Suisun Marsh Wetlands (SWRCB 2011a) (Klamath Glen HSA; SWRCB 2011a). Nutrients, such as nitrogen and phosphorus, come from natural sources such as weathering of rocks and soil, and from the ocean when nutrients are mixed in the water current, as well as animal manure, atmospheric deposition, and nutrient recycling in sediment (NOAA 2014; USEPA

1998). Anthropogenic sources include fertilizers, detergents, sewage treatment plants, septic systems, combined sewer overflows, and sediment mobilization (USEPA 1998).

Nutrients are essential to maintaining a healthy water system. However, over enrichment of nitrogen and phosphorus can contribute to a process known as eutrophication where there is an excessive growth of macrophytes, phytoplankton, or potentially toxic algal blooms. Eutrophication may also lead to a decrease of dissolved oxygen, typically at night, when plants stop producing oxygen through photosynthesis but continue to use oxygen. Low dissolved oxygen levels can kill fish, cause an imbalance of prey and predator species, and result in a decline in aquatic resources (USEPA 1998). Severely low dissolved oxygen conditions are referred to as anoxic and may enhance methylmercury production (SFB RWQCB 2012a). Over enrichment can also contribute to cloudy or murky water clarity by increasing the amount of materials (i.e., algae) suspended in the water.

6.3.1.6 Dissolved Oxygen

Dissolved oxygen is a constituent of concern in the project area primarily in the lower Klamath River, Sacramento-San Joaquin River Delta, and Suisun Marsh Wetlands (SWRCB 2011a). Oxygen in water comes primarily from the atmosphere through diffusion at the water surface, as well as from groundwater discharge into streams and when plants undergo photosynthesis releasing oxygen in exchange for carbon dioxide (USGS 2014; NOAA 2008a). Levels of dissolved oxygen vary with several factors including season, time of day, water temperature, salinity, and organic matter. The season and time of day dictate photosynthesis processes, which require sunlight. Increases in water temperature and salinity reduce the solubility of oxygen (NOAA 2008b). Fungus and the bacteria use oxygen when decomposing organic matter in water bodies. So, the more organic matter present in a water body, the more potential for dissolved oxygen levels to decline.

Adverse effects of low dissolved oxygen are a concern for water quality and aquatic organisms. Low dissolved oxygen impairs growth, immunity, reproduction, and causes asphyxiation and death (NCRWQCB 2011).

To protect aquatic life, USEPA has established water quality standards for dissolved oxygen (USEPA 1986a). However, to protect the beneficial uses of California's water bodies (Table 6.2), including warm and cold freshwater habitats in both tidal and non-tidal waters, site-specific water quality objectives were established.

Future plans to maintain a healthy level of dissolved oxygen in water bodies are also site-specific, such as plans for the San Joaquin River and the Stockton Deep Water Ship Channel (CVRWQCB 2011).

6.3.1.7 Pesticides

Pesticides are constituents of concern throughout the study area and particularly in the Central Valley. Major pesticides of concern include organophosphate (OP) pesticides – primarily diazinon and chlorpyrifos, and organochlorine (OC) pesticides – mainly Dichloro-Diphenyl-Trichloroethane (DDT) and Group A compounds. The toxicity and fates of these pesticides are described in the following sections.

6.3.1.7.1 Organophosphate Pesticides

The two most prevalent OP pesticides in the study area are man-made pesticides, diazinon and chlorpyrifos, which have been used extensively in agricultural and residential applications. Former and current uses of diazinon and chlorpyrifos have resulted in the contamination of water bodies throughout the Central Valley, as identified on the 303(d) list (SWRCB 2011a). The CVRWQCB has also identified hot spots of contamination, particularly in the Delta and in urban areas of Stockton and Sacramento (CVRWQCB 2003).

Pesticides are primarily transported into streams and rivers in runoff from agriculture (CVRWQCB 2011) but also occur or have occurred in urban non-point runoff and stormwater discharges. Treated municipal wastewater can also be a point source. However, OP pesticides, diazinon and chlorpyrifos, have been banned from non-agricultural uses since December 31st, 2004 and December, 2001, respectively. Reported non-agricultural pesticide use of diazinon and chlorpyrifos declined substantially in some counties between 2000 and 2009 (CVRWQCB 2014b). However, the reduction of OP pesticide use has resulted in the increasing use of pyrethroids and carbamates as alternative pesticides in urban and agricultural areas.

Diazinon was one of the most common insecticides in the U.S. for household lawn and garden pest control, indoor residential crack and crevice treatments and pet collars until all residential uses of diazinon were phased out, between 2002 and 2004 (USEPA 2004). Diazinon usage was then prohibited for several agricultural uses in 2007, with only a few remaining agricultural uses permitted, including uses on some fruit, vegetable, nut and field crops, and as an ear-tag on non-lactating cattle (USEPA 2007). The highest continued use of diazinon is on almonds and stone fruits (USEPA 2004).

6.3.1.7.2 Organochlorine Pesticides

Organochlorine (OC) pesticides are mainly comprised of Dichloro-Diphenyl-Trichloroethane (DDT) and Group A Pesticides (CVRWQCB 2010b). DDT is a persistent chemical that binds tightly to soil and sediment, and breaks down slowly in the environment. It degrades to the isomers o,p'- and p,p'- DDT; o,p'- and p,p'-Dicholoro-Diphenyl-Dichloroethylene (DDE) and o,p'- and p,p'-Dichloro-Diphenyl-Dichloroethane (DDD). Group A Pesticides are made up of the total concentration of the OC pesticides: aldrin, dieldrin, endrin, heptachlor, heptachlor epoxide, chlordane (total), hexachlorocyclohexane (total) including Lindane (gamma-BHC), alpha-BHC, endosulfan (total), and toxaphene. These pesticides have similar chemical properties to DDT and are also persistent in the environment.

Transport of OC pesticides into streams and rivers is primarily from agriculture runoff (CVRWQCB 2011). Other potential point sources of OC pesticides include storm sewer discharges and historic spills. Non-point sources can include areas of previous residential applications, open space and channel erosion, and some background sources through wet and dry atmospheric deposition. Most OC pesticides were previously deposited on terrestrial soils, thus erosion and transport of contaminated sediments continue to contribute to detectable levels in stream bed sediment (CVRWQCB 2010b).

OC pesticides have historically been used as insecticides, fungicides and antimicrobial chemicals in residential and agricultural pest control (CVRWQCB 2010b). Most were banned in the mid-1970s, and fish tissue concentrations declined rapidly since the ban through the mid-1980s (Greenfield et al., 2004); however, they continue to be detected in fish tissue, the water column, and sediment in the Central Valley.

6.3.1.7.3 Pyrethroid Pesticides

Pyrethroids (e.g., bifenthrin, permethrin, cypermethrin) are synthetic insecticides used in agriculture and households. The Surface Water Ambient Monitoring Program (SWAMP) studies indicate that the replacement of organophosphate pesticides by pyrethroids has resulted in an increased contribution of pyrethroids to ambient water and sediment toxicity (Anderson et al. 2011) In the water column, toxicity to the water flea *Ceriodaphnia dubia (C. dubia)* is caused by organophosphate and pyrethroid pesticides. Pyrethroids are also the major chemical class of concern in urban storm water, as indicated by the highly sensitive amphipod *Hyalella azteca (H. azteca)* which is highly sensitive to pyrethroids (Weston and Lydy 2010). Non-polar organic compounds, especially herbicides, and the herbicide Diuron have been identified as causes of algal toxicity in the Central Valley. Of the pyrethroid pesticides, bifenthrin is of major concern (Markiewicz et al. 2012).

Sediment criteria are also under development for pyrethroids that may inform waterbody impairment evaluations (SWRCB 2014b). With regard to sediment, as indicated by *H. azteca*, the majority of toxicity has been attributed to pyrethroids, particularly in urban areas (Markiewicz et al. 2012).

6.3.1.7.4 Other Pesticides

Diuron (3-(3,4-dichlorophenyl)-1,1-dimethylurea or DCMU) was introduced in 1954 and is currently is one of the most-used herbicides in California (CVRWQCB 2012b). It is an herbicide that inhibits photosynthesis and is targeted on controlling annual broadleaf and grassy weeds. EPA has not developed a WQC specific to Diuron but a TMDL in development will include the development of WQO for Diuron in the Central Valley.

6.3.1.7.5 General Pesticide Regulations

In addition to the existing water quality objectives and FCGs for pesticides in the study area, a Basin Plan Amendment for the Sacramento and San Joaquin River watersheds and the Delta is in progress to address those pesticides which currently impact or could potentially impact aquatic life uses in surface waters. The Basin

Plan Amendment will include the establishment of numeric water quality objectives for these selected pesticides. By addressing a greater grouping of pesticides than those included in the current Section 303(d) impaired water body list, the Basin Plan Amendment will help prevent the increased use of those pesticides not included on the 303(d) list (CVRWQCB 2006a).

6.3.1.8 Polychlorinated Biphenyls (PCBs)

Polychlorinated biphenyls, a group of synthetic organic chemicals, is a constituent of concern throughout California including the Sacramento River region (Sacramento River, Feather River, and American River), the Sacramento-San Joaquin River Delta, Suisun Bay, Carquinez Strait, and San Pablo Bay (SWRCB 2011a). PCBs cause harmful environmental effects and also pose a risk to human health (ATSDR 2000).

PCBs are mixtures of a variety of individual chlorinated biphenyl components, known as congeners. In the United States, many of these mixtures were sold under the trade name Aroclor, manufactured from 1930 to 1977 primarily for use as coolants and lubricants in transformers, capacitors, and other electrical equipment. Although manufacture was banned in 1979, PCBs continue to cause environmental degradation because they are environmentally persistent, easily redistributed between air, water and soil, and tend to accumulate and biomagnify in the food chain (ATSDR 2000, OEHHA 2008).

The “weathering” of PCBs is a process by which the composition of Aroclor mixtures undergo differential partitioning, degradation, and biotransformation. This results in differential environmental persistence and bioaccumulation of the mixtures, where these increase with the degree of chlorination of new mixtures. (OEHHA 2008). The biphenyls with more chlorine atoms tend to be heavier and remain close to the source of contamination, whereas those with fewer chlorine atoms are easily transported in the atmosphere. Atmospheric deposition is the primary source of PCBs to surface waters, although redissolution of sediment-bound PCBs also contributes to surface water contamination. PCBs leave the water column through sorption to suspended solids, volatilization from water surfaces, and concentration in plants and animals (ATSDR 2000).

PCBs cannot be distinctly assessed for health effects, as their toxicity is determined by the interactions of individual congeners and by the interactions of PCBs with other structurally related chemicals, including those combined with or used in the production of PCBs. However, several general health effects of PCB exposure have been identified. When PCBs are absorbed, they are distributed throughout the body and accumulate in lipid-rich tissues, including the liver, skin tissue, and breast milk. They can also be transferred across the placenta to the fetus. Studies have linked oral exposure to cancer and to adverse neurological, reproductive, and developmental effects. The International Agency for Research on Cancer has thus listed PCBs as probable human carcinogens, and OEHHA has administratively listed PCBs on the Proposition 65 list of chemicals known to the State of California to cause cancer (OEHHA 2008).

6.3.2 Trinity River Region

The Trinity River Region includes the area in Trinity County along the Trinity River from Trinity Lake to the confluence with the Klamath River; and in Humboldt and Del Norte counties along the Klamath River from the confluence with the Trinity River to the Pacific Ocean.

This water quality analysis includes Trinity Lake, Lewiston Lake, Trinity River downstream of Lewiston Dam, and the Klamath River from its confluence with the Trinity River to the Pacific Ocean. The analysis does not include Trinity River upstream of Trinity Lake, the South Fork of the Trinity River, or the Klamath River upstream of Trinity River, because these areas are not affected by changes in CVP operations.

Several water quality requirements affect the Klamath River and Trinity River basins. Beneficial uses and water quality objectives provided by the NCRWQCB and the Hoopa Valley Tribal Environmental Protection Agency (Hoopa Valley TEPA) are described below, as well as relevant TMDLs. The Yurok Tribe Basin Plan for the Yurok Indian Reservation and the Resighini Rancheria Tribal Water Quality Ordinance also regulate portions of the Trinity and Klamath Rivers that flow into and through the reservations; however, because they have not yet been approved by the USEPA, their objectives are not described in detail here. Oregon water quality requirements also affect the water quality of the Klamath River which originates in Oregon. However, this chapter only discusses the requirements within the Trinity and lower Klamath River Basins.

6.3.2.1 Beneficial Uses

Beneficial uses for all water bodies in the study area are determined by the NCRWQCB and the Hoopa Valley TEPA (Table 6.2). In addition to the beneficial uses listed in the Trinity and Klamath River basins, the North Coast Basin Plan notes that recreational use (i.e., water contact recreation [REC-1] and non-contact water recreation [REC-2]) occurs in all hydrologic units of the Klamath River Basin, with Trinity River being one of the rivers receiving the largest levels of recreational use (NCRWQCB 2011). Fish and wildlife reside in virtually all of the surface waters within the North Coast Region (NCRWQCB 2011). These species include several that are designated as rare, threatened and endangered. Trinity Dam also provides the beneficial use of hydroelectric power (i.e., POW).

6.3.2.2 Constituents of Concern

The constituents of concern that are currently not in compliance with existing water quality standards and for which TMDLs are adopted or are in development are summarized in Table 6.1 and discussed below.

6.3.2.2.1 Water Temperature

The majority of the Trinity and Klamath Rivers are not listed on the 303(d) list approved by the USEPA in 2010 as impaired by water temperature. However, the hydrologic area of the South Fork Trinity River and the lower hydrologic area of the Klamath River (Klamath Glen HSA) are listed for elevated water temperatures adversely affecting the cold freshwater habitat (SWRCB 2011c-h).

The Trinity River and lower Klamath River watersheds must maintain water temperatures to protect and support resident and seasonal fish species habitats. The North Coast Basin Plan designates narrative and numeric water temperature objectives applicable to surface waters in the Trinity River and the lower Klamath River basins. Other objectives and criteria specific to each region are specified below.

Trinity River

The South Fork Trinity River flows from its headwaters to the confluence with the mainstem of the Trinity River. It then flows into the lower Klamath River and out to the Pacific Ocean. Elevated water temperatures in the South Fork Trinity River can be attributed to the loss of shade trees due to habitat modification, range grazing, removal of riparian vegetation, streambank modification and destabilization, and water diversions (SWRCB 2011d). This reach supports steelhead, Chinook Salmon, and Coho Salmon (below Grouse Creek) (USDAFS 2014). The mainstem of the Trinity River also supports steelhead, Coho Salmon, and Chinook Salmon.

Water temperature objectives, summarized in Table 6.5, were set forth in the North Coast Basin Plan specifically applicable to the Trinity River, from Lewiston Dam to Douglas City and to the confluence with the North Fork Trinity River. These criteria are reach dependent, and vary seasonally. They were specifically developed to enhance the productivity of Trinity River Fish Hatchery, specifically for salmon and steelhead trout populations (NCRWQCB 2011).

Table 6.5 Water Quality Objectives for Temperature in the Trinity River

Period	Daily Average Temperature Not to Exceed	Trinity River Reach
July 1 – September 14	60° F	Lewiston Dam to Douglas City Bridge
September 15 – October 1	56° F	Lewiston Dam to Douglas City Bridge
October 1 – December 31	56° F	Lewiston Dam to confluence of North Fork Trinity River

Source: NCRWQCB 2011

Hoopa Valley Indian Reservation

Natural causes of temperature exceedances, such as unusually excessive ambient air temperatures coupled with flows, intended to protect aquatic habitat specified in the Trinity River Flow Evaluation report (TRFE), will not be considered to violate the water quality objectives stated in the Hoopa Valley Indian Reservation Basin Plan.

Temperature objectives for the Trinity River as it passes through the Hoopa Valley Reservation vary seasonally and are precipitation dependent (Table 6.6).

The water quality objectives are based on temperature-flow relationships that maintain TRFE flow regimes and protect adult salmonids holding and spawning. The objectives are also consistent with the temperature standards specified in the NCRWQCB Basin Plan (Hoopa Valley TEPA 2008).

Table 6.6 Trinity River Temperature Criteria for the Hoopa Valley Indian Reservation

Dates	Running 7-Day Average Temperature not to Exceed[1,2]	
	Extremely Wet, Wet and Normal Water Years	**Dry and Critically Dry Water Years**
May 23 – June 4	59º F	62.6º F
June 5 – July 9	62.6º F	68º F
July 10 – September 14	72.0º F	74.0º F[3]
September 15 – October 31	66.0º F	66.0º F
November 1 – May 22	55.4º F	59.0º F

Source: Adapted from Hoopa Valley TEPA 2008

1 Temperature standards will be monitored at the Weitchpec temperature monitoring station operated and maintained by Reclamation.

2 Temperature standard violations will be determined if more than ten percent of seven-day running averages exceed the standard, to be determined by the number of days exceeded for that seasonal period (i.e., for June 16 – September 14, a 91 day period, ten percent exceedance will equate to nine days).

3 For the seasonal period of June 16 – September 14, temperatures on the mainstem Trinity River at the Weitchpec gauging station were used to determine running seven-day averages.

The Hoopa Valley TEPA established a goal of attaining a temperature of 21º C (69.8º F) during the July 10 – September 14 period within five years of the adoption of these standards (Hoopa Valley TEPA 2008). If monitoring reveals that temperatures continue to increase, the Hoopa Valley TEPA will employ adaptive management strategies until temperatures begin to decrease

In addition to the seasonal water temperature criteria, the Hoopa Valley TEPA has established varying criteria for each life stage of salmonids (Table 6.7).

Table 6.7 Tributary Temperature Criteria for the Hoopa Valley Indian Reservation

Dates	Maximum Weekly Average Temperature (MWAT)[1,2]		Applicable Salmonid Life Stage(s)[3]
	Extremely Wet, Wet and Normal Water Years	Dry and Critically Dry Water Years	
May 23 – June 4	55.4º F	57.2º F	Adult holding; coho incubation and emergence; spawning; smoltification
June 5 – Jul 9	60.8º F	62.6º F	Adult holding; peak temperatures timeframe according to Hoopa Tribal data
July 10 – September 14	64.4º F	68.0º F	Adult holding
September 15 – October 31	57.2º F	60.8º F	Adult holding; spawning
November 1 – May 22	50.0º F	53.6º F	Adult incubation and emergence (including coho); smoltification; spawning

Source: Adapted from Hoopa Valley TEPA 2008

1 The MWAT is defined as the highest 7-day moving average of equally spaced water temperature measurements for a given time period. In this application, the time period is the duration of the existing salmonids life stage. For the MWAT objective, temperatures may not exceed the numeric objective for every 7-day period during the given life stage.

2 Applicable where a given species and life stage time period exist, and when and where the species and life stage time period existed historically, and have the potential to exist again.

3 Adult migration and juvenile rearing are considered all year life stages.

Water temperature data for Trinity River between 2001 and 2012 show seasonal trends and the warming effect of ambient conditions at the downstream location (Table 6.8 and Figure 6.1). Compliance locations for water quality monitoring along the Trinity River are shown in Figure 6.2.

Table 6.8 Monthly Average of Water Temperatures Recorded at Trinity River Compliance Locations

WY	WYT	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Douglas City													
2001	D	51.9	46.6	44.2	42.0	43.2	47.5	50.7	54.4	55.5	58.5	57.0	54.2
2002	D	51.0	47.7	42.7	43.1	43.8	46.6	52.5	49.4	56.1	58.9	56.2	54.4
2003	AN	49.8	46.5	44.6	44.9	44.8	48.0	48.8	50.4	52.8	57.0	56.6	52.7
2004	BN	51.2	46.6	43.7	41.5	43.7	47.5	51.4	50.3	51.4	54.7	56.4	53.0
2005	AN	50.9	47.4	42.9	42.8	45.3	48.2	50.8	49.9	52.2	57.9	59.5	54.7
2006	W	51.5	47.4	43.9	45.5	44.4	44.2	47.5	48.4	49.3	54.9	NA	NA
2007	D	NA	NA	43.0	39.8	43.1	48.4	52.5	47.9	55.8	58.7	57.2	54.1
2008	C	50.3	46.9	41.8	39.8	41.2	46.4	50.0	48.6	50.8	53.4	58.0	55.3
2009	D	51.4	49.3	43.5	43.0	43.4	46.8	51.7	50.9	56.6	60.5	58.1	55.9
2010	BN	51.2	47.5	42.2	44.3	45.2	46.8	48.4	48.4	52.3	57.3	58.5	55.1
2011	W	51.4	46.7	44.4	42.3	42.6	45.2	48.8	47.7	50.4	54.4	57.6	53.9
2012	BN	50.5	45.5	41.2	40.2	43.5	45.2	48.9	49.3	50.9	55.2	55.6	52.4
WY	**WYT**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
North Fork Trinity near Helena													
2001	D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2002	D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2003	AN	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2004	BN	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2005	AN	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	64.5	58.2
2006	W	53.4	47.8	44.0	45.7	44.8	44.9	48.3	49.6	51.4	59.0	NA	NA
2007	D	NA	NA	42.5	39.6	43.5	48.9	53.2	49.3	59.8	65.4	63.0	58.3
2008	C	52.5	48.3	42.0	40.6	42.3	46.6	50.1	50.1	53.2	56.7	62.8	59.2
2009	D	53.3	49.6	43.0	42.5	43.4	47.0	51.8	52.6	59.7	66.0	62.9	60.0
2010	BN	53.4	47.7	41.9	44.8	45.9	47.1	48.4	49.4	53.7	60.9	63.3	59.0
2011	W	53.9	47.1	45.1	43.1	43.0	45.2	45.5	NA	NA	NA	NA	NA
2012	BN	52.8	46.4	40.9	39.9	43.8	45.1	49.1	50.6	53.3	59.3	60.3	55.9
WY	**WYT**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Weitchpec													
2001	D	57.9	48.2	44.8	41.9	43.5	48.8	52.1	60.9	65.8	73.8	72.1	67.0
2002	D	59.3	51.2	46.0	44.7	45.8	47.4	53.9	55.9	66.1	73.6	71.1	67.2
2003	AN	57.5	49.1	46.7	49.3	50.8	54.2	54.8	58.6	69.5	70.2	71.3	64.6
2004	BN	59.7	50.4	46.3	45.3	46.8	53.5	58.7	56.6	62.3	70.4	72.1	64.4
2005	AN	58.6	49.9	45.0	44.3	46.7	50.0	51.5	54.6	59.5	69.8	73.0	64.9
2006	W	58.8	50.6	46.4	48.8	47.5	47.8	50.2	53.8	57.1	65.2	NA	NA
2007	D	NA	NA	47.9	44.9	48.3	52	56.2	56.3	66.6	73.2	72.6	NA
2008	C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2009	D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

WY	WYT	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2010	BN	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2011	W	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2012	BN	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Source: DWR 2014a,b,c

Temperatures in the Trinity River within the Reservation boundary will be monitored based on water-year type as established by the TRFE and determined by the Bureau of Reclamation.

Activities that increase water temperatures must comply with Tribal and Federal anti-degradation policies. The responsible party must not increase water temperatures, even if caused by their actions coupled with natural factors (Hoopa Valley TEPA 2008). In some streams, the numeric objectives may not be attainable due to site specific limitations. If this is the case, and provided that the stream has been restored to its full site potential; and the salmonid population is at a level consistent with the National Marine Fisheries Service (NMFS) concept of a 'Viable Salmonid Population'(McElhany et al. 2000), then the Hoopa Valley TEPA may not be applicable.

6.3.2.2.2 Mercury

Trinity Lake and the upper hydrologic area of the East Fork Trinity River are two water bodies in the North Coast that were placed on the Section 303(d) list, approved by USEPA in 2010 (SWRCB 2011a), as impaired due to mercury. Mercury in Trinity Lake can be attributed to atmospheric deposition, natural sources, resource extractions, and other unknown sources (SWRCB 2011b). Significant mercury contamination is likely due to historical gold and mercury mining activities along the East Fork Trinity River at the inactive Altoona Mercury Mine (May et al. 2004).

The commercial or recreational collection of fish, shellfish, or organisms was deemed impaired since fish tissue exceeded USEPA's recommended Fish Tissue Residue Criteria for human health of 0.3 mg of methylmercury (wet weight) per kg of fish tissue (SWRCB 2011b-g). This criterion is based on the consumption-weighted rate of 0.0175 kg of total fish and shellfish per day. Fourteen out of fifty seven fish tissue samples from fish in the North and the East Fork of the lake in September 2001 and 2002 exceeded this fish tissue criterion. Composite fish tissue samples that exceeded the criterion were from White Catfish, Smallmouth Bass, and Chinook Salmon.

For the protection of marine aquatic life, water quality objectives for mercury were set for discharges within the area specified in the North Coast Region Water Quality Control Board Basin Plan as follows (NCRWQCB 2011).

- Six-Month Median: 0.04 µg/l
- Daily Maximum: 0.16 µg/l
- Instantaneous Maximum: 0.4 µg/l (conservative estimate for chronic toxicity)

In an effort to meet the water quality standards in Trinity Lake and the East Fork of Trinity River, a TMDL is expected to be completed by 2019. An approach for calculating effluent limitations was established in the NCRWQCB Basin Plan (NCRWQCB 2011).

6.3.2.2.3 Nutrients

The lower Klamath River was placed on the 303(d) list approved by the USEPA in 2010 for being impaired by nutrients (SWRCB 2011a). Nutrient levels in the Klamath Estuary may cease to be a limiting factor and can promote levels of algal growth that cause a nuisance or adversely affect beneficial uses when excess growth is not consumed by animals or exported by flows (DOI and DFG 2012).

The Klamath River receives the greatest nutrient loading from the Upper Klamath basin, comprising approximately 40 percent of its total contaminant load (NCRWQCB 2010). Tributaries to the Klamath River are the greatest contributors of the remaining nutrient loads, with the Trinity River contributing the most.

The Hoopa Valley TEPA also designates water quality objectives to address contamination by nutrients (Table 6.9).

Table 6.9 Specific Use Water Quality Criteria for Waters of the Hoopa Valley Indian Reservation

Contaminant	Trinity River	Klamath River
Maximum Annual Periphyton Biomass	–	150 mg chlorophyll *a*/m^2 of streambed area
pH	MUN-designated waters: 5.0 – 9.0 All other designated uses: 7.0 – 8.5	7.0 – 8.5
Total Nitrogen[1]	–	0.2 mg/l
Total Phosphorus[1]		0.035 mg/l
Microcystis aeruginosa cell density	–	< 5,000 cells/mL for drinking water < 40,000 cells/mL for recreational water
Microcystin toxin concentration		< 1 µg/l total microcystins for drinking water < 8 µg/l total microcystins for recreational water
Total potentially toxigenic blue-green algal species[2]		< 100,000 cells/mL for recreational water

Contaminant	Trinity River	Klamath River
Cyanobacterial scums		There shall be no presence of cyanobacterial scums

Source: Hoopa Valley TEPA 2008

1 There should be at least two samples per 30-day period. If total nitrogen and total phosphorus standards are not achievable due to natural conditions, then the standards shall instead be the natural conditions for total nitrogen and total phosphorus. Through consultation, the ongoing TMDL process for the Klamath River is expected to further define these natural conditions.

2 Includes: Anabaena, Microcystis, Planktothrix, Nostoc, Coelsphaerium, Anabaenopsis, Aphanizomenon, Gloeotrichia, and Oscillatoria.

In addition to the water quality criteria established by the Hoopa Valley TEPA (2008), the 2010 *Klamath River TMDLs Addressing Temperature, Dissolved Oxygen, Nutrient, and Microcystin Impairments in California* provides TMDLs for nutrients which address elevated pH levels (DOI and DFG 2012). Nutrient targets include numeric targets for total phosphorus (TP), total nitrogen (TN) (NCRWQCB 2010).

The Klamath River nutrient TMDLs are in the process of being implemented by the NCRWQCB and other affiliated agencies, including the SWRCB, the USEPA, Reclamation, the USFWS, the Oregon Department of Environmental Quality, responsible for implementation of the Klamath TMDLs in Oregon, and other state, federal, and private agencies with operations that affect the Klamath River (NCRWQCB 2010).

6.3.2.2.4 Organic Matter

The lower Klamath River was placed on the 303(d) list approved by the USEPA in 2010 for impairment due to organic enrichment (SWRCB 2011a).

The Klamath River has several natural sources of organic matter. The river originates from the Upper Klamath Lake, which is a naturally shallow, eutrophic lake, with high levels of organic matter (algae), including nitrogen fixing blue-green algae (NCRWQCB 2010). Other sources of organic matter include runoff from agricultural lands (i.e., irrigation tailwater, storm runoff, subsurface drainage, and animal waste), flow regulations/modification, industrial point sources, and municipal point sources (SWRCB 2011).

To protect the beneficial uses of the lower Klamath River, including cold freshwater habitat, a TMDL was established in 2010 for organic matter and other constituents. The TMDL equals 143,019 pounds of Carbonaceous Biochemical Oxygen Demand (CBOD) per day from the Klamath River (NCRWQCB 2011h). The average organic matter (measured as CBOD) loads from all other Klamath River tributaries are sufficient to meet other related objectives, including dissolved oxygen and biostimulatory substances objectives, in the Klamath River (NCRWQCB 2010). The dissolved oxygen objectives are the primary targets associated with organic matter as well as nutrients. Organic matter allocations were also established for the Klamath River below Salmon River, and the major tributaries to the Klamath, including Trinity River.

Implementation actions and other objectives were established to ensure the TMDL is met to protect the beneficial uses of the Klamath River and other water bodies downstream. The North Coast Basin Plan states that a water quality study will be completed to identify actions for monitoring, evaluating, and implementing any necessary actions to address organic matter loading so that the TMDL will be met (NCRWQCB 2011).

6.3.2.2.5 Dissolved Oxygen

The lower Klamath River was placed on the 303(d) list approved by the USEPA in 2010 for low dissolved oxygen (SWRCB 2011a).

Sources that contribute to low dissolved oxygen include sources of organic enrichment, specified in the previous section; water temperature; and salinity, explained further in Section 6.3.2.6. Other sources that contribute to low dissolved oxygen are runoff from roads and agriculture that can transport nutrients into water bodies and lower dissolved oxygen through biostimulatory effects (NCRWQCB 2010). Over-enrichment and growth of algae and aquatic plants can produce oxygen during the day through photosynthesis but those same plants can deplete dissolved oxygen at night.

To protect the beneficial uses of the lower Klamath River, including the cold freshwater habitat, water quality objectives were established in the North Coast Basin Plan (2010) and the Hoopa Valley TEPA (2008) for dissolved oxygen in the Klamath River and its major tributary, the Trinity River (Table 6.10 and Table 6.11) (NCRWQCB 2011). Site Specific Objectives (SSOs) for dissolved oxygen were calculated as part of TMDLs developed by the NCRWQCB (2011), and have been incorporated into the North Coast Basin Plan (2011) (Table 6.12). For those waters without location-specific dissolved oxygen criteria, dissolved oxygen shall not be reduced below minimum levels, shown in Table 6.13, at any time to protect beneficial uses.

Table 6.10 Water Quality Objectives for Dissolved Oxygen in Trinity and Lower Klamath

	Dissolved Oxygen (mg/l)	
Water body	**Minimum**	**50% Lower Limit[1]**
Trinity Lake and Lewiston Reservoir	7.0	10.0
Lower Trinity River	8.0	10.0
Lower Trinity Area Streams	9.0	10.0
Lower Klamath River Area Streams	8.0	10.0

Source: NCRWQCB 2011

1: 50 percent lower limit represents the 50 percentile values of the monthly means for a calendar year. 50 percent or more of the monthly means must be greater than or equal to the lower limit.

Table 6.11 Specific Use Water Quality Criteria for Waters of the Hoopa Valley Indian Reservation

Contaminant	Trinity River	Klamath River
Minimum Water Column Dissolved Oxygen Concentration	11.0 mg/l	SPWN-designated waters[1]: 11.0 mg/l[2] COLD-designated waters: 8.0 mg/l[2]
Minimum Inter-gravel Dissolved Oxygen Concentration	8.0 mg/l	SPWN-designated waters[1]: 8.0 mg/l[2]

Source: Hoopa Valley TEPA 2008

1 Whenever spawning occurs, has occurred in the past or has potential to occur.

2 7-day moving average of the daily minimum DO. If dissolved oxygen standards are not achievable due to natural conditions, the COLD and SPWN standard shall instead be dissolved oxygen concentrations equivalent to 90 percent saturation under natural receiving water temperatures.

Table 6.12 Site Specific Objectives for Dissolved Oxygen in the Klamath River[1]

Location[2]	Percent Dissolved Oxygen Saturation Based On Natural Receiving Water Temperatures[3]	Time Period
Downstream of Hoopa-California Boundary to Turwar	85	June 1 through August 31
	90	September 1 through May 31
Upper and Middle Estuary	80	August 1 through August 31
	85	September 1 through October 31 and June 1 through July 31
	90	November 1 through May 31
Lower Estuary	For the protection of estuarine habitat (EST), the dissolved oxygen content of the Lower Klamath estuary shall not be depressed to levels adversely affecting beneficial uses as a result of controllable water quality factors.	

Source: NCRWQCB 2011

1 States may establish site specific objectives equal to natural background (USEPA 1986a. Ambient Water Quality Criteria for Dissolved Oxygen, EPA 440/5-86-033; USEPA Memo from Tudor T. Davies, Director of Office of Science and Technology, USEPA Washington, D.C. dated November 5, 1997). For aquatic life uses, where the natural background condition for a specific parameter is documented, by definition that condition is sufficient to support the level of aquatic life expected to occur naturally at the site absent any interference by humans (Davies 1997). These dissolved oxygen objectives are derived from the T1BSR run of the Klamath TMDL model and described in Tetra Tech, December 23, 2009 Modeling Scenarios: Klamath River Model for TMDL Development (Tetra Tech and WR and TMDL Center 2009). They represent natural dissolved oxygen background conditions due only to non-anthropogenic sources and a natural flow regime.

2 These objectives apply to the maximum extent allowed by law. To the extent that the State lacks jurisdiction, the Site Specific Dissolved Oxygen Objectives for the Mainstem Klamath River are extended as a recommendation to the applicable regulatory authority.

3 Corresponding dissolved oxygen concentrations are calculated as daily minima, based on site-specific barometric pressure, site-specific salinity, and natural receiving water temperatures as estimated by the T1BSR run of the Klamath TMDL model and described in Tetra Tech, December 23, 2009 (Tetra Tech and WR and TMDL Center 2009). Modeling Scenarios: Klamath River Model for TMDL Development. The estimates of natural receiving water temperatures used in these calculations may be updated as new data or method(s) become available. After opportunity for public comment, any update or improvements to the estimate of natural receiving water temperature must be reviewed and approved by Executive Officer before being used for this purpose.

Table 6.13 Water Quality Objectives for Dissolved Oxygen for Specified Beneficial Uses

Beneficial Use Designation	**Minimum Dissolved Oxygen Limit (mg/l)**
WARM, MAR, or SAL	5.0
COLD	6.0
SPWN	7.0
SPWN – during critical spawning and egg incubation periods	9.0
Klamath River Water Column[1] SPWN-designated waters[2]: COLD-designated waters:	 11.0 mg/l[3] 8.0 mg/l[3]
Klamath River Inter Gravel[1] SPWN-designated waters[2]:	8.0 mg/l[3]

Source: NCRWQCB 2011

1 Hoopa Valley TEPA (2008)

2 Whenever spawning occurs, has occurred in the past or has potential to occur.

3 7-day moving average of the daily minimum DO. If dissolved oxygen standards are not achievable due to natural conditions, the COLD and SPWN standard shall instead be

dissolved oxygen concentrations equivalent to 90 percent saturation under natural receiving water temperatures.

The 2010 *Klamath River TMDLs Addressing Temperature, Dissolved Oxygen, Nutrient, and Microcystin Impairments in California* provide numerical targets for dissolved oxygen and other constituents (NCRWQCB 2010). Site specific objectives for dissolved oxygen were proposed in this TMDL and adopted into the North Coast Basin Plan (Table 6.29). The dissolved oxygen objectives are the primary targets associated with nutrient and organic matter, with additional dissolved oxygen-related TMDLs prescribed for total phosphorus (TP), total nitrogen (TN) and organic matter (CBOD) loading, and numerical targets provided for benthic algae biomass, suspended algae chlorophyll-a, *microcystis aeruginosa*, and microcystin toxin discussed in their corresponding sections.

Plans to monitor dissolved oxygen and other constituents in the Klamath River below Trinity River, near Turwar, and the Klamath River Estuary were established in Chapter 7 of the Klamath River TMDLs to further protect the beneficial uses of the Trinity and lower Klamath Rivers (NCRWQCB 2010). The TMDL also includes a proposal to revise SSOs for dissolved oxygen in the Klamath River.

6.3.2.2.6 Sedimentation and Siltation

Sedimentation and siltation are not caused by operation of the CVP. However, the lower Klamath River and Trinity River were placed on the 303(d) list approved in 2010 as impaired by sedimentation and siltation (SWRCB 2011a).

Trinity River

Disturbance of sediment and silt is a natural part of stream ecosystems, which can contribute to fluctuating salmonid populations in response to fine sediment embedded in spawning gravels. However, human activities have resulted in an increased severity and frequency of habitat disturbance (TRRP and NCRWQCB 2009). In the Mainstem Trinity River, sediment loading can be attributed to runoff from areas of active or past mining, timber harvest, and road-related activities. Natural sources, such as landsliding, bank erosion, and soil creep, contribute the greatest sediment loads each year (NCRWQCB 2008). Future point sources of sedimentation into the Trinity River Basin, including CalTrans facilities and construction sites larger than five acres have to meet discharge requirements pursuant to California's NPDES general permit for construction site runoff (USEPA 2001f).

The primary adverse impacts of excess sedimentation are those affecting the spawning habitat for anadromous salmonids (TRRP and NCRWQCB 2009). The main affected beneficial uses include commercial or sport fishing, cold fresh water habitat, migration of aquatic organisms, spawning, reproduction, and/or early development; and rare, threatened and endangered species. Recreation in the Trinity River Basin, such as boating, fishing, camping, swimming, sightseeing, and hiking, is also potentially affected because sedimentation can affect the water clarity and water quality (USEPA 2001f). Water quality objectives for sedimentation and siltation were established in the North Coast Basin Plan.

Turbidity criteria for all waters within the Hoopa Valley Indian Reservation are also under development (Hoopa Valley TEPA 2008).

In addition to these water quality objectives, the North Coast Basin Plan also prohibits the discharge of soil, silt, bark, sawdust, or other organic and earthen material from any logging, construction, or associated activity into any stream or watercourse in quantities harmful to beneficial uses, and the placing or disposal of such materials in locations where they can pass into any stream or watercourse in quantities harmful to beneficial uses (NCRWQCB 2011).

Sediment loading in the mainstem Trinity River exceeds applicable water quality standards, and is being addressed by the Trinity River TMDL for sediment, approved by the USEPA in December 2001 (SWRCB 2011b-g, USEPA 2001f). Assimilation capacity for sediment loading was determined for this TMDL and the percent reduction of managed sediment discharge required to meet the TMDL is provided for each subarea. These allocations are adequate to protect aquatic habitat, and are expected to be evaluated on a ten year rolling basis (USEPA 2001f).

Lower Klamath River

The Klamath River downstream of Weitchpec has also been included on the 303(d) list for contamination from sedimentation and siltation, due to exceedances of the sediment water quality criteria, and long-term sedimentation and siltation influxes (SWRCB 2011h).

Major sources of sediment discharge in the lower Klamath River are from ongoing logging and runoff from major storm events. According to reports cited by the SWRCB, water quality in runoff from timber harvest in all lower Klamath watersheds exceed cumulative effect thresholds (SWRCB 2011h).

The *Long Range Plan for the Klamath River Basin Fishery Conservation Area Restoration Program* (1986 to 2006) emphasizes sedimentation in the lower Klamath Basin, and notes that the sediment is creating problems with fish passage and stream bed stability (Klamath River Basin Fisheries Task Force 1991). The near extinction of the eulachon indicated problems with sediment supply, size and bed load movement, and that aggradations in salmon spawning reaches are expected to persist for decades (SWRCB 2011h). Increased sediment loads also result from the widening of stream channels, through processes like bank erosion, and with the related reduction of riparian shade can contribute to elevated stream temperatures (NCRWQCB 2010). The North Coast Basin Plan includes the TMDLs for the region, which include those that address sedimentation and siltation (NCRWQCB 2011).

6.3.3 Central Valley Region

6.3.3.1 Sacramento Valley

Major watersheds within the Sacramento Valley that could be affected by CVP and SWP operations include the Sacramento River, Feather River, and the lower American River watersheds.

This water quality analysis section focuses on Shasta Lake, Keswick Reservoir, Whiskeytown Lake, Spring Creek and Clear Creek; the Sacramento River from Shasta Lake to the Delta (near Freeport); the Feather River below Lake Oroville; American River below Lake Natoma; and Yolo Bypass.

Beneficial uses for the Sacramento Valley, as defined in the Central Valley Basin Plan, are summarized in Table 6.2. The constituents of concern that are currently not in compliance with existing water quality standards and for which TMDLs are adopted or are in development in this region are summarized in Table 6.1.

6.3.3.1.1 Sacramento River from Shasta Lake to Verona

Water quality in the upper Sacramento River is influenced by releases from Shasta Lake and diversions from Trinity Lake. Annual and seasonal flows in the Sacramento River watershed are highly variable from year to year, as described in Chapter 5, Surface Water Resources and Water Supplies. These variations in flow are a source of variability in water quality in the Sacramento drainage.

The water quality constituents that are currently not in compliance with existing water quality standards and for which TMDLs are adopted or are in development in this region are: mercury, PCBs, unknown toxicity and multiple pesticides. Chlorpyrifos and diazinon have been addressed by changes to the Basin Plan, cadmium, copper, zinc have been addressed by a TMDL, and temperature is also closely monitored.

Water Temperature

The Sacramento River was not placed on the 303(d) list approved by the USEPA in 2010 as impaired by water temperature (SWRCB 2011a). However, water bodies in the Upper Sacramento River watershed support the beneficial uses of both warm and cold fresh water habitat, which require that the water bodies maintain water temperatures suitable for multiple fish species (CVRWQCB 2011). Water quality objectives have been established by the SWRCB for Sacramento River, as summarized in Table 6.14 and Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. Compliance locations in the upper Sacramento River basin are shown in Figure 6.2. Performance measures to meet temperature requirements are included in the 2009 NMFS BO, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations.

Table 6.14 Water Quality Objectives for Temperature in the Sacramento River

Applicable Water Bodies	Objective
Sacramento River from Keswick Dam to Hamilton City	> 56º F
Sacramento River from Hamilton City to the I Street Bridge (during periods when temperature increases will be detrimental to the fishery)	> 68º F

Source: CVRWQCB 2011

Table 6.15 and Figure 6.3 depict monthly water temperature data at selected compliance locations in the Sacramento River between 2001 and 2012.

Table 6.15 Monthly Average of Water Temperatures Recorded at Sacramento River Compliance Locations in °F

WY	WYT	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Balls Ferry													
2001	D	55.0	53.2	51.4	47.9	47.0	51.5	52.5	52.9	53.6	54.5	54.3	55.3
2002	D	56.1	54.3	50.0	49.4	48.8	50.5	53.9	53.7	53.7	54.4	54.4	54.0
2003	AN	54.4	54.2	50.0	49.6	49.3	51.7	53.2	53.3	53.5	53.6	54.9	55.4
2004	BN	54.7	52.6	50.2	48.3	47.6	50.9	52.5	53.0	53.7	54.5	54.6	56.7
2005	AN	56.5	54.9	50.6	48.8	50.0	52.1	54.1	54.2	53.5	54.0	55.4	55.6
2006	W	56.2	54.5	50.5	ND	47.8	47.7	49.7	52.7	52.8	53.6	53.8	53.5
2007	D	53.4	52.4	49.7	47.7	48.4	52.0	54.0	52.9	53.8	55.2	55.1	55.7
2008	C	55.9	55.3	50.1	45.7	46.8	49.8	50.9	52.9	55.6	56.0	56.4	57.0
2009	D	58.1	55.8	50.1	47.5	47.8	50.6	51.6	53.8	55.0	56.0	56.0	56.5
2010	BN	56.5	55.1	49.4	48.3	49.6	50.9	52.5	54.0	53.5	53.9	54.2	54.2
2011	W	54.0	51.3	51.2	49.2	48.0	48.8	51.8	54.1	53.6	53.6	54.3	54.0
2012	BN	53.1	51.2	49.6	48.4	48.6	49.6	53.6	54.5	53.4	53.6	54.0	54.1
WY	**WYT**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Jelly's Ferry													
2001	D	55.5	52.9	51.1	47.5	47.0	52.3	53.6	54.5	54.7	55.6	55.6	56.3
2002	D	56.7	54.4	49.1	47.9	48.6	51.0	55.4	55.1	55.1	55.6	55.5	55.1
2003	AN	54.9	54.1	50.3	50.0	49.0	52.4	53.4	54.5	55.4	55.0	56.0	56.6
2004	BN	55.3	52.5	50.0	47.9	48.1	52.0	54.0	54.7	55.1	55.5	55.8	57.5
2005	AN	56.8	54.6	50.2	48.4	50.3	52.8	55.3	55.6	55.3	55.6	56.7	56.5
2006	W	56.5	54.3	49.9	49.1	48.3	47.9	50.7	54.6	54.8	55.1	55.0	54.6
2007	D	54.2	52.6	49.0	47.1	48.7	52.8	55.0	54.2	54.9	56.0	56.0	56.6
2008	C	56.3	55.4	49.6	45.4	47.0	50.5	52.2	54.5	56.6	56.9	57.3	58.0
2009	D	58.0	55.8	49.8	47.4	47.9	51.2	53.3	55.7	56.4	57.1	57.0	57.8
2010	BN	57.1	54.9	48.9	48.0	49.7	51.7	53.3	55.2	55.4	55.6	55.3	55.2
2011	W	54.6	51.3	50.9	48.9	47.8	48.7	52.2	55.3	55.2	55.0	55.4	55.2
2012	BN	53.7	51.2	49.1	48.1	48.8	49.9	54.4	56.0	54.8	54.6	55.1	55.3

WY	WYT	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
WY	**WYT**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Bend Bridge													
2001	D	55.7	52.8	50.8	47.3	47.0	52.6	54.1	55.0	55.1	56.0	56.0	56.8
2002	D	56.9	54.4	49.0	48.1	48.9	51.2	55.8	55.6	55.6	56.0	56.2	55.6
2003	AN	55.1	53.9	50.2	50.0	49.0	52.6	53.8	54.7	55.9	55.4	56.7	57.0
2004	BN	55.5	52.3	49.4	48.0	48.2	52.2	54.2	55.5	55.6	56.1	56.2	57.9
2005	AN	57.0	54.4	50.0	48.3	50.4	53.1	55.7	55.9	55.5	56.0	57.2	56.9
2006	W	56.6	54.2	50.0	49.2	48.4	48.0	50.7	54.9	55.1	55.6	55.4	54.9
2007	D	54.4	52.3	49.1	46.9	48.8	52.9	55.1	54.9	55.5	56.6	56.6	57.0
2008	C	56.4	55.1	49.3	45.6	47.1	51.0	52.6	55.0	57.4	57.5	57.9	58.5
2009	D	57.4	55.8	49.4	47.3	48.1	52.0	53.6	56.1	56.9	57.7	57.2	58.0
2010	BN	57.0	54.8	48.6	47.9	49.6	51.6	53.3	55.4	55.5	56.2	56.2	55.8
2011	W	54.4	51.0	50.7	49.0	48.0	49.0	52.5	55.7	55.6	55.8	56.2	55.6
2012	BN	53.9	51.3	48.8	47.9	48.9	49.9	54.8	56.5	55.4	55.1	55.5	55.8

Source: Reclamation 2013b

Mercury

The USEPA approved a new decision to place Shasta Lake, Whiskeytown Lake, Clear Creek, and the Sacramento River from Cottonwood Creek to Red Bluff, on the Section 303(d) list in 2010 for mercury contamination (SWRCB 2011a). The Sacramento River from Red Bluff to Knights Landing has been on the 303(d) list for mercury prior to the final decision in 2010. Mercury is not a constituent of concern for the Sacramento River between Shasta Dam and the Cottonwood Creek.

Mercury in the Sacramento River Basin can be attributed to resource extraction as described in Section 6.3.2 (SWRCB 2011i-l). Significant gold mining activity took place within the Whiskeytown watershed, lands inundated by Whiskeytown Reservoir, in the Clear Creek watershed between Whiskeytown Reservoir, the confluence with the Sacramento River, and within the Sacramento River watershed.

A 2008 CALFED report tabulates methylmercury concentrations in the Sacramento River from Redding (0.3ng/l) to Freeport (0.11 ng/l) from 2003 to 2006 (Foe et al. 2008). For the 2010 listing, composite fish tissue samples were collected from Shasta Lake, Whiskeytown Lake, Clear Creek, and the Sacramento River from Cottonwood Creek to Knights Landing. The commercial or recreational collection of fish, shellfish, or organisms were deemed impaired since fish tissue exceeded USEPA's recommended Fish Tissue Residue Criteria for human health of 0.3 mg of methylmercury (wet weight) per kg of fish tissue (SWRCB 2011i-l).

In an effort to protect the beneficial uses of these water bodies, including the protection of aquatic and human health, USEPA has recommended maximum exposure concentrations. In addition, a TMDL is expected to be completed in 2021 to meet the water quality standards in these water bodies (SWRCB 2011i-l).

Cadmium, Copper, and Zinc

Shasta Lake where West Squaw Creek enters the lake, Spring Creek (from Iron Mountain Mine to Keswick Reservoir), and Keswick Reservoir downstream of Spring Creek were placed on the 303(d) list approved by the USEPA in 2010 for impairment by cadmium, copper, and zinc (SWRCB 2011a). The Upper Sacramento River from Keswick Dam to Cottonwood Creek was previously listed on the 303(d) list for impairment by cadmium, copper, and zinc but was delisted after a TMDL was completed in 2002 and the SWRCB determined the water quality standard was met. The elevated levels were primarily the result of acid mine drainage discharged from inactive mines in the upper Sacramento River watershed, located upstream of Shasta and Keswick dams (CVRWQCB 2002a). There are projects underway to clean up many inactive mine sites that discharge high concentrations of metals (CVRWQCB 2011).

Cadmium, copper and zinc contamination in the Sacramento River have been addressed by the *2002 Upper Sacramento River TMDL for Cadmium, Copper and Zinc*, and by water quality objectives in the Basin Plan (CVRWQCB 2002a). Although cadmium, copper, and zinc are generally found as mixtures in surface water, the mixtures tend to be antagonistic – less toxic than when found as individual components – thus the water quality objectives focus on individual parameters. Levels of water hardness affect the toxicity of these metals, where increased hardness decreases toxicity. Thus the water quality objectives at certain locations are determined using specific levels of water hardness (CVRWQCB 2002a). The TMDL for cadmium, copper, and zinc in Shasta Lake, Spring Creek, and Keswick Reservoir is expected to be completed in 2020 (SWRCB 2011i,m,n).

Pesticides

The Sacramento River from Red Bluff to Knights Landing was placed on the 303(d) list approved by the USEPA in 2010 as impaired by DDT and the Group A pesticide dieldrin. The Sacramento River from Knights Landing to the Delta was also placed on the 303(d) list as impaired by chlordane, DDT, and dieldrin (SWRCB 2011a). Chlordane, DDT, and dieldrin are legacy pesticides and were discontinued from the early 1970s to the late 1980s.

Although these pesticides have been discontinued since the late 1980's, the narrative water quality objective for toxicity, which applies to single or the interactive effect of multiple pesticides or substances, and states that "All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life" has not been met. Fish concentrations of DDT collected in 2005 exceeded the Total DDT OEHHA screening value of 21 µg/kg by up to five times, which was used as a criterion to evaluate the narrative water quality objective by up to five times. Concentrations of dieldrin were also found to exceed the OEHHA Evaluation Guideline of 0.46 µg/kg (SWRCB 2011o).

To protect the beneficial uses of the Sacramento River and other water bodies downstream, including the impaired commercial or recreational collection of fish, shellfish, or organisms, TMDLs for DDT and dieldrin in the Sacramento River from Red Bluff to Knights Landing are expected to be completed in 2021 (SWRCB 2011o). For the Sacramento River from Knights Landing to the Delta, TMDLs are expected to be completed in 2021 for DDT and chlordane, and in 2022 for dieldrin.

Although the Sacramento River was not placed on the 303(d) list approved by the USEPA in 2010 for chlorpyrifos and diazinon contamination, these pesticides have also been of concern in the Sacramento River (SWRCB 2011o, CVRWQCB 2007a). Water quality sampling from 1999 to 2006 revealed concentrations of both pesticides at levels of concern in the Sacramento and Feather Rivers. In addition to runoff of applied pesticides into irrigation and storm water runoff into the Sacramento and Feather Rivers, atmospheric transport of diazinon from the Central Valley to the Sierra Nevada Mountains has been noted to occur. Of particular concern were the beneficial uses of Warm and Cold Fresh water Habitat.

PCBs

The reach of the Sacramento River from Red Bluff to Knights Landing was placed on the 303(d) list approved by the USEPA in 2010 as impaired by PCBs (SWRCB 2011a). According to the *Final California 2010 Integrated Report* (303(d)/305(b) Report) Supporting Information, sources of PCBs in Sacramento River are unknown (SWRCB 2011o). PCBs, a group of synthetic organic chemicals, were manufactured from 1930 to 1977 and were banned in 1979. However, these organic pollutants persistent in the environment (ATSDR 2000).

The OEHHA Fish Contaminant Goal of total PCBs in fish is 3.6 ppb (or 3.6 ng/g) (SWRCB 2011o). Fish tissue samples collected in August and October 2005 exhibited significant exceedances. Six composite samples were analyzed for 48 individual PCB congeners and four Aroclor mixtures, with the four exceedances reported as 102.499 ng/g in channel catfish at Colusa, 9.151 ng/g in channel catfish at Grimes, 6.504 ng/g in Sacramento sucker at Colusa, and 5.767 ng/g in Sacramento sucker at Woodson Bridge.

To protect the beneficial uses of the Sacramento River, including the impaired beneficial use of commercial and sport fishing, a TMDL is expected to be completed in 2021 (SWRCB 2011o).

Unknown Toxicity

The Sacramento River from Keswick Reservoir to Knights Landing was placed on the 303(d) list as impaired for unknown toxicity (SWRCB 2011a).

Results of survival, growth, and reproductive toxicity tests performed from 1998 to 2007 showed an increase in mortality and a reduction in growth and reproduction in *C. dubia*, the Fathead Minnow *Pimephales promelas* (*P. promelas*) and the alga *Pseudokirchneriella subcapitata* (*P. subcapitata*, formerly known as *Selenastrum capricornutum*) (SWRCB 2011l,o-q). Observations violated the narrative toxicity objective found in the Sacramento – San Joaquin River Basin Plan, which states that all waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, or aquatic life (CVRWQCB 2011). This objective applies regardless of whether the toxicity is caused by a single substance or the interactive effect of multiple substances. Further research is being conducted on the causes of toxicity in the Sacramento River. The TMDL for unknown toxicity in the Upper Sacramento River is expected to be completed in 2019 (SWRCB 2011l,o-q).

A 2012 SWAMP report summarized the occurrences and causes of toxicity in the Central Valley (Markiewicz et al.2012). The SWRCB's Surface Water Ambient Monitoring Program (SWAMP) defines toxicity as a statistically significant adverse impact on standard aquatic test organisms in laboratory exposures. In order to assess the causes of toxicity in California waterways, SWAMP testing uses laboratory test organisms as surrogates for aquatic species in the environment (Anderson et al.2011).

Sediment toxicity was noted to be higher in urban areas including Sacramento, Yuba City, Redding, and Antioch, while sediments from agricultural areas were generally non-toxic (Markiewicz et al.2012). Moderate water toxicity was observed throughout the agricultural and urban-agricultural areas in the upper Sacramento watershed, including in the Colusa Basin, in the vicinity of the Sutter Buttes, and along the eastern valley floor between Chico and Lincoln.

SWAMP studies indicate that the replacement of organophosphate pesticides by pyrethroids has resulted in an increased contribution of pyrethroids to ambient water and sediment toxicity (Anderson et al. 2011). With regard to sediment, as indicated by H. azteca, the majority of toxicity has been attributed to pyrethroids, particularly in urban areas (Markiewicz et al. 2012). Of the pyrethroid pesticides, bifenthrin is of major concern.

6.3.3.1.2 Sacramento River from Verona to Freeport

The water quality of the lower Sacramento River is influenced by the upstream sources discussed above as well as by inflows from the American River and from surrounding urban and agricultural runoff. The major water quality constituents of concern are described below. Water temperature is not a major concern in this lower reach of the Sacramento River because the vitality of aquatic species in this reach are not dependent on temperature.

Mercury

The Sacramento River from Verona to Freeport is on the 303(d) list approved by USEPA in 2010 for mercury contamination (SWRCB 2011a).

Mercury in this reach of the river can be attributed to waterborne inputs from the upper Sacramento River, Feather River, Yuba River, and American River (SWRCB 2011q). These major tributaries are also listed as impaired due to mercury. As in the Klamath and Trinity River basins, historic mining has resulted in significant mercury contamination in the Sacramento River Basin.

Flows from the Yuba River are an important source of mercury loading to the lower Sacramento River. Tailings discharged from gold mines in the Sierra Nevada mountains during the nineteenth century contained significant amounts of mercury-laden sediment, due to the use of mercury to extract gold. These discharges caused the formation of anthropogenic alluvial fans at the base of the Sierra Nevada, most notably the Yuba Fan. Singer et al. (2013) predicted that mercury-laden sediment from the original fan deposit will continue to be transported to the Sacramento River for the next 10,000 years.

The Sacramento River is a key source of mercury contamination into the Sacramento – San Joaquin River Delta. Over 80 percent of total mercury flux to the Delta can be attributed to the Sacramento River Basin (CVRWQCB 2010a). The CVRWQCB (2010a) compiled data from 2000 to 2003 and reported an average of 0.10 ng/l in the Sacramento River at Freeport. Similarly, CALFED reported that the Sacramento River at Freeport contributed an average of 0.11 ng/l of methylmercury to the Delta from 2003 to 2006 (Foe et al. 2008).

Water samples were collected from the lower Sacramento River and its tributaries from March 2003 to June 2006 (Foe et al. 2008). For comparison, concentrations in samples from the upper Sacramento River from Redding to Colusa were lower, ranging from 0.03 to 0.10 ng/l. Major tributaries to the lower Sacramento River, including the Feather River (0.05 ng/l), American River (0.06 ng/l), Colusa Basin Drain (0.21 ng/l), and Yuba River (0.05 ng/l), contributed to the mean methylmercury concentration of 0.11 ng/l at Freeport in the Sacramento River.

The commercial or recreational collection of fish, shellfish, or organisms were deemed impaired prior to the current 303(d) list approved in 2010 (SWRCB 2011q). However, no new data were available to be assessed for this updated listing.

Table 6.16 presents streambed sediment mercury concentrations from the Sacramento River and Delta regions in 1995, sampled as part of the National Water Quality Assessment (NWQA) Program for the Sacramento River Basin (MacCoy and Domagalski 1999). Limited data for mercury in sediment exist; however, these data exhibit levels of mercury greatly exceeding the average amount of mercury found on the earth's surface, of about 0.05 µg/g. The highest streambed sediment concentrations of mercury were measured downstream from the Sierra Nevada and Coast Ranges. Within the Sacramento River, sites downstream of the Feather River had higher concentrations of mercury than sampled locations upstream of this confluence. The highest reported mercury concentrations were from the Yuba River, Bear River, Sacramento River at Verona, and the Feather River which exceeded the threshold effect concentration (0.18 µg/g), but not the probable effect concentration (1.06 µg/g) reported by MacDonald et al. (2000).

Table 6.15 Streambed sediment concentrations of mercury in the Sacramento River and Delta regions

Water body/Site	Concentration
Feather River sites	
Feather River	0.21 µg/g
Yuba River	0.37 µg/g
Bear River	0.37 µg/g
Feather & Sacramento Rivers Downstream of the confluence at Verona	0.24 µg/g
Sacramento River sites	
Bend Bridge	0.16 µg/g
Freeport	0.14 µg/g
Cache Creek	0.15 µg/g
Arcade Creek	0.13 µg/g
American River	0.16 µg/g

Source: MacCoy and Domagalski 1999

Reported in bottom material <63 micron fraction dry weight.

* Concentration exceeds the MacDonald et al. (2000) threshold effect concentration (0.18 µg/g dry weight) but not the probable effect concentration (1.06 µg/g dry weight).

In an effort to protect the beneficial uses of the Sacramento River, including the impaired commercial and recreational collection of fish, shellfish, or organisms, the CVRWQCB (2011) made recommendations for the future reduction of mercury contamination. Additionally, the Delta Mercury Control Program (MERP 2012) provides potential load allocations for mercury pertaining to the Sacramento River and the Yolo Bypass, while the Cache Creek Watershed Mercury Program provides load allocations for Cache Creek, Bear Creek, Sulphur Creek, and Harley Gulch.

Pesticides

The Sacramento River was placed on the 303(d) list approved by the USEPA in 2010 as impaired by the pesticides chlordane, DDT, and dieldrin from Knights Landing to the Delta. These three pesticides listings were based on the evaluation of fish contaminant data from 2005. Chlordane, DDT, and dieldrin are legacy pesticides that were discontinued from the early 1970s to the late 1980s. However, samples collected in the Sacramento River at the Veterans Bridge in September 2005 revealed elevated pesticide concentrations (SWRCB 2011q).

A composite sample of carp and a composite sample of channel catfish had total chlordane concentrations of 6.72 µg/kg and 10.20 µg/kg, respectively, both exceeding OEHHAs (2008) FCG of 5.6 µg/kg for total chlordane in fish tissue (SWRCB 2011q).

Composite samples of carp and Channel Catfish contained total DDT concentrations of 59. µg/kg and 109. µg/kg, respectively. These concentrations exceeded the OEHHAs (2008) FCG of 21 µg/kg (SWRCB 2011q).

Composite samples of carp and Channel Catfish contained total dieldrin concentrations of 0.98 µg/kg and 1.49 µg/kg, respectively, These concentrations both exceeded the OEHHAs (2008) FCG of 0.46 µg/kg (SWRCB 2011q).

PCBs

The Sacramento River from Knights Landing to the Delta was placed on the 303(d) list approved by the USEPA in 2010 as impaired by PCBs (SWRCB 2011a).

According to the Final California 2010 Integrated Report (303(d)/305(b) Report) Supporting Information, sources of PCBs in this reach of the Sacramento River are unknown (SWRCB 2011q).

The Sacramento River from Knights Landing to the Delta has also been newly listed as contaminated by PCBs. Three of three composite samples analyzed for total PCBs in September 2005 exceeded the OEHHA Fish Contaminant Goal for total PCBs of 3.6 ppb (or 3.6 ng/g), wet weight. The exceeding concentrations were recorded at 53 ng/g in channel catfish, 6.0 ng/g in Sacramento sucker, and 26 in carp (SWRCB 2011q).

A TMDL for PCBs in the Sacramento River from Knights Landing to the Delta is expected to be completed in 2021 to protect the beneficial uses of the Sacramento River and downstream waterbodies (SWRCB 2011q).

Dissolved Oxygen

The Sacramento River was not placed on the 303(d) list approved by the USEPA in 2010 for low dissolved oxygen (SWRCB 2011a).

Salinity, Electrical Conductivity, and Total Dissolved Solids

The Sacramento River was not placed on the 303(d) list approved by the USEPA in 2010 as impaired by salinity (SWRCB 2011a).

Selenium

Water bodies in the Sacramento River Basin were not listed on the 303(d) list as impaired by selenium. Waterborne selenium concentrations in the Sacramento River near Verona are relatively low compared to concentrations in the San Joaquin River Basin. However, the much larger flow that the Sacramento River contributes to the Delta, in comparison to the San Joaquin River, results in a substantial contribution to the mass loading of selenium to the Delta from the Sacramento River (Cutter and Cutter 2004; SWRCB 2008a). Loads to the Delta from the Sacramento River were projected to be about half of what the Grasslands basin was projected to contribute to the San Joaquin River, with subsequent loading to the Delta from the San Joaquin River dependent on flow (Presser and Luoma 2006).

Data for selenium in fish from the Sacramento River are limited, but Largemouth Bass were sampled in 1999, 2000, 2005, and 2007 from the lower Sacramento

River, San Joaquin River, and Delta by the CVRWQCB. The fillet data and whole-body selenium concentrations, estimated using an equation from Saiki et al. (1991), were used to evaluate potential human and wildlife health risks (Foe 2010). Selenium concentrations in fillets and whole bodies of the bass from the Sacramento River at Veterans Bridge were well below the draft criteria released in May 2014 (11.8 mg/kg for fillets and 8.1 mg/kg for whole body) (USEPA 2014b).

Unknown Toxicity

The Sacramento River from Knights Landing to the Delta is listed as impaired by toxicity due to the results of survival, growth and reproductive toxicity tests performed in 2006 and 2007. Observations of increased mortality and reduction in growth and reproduction in *C. dubia* and *P. promelas* compared to laboratory controls violated the narrative toxicity objective of the Basin Plan. The TMDL for toxicity in this reach of the river is expected to be completed in 2019 (SWRCB 2011q).

6.3.3.1.3 Colusa Basin Drain

The Colusa Basin Drain receives inflow from local creeks and discharge and runoff from the Colusa agricultural basin. Under conditions of low water levels, it drains by gravity into the Sacramento River at Knights Landing; however, when the water levels at Knights Landing are too high for this gravity flow to occur, discharge from the Colusa Basin Drain is routed directly to the Yolo Bypass through the Ridge Cut canal (USGS 2002). During the non-storm season, flows from the Colusa Basin Drain can contribute over ten percent of Sacramento River flows at Verona when there are floods in the Colusa Basin, high irrigation discharges, and/or low Sacramento River flows (Colusa Basin Drain Steering Committee 2005).

Beneficial uses designated for the Colusa Basin Drain include agricultural irrigation and stock watering, water contact recreation, and warm and cold water habitat, migration and spawning for aquatic biota (CVRWQCB 2011). In spite of the many uses of the waterway, the Colusa Basin Drain is listed as impaired for numerous contaminants. Water quality constituents of concern impact both local beneficial uses and the water quality of receiving waterways, including the Sacramento River and the Yolo Bypass. Suspended solids, agricultural chemicals, heavy metals and organic matter are often present in concentrations that exceed those in the Sacramento, Feather, and American Rivers (Colusa Basin Drain Steering Committee 2005, SWRCB 2011r, USGS 2002)

Mercury

The Colusa Basin Drain is listed on the 303(d) list for contamination by mercury due to multiple exceedances of the USEPA Fish Tissue Residue Criterion for methylmercury in fish of 0.3 mg/kg (or 0.3 ppm) for the protection of human health (SWRCB 2011r). Samples exceeding the criterion included two of seven samples collected at the County Road 99E bridge crossing between 1997 and 2002 (one carp composite sample with a concentration of 0.41 ppm and one white catfish composite sample with concentration of 0.30 ppm) and one of ten samples collected in the Colusa Basin Drain at Abel Road between 1980 and 1988 (one brown bullhead composite sample with concentration of 0.58 ppm).

The Delta mercury TMDL study reported an average concentrations of methylmercury in the Colusa Basin Drain was reported to be 0.214 ng/l between 2000 and 2003. The Colusa Basin Drain contributed 3.3 percent of total mercury inputs to the Sacramento Basin between 1984 and 2003 (CVRWQCB 2010a). A TMDL for the Colusa Basin Drain is expected to be completed in 2021 (SWRCB 2011r).

Pesticides

The Colusa Basin Drain is listed as contaminated by the organophosphate pesticides azinphos-methyl (Guthion), diazinon, DDT and malathion. Azinphos-methyl and malathion have been included on the 303(d) list since 2006; thus, supporting information for their listing is not readily available. However, diazinon has been listed due to samples collected between 1996 and 2000 and again in 2004 exceeding the CDFW acute criterion of 0.16 µg/l one hour average. Samples collected in 2004 also exceeded the four day average criterion of 0.10 µg/l. Diazinon was addressed by a 2008 basin plan amendment but has not been removed from the 303(d) list (SWRCB 2011r).

Two of two samples assessed for DDT in the Colusa Basin Drain in 2005 greatly exceeded the OEHHA 2008 FCG for DDT, of 21 µg/kg of total DDT in fish tissue. Concentrations of 44.009 µg/kg and 65.903 µg/kg were recorded in composite samples of white catfish and carp, respectively. The TMDL for DDT is expected to be completed in 2021 (SWRCB 2011r).

The organochlorine pesticide dieldrin, and the Group A pesticides generally, are included on the 303(d) list for the Colusa Basin Drain (SWRCB 2011r). The Group A pesticides have been listed since 2006, thus supporting information is not readily available. Dieldrin is listed due to two of two samples collected in August 2005 exceeding the OEHHA FCGs for dieldrin of 0.46 µg/kg dieldrin in fish tissue. One composite sample of white catfish recorded a concentration of 0.7 µg/kg and one composite sample of carp recorded a value of 1.14 µg/kg. Contamination by organochlorine pesticides in the Colusa Basin Drain will be addressed by the Central Valley Organochlorine Pesticide TMDL and Basin Plan Amendment.

The carbamate pesticide carbofuran is also included on the 303(d) list for the Colusa Basin Drain. It has been listed since 2006; thus, supporting information is not readily available. A TMDL is expected by 2021 (SWRCB 2011r).

Dissolved Oxygen

The Colusa Basin Drain was placed on the 303(d) list approved by the USEPA in 2010 for low dissolved oxygen (SWRCB 2011a). According to the Final California 2010 Integrated Report (303(d)/305(b) Report) Supporting Information, sources of contributing to the dissolved oxygen impairment in the Colusa Basin Drain are unknown (SWRCB 2011r).

Samples collected from the Colusa Basin Drain (at Maxwell Road, above Knights Landing, at Highway 162, and at "Colusa Basin Drain #5") between September 2004 and October 2006 and were tested for dissolved oxygen (SWRCB 2011r). Thirty of the 73 samples exceeded the general number water quality objectives for COLD and SPWN beneficial uses. Five of the samples exceeded the water quality objective for WARM beneficial uses.

Other Constituents of Concern

The Colusa Basin Drain is also listed as contaminated by *E. coli*, low dissolved oxygen, and unknown toxicity (SWRCB 2011r). Knights Landing Ridge Cut is listed as contaminated by boron, low dissolved oxygen, and salinity. A USGS study of Yolo Bypass water quality in 2000 also reported that significant concentrations of ammonium and dissolved organic carbon in the Yolo Bypass were correlated with high concentrations in the Colusa Basin Drain, and that the Colusa Basin Drain was a major discharger of sulfate to the Yolo Bypass (USGS 2002)

6.3.3.1.4 Feather River from Lake Oroville to the Confluence with the Sacramento River

Water quality constituents of concern in the Lower Feather River have the potential to affect several supported beneficial uses, including municipal and agricultural water supply, contact and non-contact water recreation, and fish habitat and migration uses, for cold and warm water. The 303(d) listed contaminants in this reach of the Feather River.

Water Temperature

The Lower Feather River (downstream of Lake Oroville) is not listed on the 303(d) list as impaired by water temperature (SWRCB 2011a). However, water temperature in the lower Feather River is crucial to maintaining fresh water habitat for both warm and cold fresh water fish species in downstream habitats (DWR 2007). The SWP operates Lake Oroville and the Thermalito Reservoir Complex to meet temperature objectives established through a 1983 agreement with California Department of Fish and Wildlife and biological opinions issued by NMFS, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. Releases from Lake Oroville determine initial river temperatures. Water is released at different depths through shutters at the intake structures (DWR 2007). Although Lake Oroville releases determine water temperatures initially, atmospheric conditions modify downstream river temperatures. Water temperatures vary seasonally and spatially between the low flow channel (LFC) and high flow channel (HFC) of the Lower Feather River downstream of the fish barrier dam. The LFC is the reach of the river between the Fish Barrier Dam and the confluence with the Thermalito Afterbay Outlet and it is managed to protect cold water fish species. The HFC is the downstream reach of the river, from the Thermalito Afterbay Outlet to the confluence with the Sacramento River.

Warmer temperatures in the LFC start to appear in March, reaching maximum temperatures in July and early August ranging from 61° F upstream of the Feather

River Fish Hatchery to 69º F upstream of the Thermalito Afterbay Outlet (DWR 2007a). Cooling of the LFC begins in September, with a minimum temperature of approximately 45º F occurring in February. At the Feather River Fish Hatchery, water temperatures are generally compliant with the 1983 Agreement. Temperatures from 2002 to 2004 were in compliance 95 percent of the time, exceeding requirements for 23 days during an extended warm period in fall 2002, and dropping below requirements for 13 days during the warm summer months. Water temperatures at Robinson Riffle are almost always met when the fish hatchery temperatures are met. Agricultural temperature requests cannot always be satisfied due to the requirements of the fish species and the fluctuating meteorological conditions.

Temperatures in the HFC are influenced by releases from the Thermalito Afterbay and flow contributions from Honcut Creek, the Yuba River, and the Bear River from April through October (DWR 2007). Except for during high flows from the Thermalito Afterbay (occurring frequently in July and August), releases in the warm season generally raise the water temperature. Honcut and Bear River inflows tend to increase downstream temperatures as well, while flows from the Yuba River tend to cool downstream temperatures during the warmer months.

Warming water temperatures appear in the HFC starting in March, with maximum temperatures occurring in July and August, ranging from 71 to 77º F (DWR 2007). In late august, the HFC begins to cool, reaching minimum temperatures of 44 to 45º F by January or February.

In addition to effects on fish species, agriculture is potentially affected by changes in water temperature, because the temperatures of irrigation water can affect crop growth (DWR 2007). In the Feather River Basin, this is particularly an issue for rice production. Water contact recreation can also be affected by water temperatures, as flows in the LFC are managed for cold water species and thus may be too cold for some water-contact recreation.

Mercury

The Lower Feather River is included on the 303(d) list for mercury contamination (SWRCB 2011a). The listing was made before the 2006 Integrated Report; thus, the evidence of water quality exceedance is not readily available. It has been noted, however, that the Feather River has relatively large mercury loadings and high mercury concentrations in suspended sediment, contributing significantly to mercury loading to the Delta. The Feather River transports much of the mercury to the Sacramento River that was released in the Sierra Nevada Mountains during gold mining operations (CVRWQCB 2010a).

FERC relicensing studies indicate that mercury consistently exceeds USEPA guidelines in most fish species and locations, and that biomagnification appears to have caused elevated mercury levels in fish (DWR 2007). A beneficial effect of Lake Oroville is the capture of contaminated sediments, preventing their further transport downstream.

In the Sacramento – San Joaquin Delta Estuary TMDL for methylmercury, the CVRWQCB (2010a) recommends that the Feather River be targeted for mercury reduction during initial efforts focusing on the watersheds that export the largest volumes of highly mercury-contaminated sediment to the Delta.

Pesticides

The Feather River below Lake Oroville is listed as contaminated for chlorpyrifos. Samples collected during storm events at the Feather River near Nicolaus in 2004 exceeded the California DFG Hazard Assessment Criteria of 25 ng/l over a one hour average. The TMDL for chlorpyrifos in the Feather River is expected to be completed in 2019 (SWRCB 2011t).

Group A Pesticides have also been detected in exceedance of water quality criteria (SWRCB 2011t). Data collected for organochlorine pesticide contamination in the Feather River between 2000 and 2009 as part of the NPDES permit program did not indicate exceedances of CTR criteria, but did show detections in all samples in the water column. Channel catfish tissue samples from the Feather River at Highway 99 between 1978 and 2008 exhibited high concentrations of DDT and dieldrin. These water quality and fish tissue data were presented as part of supplemental documents in the process to develop a basin plan amendment to address organochlorine pesticides in Central Valley water bodies. This basin plan amendment is currently in development and will include organochlorine pesticides in the Feather River (CVRWQCB 2010c).

PCBs

The Lower Feather River was placed on the 303(d) list approved by the USEPA in 2010 as impaired by PCBs (SWRCB 2011a).

According to the *Final California 2010 Integrated Report* (303(d)/305(b) Report) Supporting Information, sources of PCBs in the Feather River are unknown (SWRCB 2011t). However, The Draft Environmental Impact Report for the FERC relicensing notes that PCBs have been detected in all fish and crayfish species from all sampled water bodies. Aroclors were also detected in at least some fish in all water bodies, as well as in crayfish in the Feather River downstream from the State Route 70 bridge (DWR 2007). PCBs have been released into the Feather River watershed from several activities. Two events in the 1980s resulted in PCB contamination in the watershed: oil containing PCBs was applied to a dirt road and entered the Ponderosa Reservoir in surface runoff, and PCBs contaminated soil and water at Belden Forebay due to a landslide which damaged powerhouses. Some remediation was performed in response to these events.

The same narrative water quality objective and evaluation criteria of 3.6 ng/g that was used as guidance to place the Sacramento River on the 303(d) list was also used to evaluate the Feather River. Composite samples of Largemouth Bass and crayfish collected in 2002 and 2003 showed high exceedances of the FCG. Upstream of the Thermalito Afterbay Outlet, a composite sample of Largemouth Bass had a concentration of 15.6 ng/g total PCBs, wet weight. Downstream of the outlet, the concentration of total PCBs in two composite samples of Largemouth Bass were 11.2 and 15.0 ng/g. Downstream of the Highway 70 Bridge, the concentration of total PCBs in a composite sample of crayfish was 56 ng/g (SWRCB 2011t)

An additional study performed in 2003 and 2004 also revealed high exceedances of the OEHHA FCG for PCBs. Concentrations of total PCBs in composite samples of hardhead and pikeminnow were 26 ng/g and 31 ng/g wet weight, respectively. All samples were analyzed for 48 individual PCB congeners and two Aroclor mixtures (SWRCB 2011t)

A TMDL for PCBs in the Lower Feather River is expected to be completed in 2021 to protect the beneficial uses of the Feather River and other water bodies downstream (SWRCB 2011t).

Other Constituents of Concern

The Lower Feather River is listed as impaired by unknown toxicity due to significant exceedances of the toxicity criteria outlined by the CVRWQCB (SWRCB 2011t, CVRWQCB 2011). Water samples were tested with *C. dubia, P. promelas*, and *P. subcapitata* for survival, growth and/or reproductive toxicity between 1998 and 2007. Of 212 samples tested with *C. dubia* for survival and/or reproductive toxicity, 85 exceeded the narrative toxicity objective. Of 34 samples tested with *P. promelas* for survival and/or growth toxicity, seven exceeded the objective. Of 23 samples tested with *P. subcapitata*, none exceeded the objective. Samples in violation of the toxicity objective were collected in the Feather River at Nicolaus; in the Thermalito Diversion Pool; downstream from the Feather River Hatchery; upstream and downstream from the Thermalito Afterbay Outlet; downstream from the Sewage Commission Oroville Region (SCOR) Outlet; and downstream from the FERC Project 2100 project boundary.

6.3.3.1.5 American River below Lake Natoma

The lower American River flows for 23 miles from Nimbus Dam to its confluence with the Sacramento River. Water quality in this reach of the river is influenced by releases from upstream reservoirs, including Lake Natoma and Folsom Lake. In general, the runoff that flows into Folsom Reservoir and Lake Natoma, upstream of the lower American River, is of high quality (Wallace, Roberts, and Todd et al. 2003). Water quality parameters measured in Folsom Reservoir, upstream of the lower American River, include pH, turbidity, dissolved oxygen (DO), total organic carbon (TOC), nutrients (nitrogen and phosphorus), electrical conductivity, total dissolved solids (TDS), and fecal coliform.

Water Temperature

The lower American River is not listed on the 303(d) list as impaired by water temperature (SWRCB 2011a). The lower American River supports warm and cold fresh water habitat beneficial uses, as well as migration and spawning uses. In particular, in-stream rearing of juvenile steelhead requires certain water temperatures which are targeted through water temperature objectives (CVRWQCB 2011, NMFS 2009).

The CVP operates Folsom Lake to meet temperature objectives, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations.

Mercury

The American River from Nimbus Dam to the confluence with the Sacramento River was listed on the 303(d) list for mercury contamination in 2010, due to exceedances of OEHHA's guidance tissue levels for mercury (SWRCB 2011u). The major source of mercury to the lower American River is mercury lost during historic mining activities that is now distributed downstream.

The American River contributes mercury to the Sacramento River, and thus the Delta, due to its relatively large mercury loadings and high mercury concentrations in suspended sediment (CVRWQCB 2010a). Like the Feather River, the lower American River is recommended for initial mercury reduction efforts as part of the Sacramento – San Joaquin Delta Estuary TMDL for Methylmercury. In addition to load allocations recommended as part of the Delta TMDL for methylmercury, mercury contamination in the American River and its reservoirs will be addressed as part of the statewide water quality control program for mercury (SWRCB 2014a).

PCBs

The lower American River was placed on the 303(d) list approved by the USEPA in 2010 as impaired by PCBs (SWRCB 2011a).

Composite samples of white catfish and Sacramento sucker collected in the American River at Discovery Park were analyzed for 48 individual PCB congeners and three Aroclor mixtures (SWRCB 2011u). The total PCBs recorded in the White Catfish and Sacramento Sucker were 3.934 ng/g and 44.094 ng/g, respectively. An additional Sacramento Sucker composite sample collected at Nimbus Dam did not exceed the OEHHA goal.

A TMDL for PCBs in the lower American River is expected to be completed in 2021 to protect the beneficial uses of the American River and other water bodies downstream (SWRCB 2011u).

Unknown Toxicity

The lower American River is listed as impaired by unknown toxicity. Toxicity has been indicated for vertebrates and invertebrates from samples collected at Discovery Park, using survival, growth, and reproduction toxicity tests with *C. dubia* and *P. promelas*. These tests, conducted between 1998 and 2007, exhibited significant increases in mortality and reductions in growth and reproduction in the test organisms (SWRCB 2011u). The TMDL is expected to be completed in 2021 (SWRCB 2011u).

6.3.3.1.6 Yolo Bypass

The Yolo Bypass supports a variety of beneficial uses, including agricultural supply, recreational uses, and spawning, migration and habitat use. The Yolo Bypass is used for agriculture in times of low flow, and discharges to the San

Francisco Bay-Delta contribute to drinking water supplies. The Yolo Bypass also supports seasonal fish and bird populations when it is inundated, and resident fish species in its perennial channel. Water quality in the Yolo Bypass is of great importance because of the in-Bypass water uses and its effects on receiving waters downstream (CVRWQCB 2011, Sommer et al. 2001)

Mercury

The Yolo Bypass contributes a significant amount of methylmercury and total mercury to the Delta. While the Sacramento River is the primary tributary source of mercury to the Delta in dry years, mercury loading from the Yolo Bypass increases in wet years and is comparable to that of the Sacramento River. Although only two thirds of the Yolo Bypass floodplain lie within the legal Delta, the entire floodplain was evaluated as part of the Sacramento – San Joaquin Delta Estuary TMDL for Methylmercury (Delta Methylmercury TMDL) (CVRWQCB 2010a). Compounding the issue of mercury contamination in the Yolo Bypass, the USGS study noted that the Bypass has conditions conducive to the production of methylmercury, including stagnant waters and marshes with an abundance of sulfate and organic carbon (USGS 2002).

A major source of mercury to the Yolo Bypass is Cache Creek. Mercury mine wastes have contributed relatively large mercury loading and high mercury concentrations in suspended sediment, making this area a priority for mercury reduction as part of the Delta Methylmercury TMDL (CVRWQCB 2010a). Elevated methylmercury concentrations in the Colusa Basin Drain are also a concern (USGS 2002).

The Cache Creek Settling Basin (CCSB) captures sediment and mercury transported by Cache Creek; however, any sediment that is not captured is transported to the Yolo Bypass (approximately half of the sediment transported by Cache Creek). The CTR mercury criterion of 0.050 µg/l for drinking water is exceeded in outflow from the CCSB (and possibly in other tributaries to Yolo Bypass), thus it is anticipated that when the Yolo Bypass is dominated by flows from Cache Creek, it also exceeds the CTR criterion (CVRWQCB 2010a).

The Delta Methylmercury TMDL recommends reducing mercury loads entering the CCSB, and regularly excavating the sediment accumulating in the CCSB, in order to increase its effectiveness and prevent its filling and thus cessation of sediment and mercury deposition. Additional reductions in mercury loading to Cache Creek will be achieved through the existing mercury TMDL in the watershed, which includes measures for mine remediation, erosion control in mercury-enriched areas, and the removal of floodplain sediments containing mercury (CVRWQCB 2010a).

In addition to efforts targeting mercury loading reductions in Cache Creek, the TMDL includes methylmercury and total mercury load and waste load allocations for agricultural drainage, tributary inputs and NDPES facilities in the Yolo Bypass to enable reductions in mercury contamination in water and fish (CVRWQCB 2010a).

Agricultural Runoff

The City of Woodland developed a water quality management plan for the Yolo Bypass which included water quality testing to identify pollutants of concern. Water quality was monitored within the Yolo Bypass and in its major tributaries, at the locations where they enter the Bypass. The study indicated that the highest concentrations of several contaminants were found in tributaries receiving predominantly agricultural discharge: the Willow Slough Bypass; Knights Landing Ridge Cut, which drains the Colusa Basin Drain; and for some contaminants, the Z Drain (City of Woodland 2005). Although the Yolo Basin is not included as a water body on the 303(d) list, the Tule Canal is listed as contaminated by several of these agricultural by-products, including boron, salinity, E. coli and fecal coliform. These contaminants will be addressed by TMDLs expected to be completed in 2021 (SWRCB 2011w).

Pesticides are of major concern in the agricultural drains tributary to the Yolo Bypass. DDE, a degradation product of the organochlorine pesticide DDT, was detected in the water column in agricultural drains and in Putah Creek sediment. The organophosphate pesticide chlorpyrifos was detected in excess of the concurrent DFG criterion of 0.009 µg/l in four samples, while diazinon was not reported in excess of its criterion. The carbamate pesticides diuron and methomyl were detected, but did not exceed their applicable criteria. Pyrethroids were not monitored, but were noted to be of increasing concern in the Yolo Bypass as in the rest of the Central Valley (City of Woodland 2005).

6.3.3.2 San Joaquin Valley

Water quality conditions in the San Joaquin River are described for locations that would be influenced by implementation of Alternatives 1 through 5, including Stanislaus River near Caswell Park in the vicinity of the confluence with the San Joaquin River; San Joaquin River near Vernalis, and San Joaquin River near Buckley Cove and Stockton

6.3.3.2.1 San Joaquin River

Water quality concerns in the San Joaquin River near Vernalis are primarily salinity, boron, and selenium which are influenced by low flows due to upstream diversions and water use and agricultural return flows.

Water Temperature

The reach of the San Joaquin River from Merced River to Stanislaus River was placed on the Section 303(d) list per the partial approval by USEPA in 2010 and the final approval in 2011 (SWRCB 2011a).

According to the *Final California 2010 Integrated Report* (303(d) list/305(b) Report) Supporting Information, water temperature concerns in San Joaquin River from Merced River to Stanislaus River are attributed to unknown sources (SWRCB 2011x,y). However, declines in fish populations, particularly salmon and steelhead trout, have been linked to increases in water temperatures and suggestions have been made that the population declines may be a result of watershed changes from the construction of dams, water diversions, mining, and harvest (NMFS 2009).

USEPA (2011) evaluated salmonid migration and spawning temperatures to assess the water quality of the San Joaquin River. Recommended water temperature criteria for salmon and steelhead trout life stages are presented in Table 6.16. San Joaquin River temperatures from the Merced River to the Stanislaus River in 1996-2007 exceeded USEPA's recommendations, thus impairing the cold freshwater habitat.

Table 6.16 San Joaquin River Maximum Temperature Criteria and Recommended Uses for Summer

Applicable to:	Criteria:
Chinook Salmon Adult Migration	64 °F
Chinook Salmon Spawning	55 °F
Chinook Salmon Smoltification and Juvenile Rearing	61 °F
Steelhead Trout Summer Rearing	64 °F

Source: SWRCB 2011x,y; USEPA 2003

TMDLs for the lower reaches in the San Joaquin River (Merced to Tuolumne and Tuolumne to Stanislaus) are expected to be completed in 2021 in an effort to further protect the beneficial uses of this water body (SWRCB 2011).

Selenium

San Joaquin River from Mud Slough to Merced River was placed on the Section 303(d) list in 2010 for selenium contamination per the list approved by USEPA (SWRCB 2011a). Other water bodies that drain to the San Joaquin River upstream of this reach and are listed as impaired by selenium contamination on the 303(d) list include Mendota Pool, Panoche Creek from Silver Creek to Belmont Avenue, Agatha Canal, Grasslands Marshes, Mud Slough (North, downstream of San Luis Drain), and Salt Slough (upstream from confluence with San Joaquin River).

TMDLs for selenium were approved by the USEPA for the San Joaquin River (Mud Slough to Merced River) (in 2002), Grasslands Marshes (in 2000), Agatha Canal (in 2000), and Mud Slough (north, downstream of San Luis Drain) (in 2002) (SWRCB 2011z-ac). A TMDL is expected to be completed for Panoche Creek in 2019 and another for Mendota Pool in 2021. Water quality objectives defined in the Basin Plan for the Sacramento River basin and the San Joaquin River basin are shown in Table 6.17 (CVRWQCB 2011).

Table 6.17 Water Quality Objectives for Selenium in the San Joaquin River Region, mg/l

Objective	Applies to:
0.012 (maximum concentration)	San Joaquin River, mouth of the Merced River to Vernalis
0.005 (4-day average)	–
0.020 (maximum concentration)	Mud Slough (north), and the San Joaquin River from Sack Dam to the mouth of Merced River
0.005 (4-day average)	–
0.020 (maximum concentration)	Salt Slough and constructed and re-constructed water supply channels in the Grassland watershed*
0.002 (monthly mean)	–

Source: CVRWQCB 2011

*Applies to channels identified in Appendix 40 of the CVRWQCB (2011) Basin Plan

The drainage area for the Grasslands Bypass Project is a major but decreasing source of selenium to the San Joaquin River. Selenium from subsurface agricultural drainage waters originating in the Drainage Area was historically transported through the Grassland Marshes through tributaries such as Mud Slough and Salt Slough (CVRWQCB 2001). Efforts to decrease the selenium loading to the San Joaquin River include the Grassland Bypass Project, discussed in more detail below, which has decreased selenium loading by an average of 55 percent from the Grasslands Drainage Area in comparison to pre-Grassland Bypass Project conditions (1986-1996 to 1997-2011) (GBPOC 2013). In the San Joaquin River below the Merced River, selenium concentrations decreased from an average of 4.1 µg/l during pre-project conditions (1986 to 1996) to 2 µg/l (1997 to 2011). The continued operation of the Grassland Bypass Project is expected to achieve the CVRWQCB Basin Plan objectives for the San Joaquin Valley (Reclamation & SLDMWA 2009).

Largemouth Bass were sampled during 1999, 2000, 2005, and 2007 from the San Joaquin River, lower Sacramento River, and Delta by the CVRWQCB (Foe 2010). The samples were analyzed as fillets to evaluate potential human health risks, and whole-body selenium concentrations were estimated using an equation from Saiki et al. (1991) to evaluate risks to wildlife. The data do not exceed the draft water quality criteria released by the USEPA in May 2014.

The draft discharge requirements released by the CVRWQCB in 2014 were created in an effort to meet the water quality objective for the San Joaquin River. In 2010, the CVRWQCB and SWRCB approved amendments (Resolution 2010-0046) to the Basin Plan for the Sacramento River and San Joaquin River Basins to address selenium control in the San Joaquin River basin as related to the Grassland Bypass Project (which is described below) (CVRWQCB 2010g, SWRCB 2010b).

Other relevant requirements/actions to meet the water quality objectives for the San Joaquin River, in addition to release of the draft waste discharge requirements by the CVRWQCB (2010g), include the following:

- The Basin Plan amendments (CVRWQCB 2010g, SWRCB 2010b) modify the compliance time schedule for discharges regulated under waste discharge requirements to meet the selenium objective or comply with a prohibition of discharge of agricultural subsurface drainage to Mud Slough (north), a tributary to the San Joaquin River, in Merced County. For Mud Slough (north) and the San Joaquin River from the Mud Slough confluence to the mouth of the Merced River:
  - The interim performance goal is 15 µg/l (monthly mean) by December 31, 2015 (adds to Table 6.46), and
  - The water quality objective to be achieved by December 31, 2019, is 5 µg/l (4-day average).

An extensive water quality and biological monitoring program was implemented in conjunction with the Grassland Bypass Project, and reports are issued periodically through the San Francisco Estuary Institute (e.g., SFEI 2011).

Electrical Conductivity and Salinity

Grasslands Marshes, North Mud Slough (downstream of San Luis Dam), Salt Slough (upstream from confluence with San Joaquin River), and San Joaquin River (Bear Creek to Vernalis) are water bodies in the Central Valley that were placed on the Section 303(d) list approved by the USEPA in 2010 as impaired by electrical conductivity (SWRCB 2011a). Salinity, which is linked to electrical conductivity, is a major concern for water quality in the San Joaquin Valley (CVRWQCB 2011). The RWQCB has adopted a TMDL for the San Joaquin River upstream of Vernalis for salt and boron.

Elevated electrical conductivity in Grasslands Marshes, North Mud Slough (downstream of San Luis Dam), Salt Slough (upstream from confluence with San Joaquin River), and San Joaquin River (Bear Creek to Vernalis) can be attributed to agriculture (SWRCB 2011x-aa,ac-af). Likewise, high salinity in the San Joaquin River near Vernalis has been linked to the discharge of water from agricultural practices (CALFED 2007). Saline water from agricultural return flow is added to the southern Delta by the San Joaquin River whereupon a portion is pumped by the export pumps back to the farms that eventually drain back to the river, exacerbating the problem of salinity control and salt buildup in the San Joaquin Valley.

To protect the beneficial uses of these water bodies, including agricultural supply, and municipal and domestic supply, particularly for San Joaquin River from Bear Creek to Mud Slough, water quality objectives were established in the SWRCB (2006a) Basin Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Table 6.18).

Table 6.18 SWRCB Water quality objectives for electrical conductivity in the San Joaquin River (Airport Way Bridge, Vernalis)

Time Period	Water Quality Objective[1]
April 1 to August 31	0.7 mmhos (700 μS/cm)
September 1 to March 31	1.0 mmhos (1000 μS/cm)

Source: SWRCB 2006a

1 Maximum 30-day running average of mean daily

Several samples from San Joaquin River (Bear Creek to Vernalis) between October 1995 and February 2007 exceeded the SWRCB Basin Plan's water quality objective for electrical conductivity in the San Joaquin River (SWRCB 2011 x-aa,ac-af). Samples were collected from San Joaquin River at Lander Avenue, Fremont Ford, Patterson Fishing Access, Hills Ferry Bridge, and Crows Landing. Guidelines for evaluating Grasslands Marshes, North Mud Slough, and Salt Slough are not available because the listing was made prior to 2006.

The record of monthly average electrical conductivity (EC) readings for recent years for the San Joaquin River at Vernalis is shown in Figure 6.4. Salinity in the lower San Joaquin River as observed at Vernalis often exceeds the water quality objective for individual records during summer months. The highest salt concentrations emanate from Mud and Salt sloughs, while less saline water provides dilution from the Merced River (CALFED 2007). Note the marked increase in salinity during dry months and dry years at Vernalis, ranging from midwinter lows near 100 μmhos/cm up to summer high values near 1000 μmhos/cm.

A TMDL is expected to be completed in 2019, with the exception of San Joaquin River from Tuolumne to Stanislaus River which is expected to be completed in 2021 (SWRCB 2011 x-aa,ac-af). In addition, the Board has implemented the comprehensive salt management program, known as CV-SALTS (Central Valley Salinity Alternatives for Long Term Sustainability), to develop salt control strategies for the San Joaquin and the entire Central Valley watershed (CVRWQCB 2011, 2010h). The San Joaquin River Water Quality Improvement Program (SJRIP) was designed to address issues of chronically saline water, reuse, treatment options, and the development of salt-tolerant crops for this area of the valley, as part of the Grasslands Bypass Project.

Mercury

Mercury is a constituent of concern for the San Joaquin River from Bear Creek to the Delta boundary, and was placed on the 303(d) list in 2010 (SWRCB 2011a). San Joaquin River from Friant Dam to Bear Creek was not included on the 303(d) list for mercury contamination.

Mercury in this reach of the San Joaquin can be attributed to resource extraction. Significant gold mining took place along the major tributaries of the San Joaquin River, including Merced River, Tuolumne River, Stanislaus River, and Cosumnes River in the San Joaquin River basin (CVRWQCB 2010a).

Mercury and enhanced mercury methylation can affect the beneficial uses of the San Joaquin River and receiving waters downstream. At the Delta boundary in Vernalis, the waterborne methylmercury concentration in the San Joaquin River from 2003 to 2006 ranged from 0.10-0.75 ng/l with an average of 0.19 ng/l (Foe et al. 2008). The average fish tissue mercury concentration in Largemouth Bass from Vernalis in 2000 was 0.68 mg/kg (wet weight) (CVRWQCB 2010a). This fish tissue concentration exceeds the USEPA wet weight methylmercury fish tissue criterion (0.3 mg/kg) for the protection of human health.

To further protect the health of humans and wildlife, the Sacramento-San Joaquin Delta TMDL specified narrative and more stringent numeric water quality objectives for the more bioavailable and more toxic form of methylmercury (CVRWQCB 2011). The TMDL for the Sacramento-San Joaquin Delta (CVRWQCB 2010a), which is applicable to the Delta, Yolo Bypass, and their waterways, includes the reach of the San Joaquin River from Bear Creek to the Delta boundary.

Pesticides

The San Joaquin River (all segments from Mendota Pool to Vernalis), North Mud Slough (downstream of San Luis Drain), and Salt Slough (upstream from confluence with San Joaquin River) were placed on the Section 303(d) list approved by the USEPA in 2010 as impaired by pesticides (SWRCB 2011a). North Mud Slough is listed as impaired by "pesticides"; Salt Slough by chlorpyrifos and prometryn, and San Joaquin River by OP pesticides (chlorpyrifos and diazinon), OC pesticides (DDT, DDE, Group A Pesticides, including toxaphene), alpha.-BHC, and diuron. Impairment listings vary between reaches of the San Joaquin River. Several other small tributaries to the San Joaquin River from the west are also 303(d) listed as impaired by pesticides (i.e., Mud Slough North (upstream and downstream of San Luis drain).

Pesticides in North Mud Slough, Salt Slough, and the San Joaquin River can be attributed to runoff from agriculture, with the exception of the alpha-BHC in the San Joaquin River (from Merced to Tuolumne) and toxaphene in the San Joaquin River (from Stanislaus to the Vernalis) whose sources are unknown (SWRCB 2011x-z,ac-ag).

Boron

The lower San Joaquin River upstream of Vernalis is listed as impaired due to elevated concentrations of boron (CVRWQCB 2002b, 2007c). A draft Amendment to the Basin Plan for the Sacramento River and San Joaquin River Basins for the control of Salt and Boron discharges into the lower San Joaquin River (resolution R5-2004-0108) (CVRWQCB 2007c) describes a pending TMDL and establishes Waste Load Allocations to meet boron water quality objectives near Vernalis (at the Airport Way Bridge).

Mean salinity in the lower San Joaquin River at Vernalis has doubled since the 1940s while boron and other trace elements have also increased to concentrations that exceed the water quality criteria of 750 μg/l. These criteria were established to be protective of sensitive crops under long-term irrigation (USEPA 1986b).

Water quality improves in the San Joaquin River downstream of confluences with the Merced, Tuolumne, and Stanislaus rivers.

Most of the boron load to the Delta comes from the lower San Joaquin River as a result of surface and subsurface agricultural discharges (CVRWQCB 2007c) on soils overlying old marine deposits and from groundwater (Hoffman 2010h, CALFED 2000). Major boron contributions come from Salt and Mud sloughs to the lower river (CVRWQCB 2002b). Point sources contribute very little of the salt and boron loads to the San Joaquin River (CVRWQCB 2007c).

Boron concentrations in surface water from two surface water sources in the lower San Joaquin River are variable, and range from 100 to over 1000 µg/l (Hoffman 2010). Effluent from subsurface drains in the New Jerusalem Drainage District have also been reported up to 4200 µg/l (Hoffman 2010). These concentrations at times exceed the water quality criteria and thresholds for sensitive crops (i.e., bean tolerance threshold is 750 to 1000 µg/l).

The collaborative effort by stakeholders and regulators is developing comprehensive management programs that will lead to attainment of water-quality objectives for salinity and boron. This program, CV-SALTS, is scheduled to be completed by 2016 and may lead to a basin plan amendment that will support the protection of beneficial uses.

Arsenic

The San Joaquin River from Bear Creek to Mud Slough was placed on the 303(d) list approved by the USEPA in 2010 for impairment by arsenic (SWRCB 2011a). Arsenic can cause adverse dermal, cardiovascular, respiratory, gastrointestinal, and neurological effects, and can cause cancer (ATSDR 2007). A TMDL addressing impairment due to arsenic is expected to be complete in 2021to protect the beneficial uses of this reach of the San Joaquin River, including the municipal and domestic supply (SWRCB 2011ae).

Bacteria

San Joaquin River (Bear Creek to Merced River; Stanislaus River to Delta Boundary) and Salt Slough (upstream from confluence with San Joaquin River) is a water body in the Central Valley that were placed on the Section 303(d) list approved by the USEPA in 2010 as impaired by *E. coli* (SWRCB 2011a).

Invasive Species

San Joaquin River (Friant Dam to Mendota Pool) is a water body in the Central Valley that was placed on the Section 303(d) list approved by the USEPA in 2010 as impaired by invasive species (SWRCB 2011a).

A TMDL for invasive species is expected to be completed in 2019 in an effort to meet the narrative water quality objective in San Joaquin River (Friant Dam to Mendota Pool).

6.3.3.2.2 Stanislaus River

Water Temperature

The lower Stanislaus River was placed on the 303(d) list per the partial approval by USEPA in 2010 and the final approval in 2011 (SWRCB 2011a). The Stanislaus River supports warm and cold fresh water habitat for aquatic species such as steelhead.

According to the *Final California 2010 Integrated Report* (303(d) list/305(b) Report) Supporting Information, water temperature concerns are attributed to unknown sources (SWRCB 2011). Future climate conditions that are warmer or drier or both will further restrict the extent of suitable habitat for steelhead (NMFS 2009).

USEPA recommended water temperature criteria for different salmon and steelhead trout life stages. Data from 1991 to 2007 exceeded USEPA's criteria and thus impairing the cold freshwater habitat. The 2009 NMFS BO also includes temperature objectives for the Stanislaus River, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations.

Mercury

Lower Stanislaus River is a water body in the Central Valley that was placed on the Section 303(d) list approved by the USEPA in 2010 as impaired by mercury (SWRCB 2011a).

Mercury has impaired the beneficial use of the commercial or recreational collection of fish, shellfish, or organisms (SWRCB 2011aj-al). The lower Stanislaus River was evaluated prior to 2006, so the evidence for the list is not readily available. However, the total methylmercury concentration in the Stanislaus River at Caswell State Park from 2003 to 2006 was 0.12 ng/l (Foe et al. 2008). Concentrations of methylmercury in Largemouth Bass, carp, Channel Catfish, and White Catfish tissue samples from the Stanislaus River between 1999 and 2000 exceeded the USEPA methylmercury fish tissue criterion (0.3 mg/kg wet weight) for the protection of human health (Shilling 2003).

In an effort to protect the beneficial uses of these water bodies mentioned above, and including the commercial and recreational collection of fish, shellfish, or organisms beneficial use, TMDLs are expected to be completed between 2019 to 2021 to meet the water quality standards in these water bodies (CVRWQCB 2011).

Pesticides

Lower Stanislaus River was placed on the Section 303(d) list approved by the USEPA in 2010 as impaired by pesticides (chlorpyrifos, diazinon, Group A Pesticides) (SWRCB 2011a). OP pesticides (e.g., diazinon and chlorpyrifos) and OC pesticides (e.g., Group A Pesticides) are primarily transported to streams and rivers in runoff from agriculture (CVRWQCB 2011). Sources and descriptions of the listed pesticides are discussed further in Section 6.3.2.7.

Other Constituents of Concern

Lower Stanislaus River was placed on the Section 303(d) list approved by the USEPA in 2010 as impaired by unknown toxicity (SWRCB 2011a).

To protect the beneficial uses of Lower Stanislaus River, a narrative water quality objective, which addresses *E. coli*, was established in the CVRWQCB (2011) Basin Plan.

A TMDL is expected to be complete in 2021 in an effort to meet the water quality standards in the lower Stanislaus River.

6.3.3.3 Sacramento-San Joaquin River Delta

Water quality conditions in the Sacramento and San Joaquin River in the Delta are described in this subsection against criteria to protect the beneficial uses as summarized in Table 6.2. The constituents of concern that are currently not in compliance with existing water quality standards and for which TMDLs are adopted or are in development in this region are summarized in Table 6.1.

6.3.3.3.1 Salinity

Delta waterways were placed on the Section 303(d) List approved by the USEPA in 2010 as impaired by electrical conductivity (SWRCB 2011a). Electrical conductivity is linked to salinity and salinity is of particular concern in the tidally-influenced Delta (CVRWQCB 2011, CALFED 2007).

Electrical conductivity in Delta waterways (export area, northwestern portion, southern portion, western portion) can be attributed to runoff from agricultural practices (SWRCB 2011at-aw). Salinity in the Delta can vary significantly depending on several factors including hydrology, water operations, and Delta hydrodynamics (Jassby et al. 1995). Hydrology and upstream water operations influence the Delta inflows, which in turn influences the balance with the highly saline seawater intrusion. Various upstream watershed sources determine the quality of the Delta inflows, in addition to the in-Delta sources such as agricultural returns, natural leaching, municipal and industrial discharges that influence the Delta salinity conditions. Operation of various Delta gates and barriers, pumping rates of various diversions and volume of the open water bodies are the other key factors that influence the Delta hydrodynamics and salinity transport in the Delta.

The CVP and SWP are operated to achieve salinity objectives in the Delta, as described in detail in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations.

Water quality objectives for electrical conductivity were established in the SWRCB (2006a) Basin Plan to protect the beneficial uses of these Delta waterways, including agricultural supply. Objectives are specific to the western Delta, interior Delta, southern Delta and export area, as well as for inflows and outflows to the delta from other water bodies. Compliance locations in the Delta are shown in Figure 6.5.

The patterns of EC and salinity in the Delta over time and space follow predictable patterns, under the strong influence of higher saline water from the San Joaquin and less saline water from the Sacramento and Eastside streams in an ever-changing balance with tidal influence upstream from Suisun Bay and the losses from south Delta pumping. The record of monthly average EC readings for recent years at five sites throughout the Delta shows the pattern of increasing average EC in the western Delta, as shown in Figures 6.6 through 6.8. The highest salinity occurs in the late summer months when the flows from the Sacramento and San Joaquin rivers are the lowest, and sea water intrusion occurs. The lower Sacramento River at Collinsville experiences strong tidal influence during dry periods (EC above 8000 µmhos/cm) but is flushed with fresh water during winter flows. Historical salinity discharged from the CVP Jones Pumping Plant into the Delta Mendota Canal is summarized in Figure 6.9.

Salinity objectives for the southern Delta are now under review by the SWRCB (SWRCB 2008b).

6.3.3.3.2 Mercury

Mercury is a constituent of concern for the Sacramento-San Joaquin River Delta, which was placed on the 303(d) list in 2010 (SWRCB 2011a). In 2008, the San Francisco Bay Mercury TMDL was approved by the USEPA and the implementation plan is expected to attain the water quality standard 20 years after the approval (SFB RWQCB 2006). In 2010, the RWQCB approved amendments to the Basin Plan for the Sacramento River and San Joaquin River Basins to include the Sacramento-San Joaquin Delta Methylmercury TMDL (CVRWQCB 2011). The TMDL was created to control methylmercury and total mercury in the Sacramento-San Joaquin River Delta Estuary, which is applicable to the Delta, Yolo Bypass, and their waterways (CVRWQCB 2010a). The waterways include the major tributaries to the Delta, the Sacramento River, eastside streams, and the San Joaquin River. Fish tissue and waterborne mercury concentration data for these water bodies are summarized in Tables 6.19 and 6.20.

Table 6.19 Fish and Waterborne Methylmercury (as Total Mercury) Concentrations by Delta Subarea

	Delta Subarea[1]				
	Sacramento River	**Mokelumne River**	**Central Delta**	**San Joaquin River**	**West Delta**
Fish (Sampled in September/October 2000) (mg/kg wet weight)					
Standardized 350-mm Largemouth Bass[2]	0.72	1.04	0.19	0.68	0.31
Water (Sampled between March and October 2000) (ng/l)					
Average	0.120	0.140	0.055	0.147	0.087
Median	0.086	0.142	0.032	0.144	0.053
Water (Sampled between March 2000 and April 2004) (ng/l)					
Annual Average	0.108	0.166	0.060	0.160	0.083
Annual Median	0.101	0.161	0.051	0.165	0.061
Cool Season[3] Average	0.137	0.221	0.087	0.172	0.106
Cool Season[3] Median	0.138	0.246	0.077	0.175	0.095
Warm Season[3] Average	0.094	0.146	0.050	0.156	0.075
Warm Season[3] Median	0.089	0.146	0.040	0.162	0.055

Source: Adapted from CVRWQCB 2010a.

1 Location of each water and fish collection site provided on Figure 5.1 of the 2008 Draft Staff Report for the Sacramento-San Joaquin Delta Estuary TMDL for Methylmercury (CVRWQCB 2010a).

2 See CVRWQCB 2010a for the method used to calculate standard 350-mm Largemouth Bass mercury concentrations.

3 For this analysis, “cool season” is defined as November through February and “warm season” is defined as March through October.

Table 6.20 Historical Methylmercury Concentrations in the Five Delta Source Waters for the Period 2000-2008

Source Water	**Sacramento River**		**San Joaquin River**		**San Francisco Bay**		**East Side Tributaries**		**Agriculture in the Delta**	
	Total[2]	**Dissolved[3]**	**Total[2]**	**Dissolved[3]**	**Total[2]**	**Dissolved[3]**	**Total[2]**	**Dissolved[3]**	**Total[2]**	**Dissolved[3]**
Mean[1] (ng/L)	0.10	0.05	0.15	0.03	0.032	-	0.22	0.08	0.51	-
Minimum (ng/L)	0.06	0.02	0.09	0.01	-	-	0.02	0.02	0.02	-
Maximum (ng/L)	0.16	0.12	0.26	0.08	-	-	0.32	0.41	5.44	-
75th Percentile (ng/L)	0.13	0.08	0.18	0.06	-	-	0.2	0.15	0.53	-
99th Percentile (ng/L)	0.16	0.12	0.26	0.08	-	-	0.31	0.39	4.81	-
Data Source	CEDEN 2014 (Irrigated Lands Regulatory Program)		Central Valley Water Board 2010a		SFEI 2014b	-	Central Valley Water Board 2010a		Heim et al. 2009	-
Station(s)	Sacramento River at Freeport		San Joaquin River at Vernalis		Suisun Bay		Mokelumne and Calaveras Rivers		Delta locations	
Date Range	12/2006-08/2007		2000-2001; 2003-2004	2000-2002	2008	-	2000-2001; 2003-2004	2000-2002	10/2005-03/2008	-

Source Water	Sacramento River		San Joaquin River		San Francisco Bay		East Side Tributaries		Agriculture in the Delta	
	Total[2]	**Dissolved[3]**	**Total[2]**	**Dissolved[3]**	**Total[2]**	**Dissolved[3]**	**Total[2]**	**Dissolved[3]**	**Total[2]**	**Dissolved[3]**
ND Replaced with RL	No		Not Applicable	Yes	-		Yes		Not Applicable	
Data Omitted	No		None		-		None		None	
No. of Data Points	8	8	49	25	-	-	27	9	183	-

Source: Adapted from DWR, Reclamation, USFWS and NMFS 2013.

1 Geometric mean.

2 Total recoverable concentration of analyte.

3 Dissolved concentration of analyte.

For the protection of the beneficial uses of the Sacramento – San Joaquin Delta, water quality objectives were specified in the San Francisco Bay Mercury TMDL (Table 6.21) and the Sacramento-San Joaquin Delta Methylmercury TMDL (Table 6.22).

Table 6.21 Water Quality Objectives for Total Mercury in the Delta within the San Francisco Bay Region[1]

For the protection of human health	0.2 mg/kg wet weight mercury in fish tissue[2]
For the protection of aquatic organisms and wildlife	0.03 mg Hg/kg in fish[3]
1-hour average	2.1 µg/l, in water

Source: SFB RWQCB 2013

1 Water quality objectives are applicable to Sacramento/San Joaquin River Delta (within the San Francisco Bay region as specified in the SFB RWQCB Basin Plan, 2013), Suisun Bay, Carquinez Strait, and San Pablo Bay.

2 measured in the edible portion of trophic level 3 and trophic level 4 fish

3 measured in whole fish 3-5 cm in length

Table 6.22 Water Quality Objectives for total mercury in the Delta within the Central Valley

Water body	Wet Weight Methylmercury Concentration of Fish Tissue (mg/kg wet weight)	
	Trophic Level 3 Fish	Trophic Level 4 Fish
Cache Creek, North Fork Cache Creek, and Bear Creek	0.12	0.23
Harley Gulch	0.05[1]	–
Sacramento-San Joaquin Delta[2] and Yolo Bypass	0.08[3], 0.03[4]	0.24[3], 0.03[4]

Source: CVRWQCB 2011

1 Applies to whole fish of trophic levels 2 and 3.

2 Applies to the 146 Sacramento-San Joaquin Delta and Yolo Bypass waterways listed in Appendix 43 of the Basin Plan for the Sacramento River and San Joaquin River Basins.

3 Applies to fish of total length 150-500 mm.

4 Applies to whole fish less than 50 mm in length.

Methylation processes in the Delta are enhanced by environmental characteristics such as the source of inorganic mercury, nutrient enrichment, dissolved oxygen in the water column, sediment organic content and grain size, water residence time and sediment accumulation, periodic drying and wetting, and fish species and age structure (Alpers et al. 2008). The mercury-laden sediment that accumulates in the Delta as a result of waterborne loading is subject to methylation (Heim et al. 2007). Waterborne methylmercury in the Delta may be a more significant factor to bioaccumulation in fish than mercury-laden sediment that is subject to methylation (Melwani et al. 2009). Another factor affecting bioaccumulation in fish may be dissolved organic carbon (DOC). Laboratory studies have shown mercury uptake is much higher in water with lower DOC (as might be expected from the tributaries versus the interior Delta) (Pickhardt et al. 2006).

Mercury exposure and methylation can affect the beneficial uses of the Sacramento-San Joaquin Delta, and receiving waters downstream such as the Suisun Bay, Carquinez Strait, San Pablo Bay, and San Francisco Bay. To protect the beneficial uses of the water body a narrative water quality objective was specified, in addition to numeric water quality objectives, stating that surface waters are to "…be maintained free of toxic substances in concentrations that are toxic to or that produce detrimental physiological responses to human, plant, animal, and aquatic life" (CVRWQCB 2011).

In an effort to meet the water quality objectives, the CVRWQCB plans to continue monitoring metals in the Delta and control mass emissions from inactive or abandoned mines and other significant sources (CVRWQCB 2011). The ongoing interest in controlling mercury in fish in the Delta has spawned the Mercury Exposure Reduction Program (MERP), developed by the CVRWQCB, with the goal of pooling the resources of mercury dischargers to develop reduction programs and a better understanding of mercury bioaccumulation in Delta fish (MERP 2012). The MERP is designed to build on previous CALFED efforts. MERP was included as part of an amendment to the Sacramento River and San Joaquin River Basins Basin Plan in 2011 (CVRWQCB 2011), and is applicable to people eating one meal of trophic level 3 or 4 fish per week (32 g/day) from the Delta and Yolo Bypass, as well as their waterways. The two-phase program was put into effect October 20, 2011 and will be completed in 2030. Phase 1 consists of implementing programs to minimize pollution, implementing interim mass limits for point sources, and controlling potentially methylated sediment-bound mercury in the Delta and Yolo Bypass. Phase 1 also includes developing a program to control mercury in tributaries upstream. Plans for Phase 2 include implementing control programs and monitoring compliance. In addition to the Delta Control Mercury Program, the CVRWQCB designated load and waste load allocations for point sources within and to the Delta as specified in the Basin Plan.

6.3.3.3.3 Selenium

Selenium is a constituent of concern for the Sacramento-San Joaquin River Delta and the Delta was placed on the 303(d) list in 2010 (SWRCB 2011a). Selenium criteria were promulgated for all San Francisco Bay and Delta waters in the NTR (SFB RWQCB 2011a). Although the entire San Francisco Bay is listed as impaired by selenium, the TMDL for the San Francisco Bay focuses on the North San Francisco Bay (North Bay, defined to include a portion of the Delta, Suisun Bay, Carquinez Strait, San Pablo Bay, and the Central Bay) because sources there are substantially different from sources in the South San Francisco Bay (South Bay) (Lucas and Stewart 2007). The NTR criteria specifically apply to San Francisco Bay upstream to and including Suisun Bay and the Delta. The NTR values are 5.0 µg/l (4-day average) and 20 µg/l (1-hour average).

Selenium concentrations in whole-body fish and in bird eggs are most useful for evaluating risks to fish and bird wildlife receptors (Skorupa and Ohlendorf 1991; DOI 1998; Ohlendorf 2003). Analyses of dietary items (such as benthic [sediment-associated] or water-column invertebrates) can be used for evaluating risks through dietary exposure, although with less certainty than when using concentrations measured in fish or wildlife receptors. The USEPA (2014b) released draft water quality criteria for public comment in May 2014 for selenium in fish tissue; they include 15.2 mg/kg in egg/ovary, 8.1 mg/kg whole body, or 11.8 mg/kg muscle (skinless, boneless fillet).

A large number of fish tissue samples were collected from the Sacramento and San Joaquin River watersheds and the Delta between 2000 and 2007 (Foe 2010). As part of the Strategic Workplan for Activities in the San Francisco Bay/Sacramento–San Joaquin Delta Estuary (SWRCB 2008a), archived Largemouth Bass samples were analyzed for selenium to investigate possible sources of selenium being bioaccumulated in bass in the Delta and whether selenium concentrations in bass were above recommended criteria for the protection of human and wildlife health (Foe 2010). Results of this study are the most relevant biota data from the Delta, and they are summarized in Table 6.23 to compare to tissue guidelines.

Table 6.23 Selenium Concentrations in Largemouth Bass

Site	Number of Samples	Selenium Concentrations in Fish Fillets (mg/kg, wet weight)			Selenium Concentrations in Whole-Body Fish (mg/kg, dry weight)			Years
		Min.	Max.	Mean	Min.	Max.	Mean	–
Sacramento River at Veterans Bridge	3	0.40	0.81	0.56	1.7	2.9	2.2	2005
Sacramento River at River Mile 44[a]	9	0.27	0.72	0.46	1.2	2.7	1.9	2000, 2005, 2007
Sacramento River near Rio Vista	9	0.30	0.80	0.44	1.3	3.2	1.9	2000, 2005, 2007
San Joaquin River at Freemont Ford	3	0.35	0.46	0.48	1.46	2.44	1.9	2005
San Joaquin River at Vernalis	8	0.15	0.63	0.40	0.77	2.5	1.7	2000, 2005, 2007
Old River near Tracy	3	0.45	0.69	0.55	2.0	2.9	2.4	2005
San Joaquin River at Potato Slough	9	0.22	0.89	0.38	1.1	3.5	1.6	2000, 2005, 2007
Middle River at Bullfrog	6	0.37	0.58	0.47	1.6	2.3	2.0	2005, 2007

Site	Number of Samples	Selenium Concentrations in Fish Fillets (mg/kg, wet weight)			Selenium Concentrations in Whole-Body Fish (mg/kg, dry weight)			Years
		Min.	Max.	Mean	Min.	Max.	Mean	–
Franks Tract	8	0.15	0.70	0.37	0.79	3.0	1.7	2000, 2005, 2007
Big Break	9	0.15	0.82	0.38	0.81	3.1	1.6	2000, 2005, 2007
Discovery Bay	3	0.32	0.41	0.37	1.5	1.7	1.6	2005
Whiskey Slough	2	0.35	0.47	0.41	1.6	1.9	1.7	2005

Source: Foe 2010

Notes: Means are geometric means.

Max. = maximum, mg/kg = milligrams per kilogram, Min. = minimum.

a. Near Clarksburg.

Average selenium concentrations varied slightly in Largemouth Bass caught in the Sacramento River between Veterans Bridge and Rio Vista in 2005, as well as on the San Joaquin River between Fremont Ford and Vernalis (Foe 2010). These concentrations also varied slightly among years (2000, 2005, and 2007) in the Sacramento River at Rio Vista and in the San Joaquin River at Vernalis. The lack of a significant difference in bioavailable selenium between the two river systems was unexpected because the San Joaquin River is considered a significant source of selenium to the Delta. Selenium concentrations in the Largemouth Bass were compared to criteria recommended for the protection of human health (based on fillets; 2 mg/kg, wet weight) and fish and wildlife health (based on whole-body fish; concern threshold of 4–9 mg/kg, dry weight) (Foe 2010). Geometric means and maximum concentrations (Table 6.23) did not exceed the draft criteria.

Sporadic sampling of selenium has been conducted at a few locations in the Delta. Five major sources, shown in Table 6.24, are Sacramento River, Yolo Bypass, Eastside Delta Tributaries, San Joaquin River, and Martinez/Suisun Bay. Total selenium concentrations in Sacramento and San Joaquin river surface waters just upstream of Mallard Island (near the western limit of the Delta [Regional Monitoring Program stations BG20 and BG30, respectively]) are considered more representative of generalized Delta concentrations than of the individual rivers (SWRCB 2008a). Total and dissolved selenium concentrations were somewhat lower at those locations during low flow in a dry year (<0.1 µg/l in August 2001) than during high flow (>0.1 µg/l in February 2001) (SWRCB 2008a). Cutter and Cutter (2004) reported similar flow-related patterns for those locations. The maximum selenium concentration found in the Delta was 2 µg/l at an Old/Middle River location in the south subarea of the Delta. Except for that location, the available data show geometric mean concentrations well below 1 µg/l.

Table 6.24 Selenium Concentrations in Water at Inflow Sources to the Delta

Source Water[1]	**Sacramento River**	**San Joaquin River**	**San Francisco Bay**	**East Side Tributaries[3]**	**Agriculture in the Delta**
Mean[2] (ng/L)	0.10	0.54	0.09	0.1	0.11
Minimum (ng/L)	0.04	0.07	0.03	0.1	0.11
Maximum (ng/L)	0.23	1.50	0.45	0.1	0.11
75th Percentile (ng/L)	0.11	0.76	0.12	0.1	0.11
99th Percentile (ng/L)	0.23	1.50	0.44	0.1	0.11
Data Source	USGS Website 2014b	USGS Website 2014c	SFEI 2014b	None	Lucas and Stewart 2007
Station(s)	Sacramento River at Freeport	San Joaquin River at Vernalis	Central-West; San Joaquin River Near Mallard Island	None	Mildred Island, Center
Date Range	11/2007-07/2014	11/2007-08/2014	02/2000-08/2013	None	2000, 2003-2004
ND Replaced with RL	Not Applicable	Not Applicable	Yes	Not Applicable	No
Data Omitted	None	None	-	Not Applicable	No
No. of Data Points	88	93	14	None	1

Sources: Adapted from DWR, Reclamation, USFWS and NMFS 2013; U.S. Geological Survey 2014b,c; San Francisco Estuary Institute 2014b; Lucas and Stewart 2007

1 Dissolved selenium concentration.

2 Geometric mean.

3 Dissolved selenium concentration in Mokelumne, Calaveras, and Cosumnes Rivers is assumed to be 0.1 µg/L because of lack of available data and lack of sources that would be expected to result in concentrations greater than 0.1 µg/L

In efforts to address the selenium in the Delta and water bodies downstream, the SFB RWQCB is conducting a new TMDL project to address selenium toxicity in the North Bay (SFB RWQCB 2011, 2013). The North Bay selenium TMDL will identify and characterize selenium sources to the North Bay and the processes that control the uptake of selenium by fish and wildlife. The TMDL will quantify selenium loads, develop and assign waste load and load allocations among sources, and include an implementation plan designed to achieve the TMDL and protect beneficial uses.

USEPA's Action Plan for Water Quality Challenges in the San Francisco Bay/Sacramento-San Joaquin Estuary (USEPA 2012a) identifies selenium as one of seven priority items for action. The plan indicated that USEPA will draft new site-specific numeric selenium criteria by December 2012 to protect aquatic and terrestrial species dependent on the aquatic habitats of the Bay Delta Estuary. More stringent selenium water quality criteria will require actions that decrease allowable concentrations of selenium in surface waters of the Bay Delta Estuary and may set allowable levels of selenium in the tissue of fish and wildlife. Following the development of the Bay Delta selenium criteria, USEPA plans to develop site-specific criteria for other parts of California, including the San Joaquin Valley watershed (USEPA 2012a). USEPA also is engaged in other efforts to minimize selenium discharges to the San Joaquin River and the Bay Delta Estuary, including the Grasslands Bypass Project and the North San Francisco Bay TMDL.

6.3.3.3.4 PCBs

The Sacramento-San Joaquin River Delta was placed on the 303(d) list approved by the USEPA in 2010 as impaired by PCBs (SWRCB 2011a). A TMDL for PCBs in the Sacramento River from Knights Landing to the Delta is expected to be completed in 2021 to protect the beneficial uses of the Sacramento River and other water bodies downstream (SWRCB 2011ax).

6.3.3.3.5 Pesticides

Sacramento-San Joaquin River Delta (central, eastern, northern, northwestern, southern, western portions, the export area, and the Stockton Ship Channel) were placed on the Section 303(d) List approved by the USEPA in 2010 as impaired by pesticides (chlorpyrifos, DDT, Diazinon, Group A Pesticides, Chlordane, Dieldrin, Dioxin, and Furan and Dioxin compounds) (SWRCB 2011a).

Samples were collected from Sacramento River at Rio Vista, near Hood along the Sacramento/Yolo County line, San Joaquin River at Highway 4 and Antioch, 1 1/2 miles upstream from the Mossdale launch ramp, and other locations north portion of the Delta waterways (SWRCB 2011at-bb).

In an effort to meet the water quality standards in Sacramento-San Joaquin River Delta, TMDLs are expected to be complete in 2019 with the exception of the TMDL for chlorpyrifos and diazinon. A Delta Diazinon and Chlorpyrifos TMDL Project was approved in 2007.

6.3.3.3.6 Nutrients

The Sacramento-San Joaquin River Delta was not placed on the 303(d) list approved by USEPA in 2010 as impaired by nutrients (SWRCB 2011a). However, nutrients are a cause of concern in the Delta (e.g., CVRWQCB 2010j) and have been the subject of discussion. A decline in pelagic fish species in the Delta, known as the pelagic organism decline (POD), including the endangered California Delta smelt, may be related to bottom-up effects from nutrients among other drivers (Baxter et. al. 2010; Sommer et al. 2007). However, unlike most waterbodies where nutrients cause too much primary production, the problem affecting beneficial uses in parts of the Delta is too little primary production to support fish populations. Nutrient effects are also dependent on flow and other factors (e.g., temperature, turbidity, and invasive species) that are potentially associated with the POD. Specific hypotheses for an association between nutrients and the POD are that ammonium (a dominant form of nitrogen in the Delta and Suisun Bay, inhibits the uptake of nitrate which is a better fuel for algae blooms (Dugdale et al. 2007) and that changes in nutrient forms and rations have caused a shift in the food web (Glibert et al. 2011). Alternatively, causes of the POD may be related to reduced phosphorus that has become a limiting factor for primary production (Van Nieuwenhuyse 2007), or that invasive clam consumption of algae have made this food source unavailable to zooplankton and fish since their introduction in the mid-1980s (Lucas and Thompson 2012; Kimmerer et al. 1994).

The Delta is a major source of anthropogenic ammonium loading to the Suisun Bay, which exchanges nutrients with Suisun Marsh, an estuarine habitat impaired by nutrients (Senn et al. 2014, Tetra Tech Inc. and WWR 2013). Primary sources of nutrients are erosion, agricultural runoff, urban runoff, and treated effluent. The Sacramento Regional Wastewater Treatment Plant (SRWTP) is the largest major point source of ammonium in the Delta, contributing 90 percent of ammonium in the river from 1986 to 2005 (Jassby 2008). Nitrogen inputs to the Delta will change as SRWTP's current NPDES permit (NO. CA0077682) includes effluent limits for nitrogen that require the addition of nitrification and denitrification treatment by 2020. Another source of ammonium loading has already changed as the Stockton Regional Wastewater Control Facility, which discharges to the San Joaquin River began implementing nitrification and denitrification treatment in 2007 (SWRCB 2012b).

Nutrients, primarily nitrogen and phosphorous, may trigger excessive growth of algae or toxic blue-green cyanobacteria. However, within the Delta, it is generally recognized that nutrients are too high in concentration to be limiting (as compared to light, for example) (Jassby et al. 2002). The secondary effects of nutrient enrichment and oxygen depletion are most often found in the central and southern Delta near Stockton rather than the Sacramento River.

6.3.3.3.7 Dissolved Oxygen

The Stockton Ship Channel in the Delta waterways was placed on the Section 303(d) list approved by the USEPA in 2010 as impaired by dissolved oxygen (SWRCB 2011a).

Low dissolved oxygen is of concern in the central and southern Delta because of enhanced treated effluent loading from Stockton, agricultural runoff, and reduced flushing of dead-end channels. Middle River, Old River, and the Stockton Deep Water Ship Channel are listed as impaired due to dissolved oxygen depletion, with dissolved oxygen concentrations criteria set at 6 mg/L minimum for the San Joaquin River between Turner Cut and Stockton between September 1 and November 30 (SWRCB 2011a, SWRCB 2006a). Loading from the Stockton Regional Wastewater Control Facility had the greatest effect in reducing DO, with hydrologic flushing (as related to upstream river flows, upstream discharges of materials that increase biological oxygen demand), geometrical cross-sections of the channels, temperature, and phytoplankton being less important (Jassby and Niewenhuyse 2005). Following recent upgrades to the Stockton Regional Wastewater Control Facility in 2006, less oxygen demand constituents have been discharged into the channels.

A TMDL addressing impairment due to dissolved oxygen was approved by the USEPA in 2007 to meet the water quality standards in the Stockton Ship Channel.

6.3.3.3.8 Organics and Pathogens

The Stockton Ship Channel in the Delta waterways was placed on the Section 303(d) list approved by the USEPA in 2010 as impaired by organic enrichment and pathogens (SWRCB 2011a).

The Delta as a source of drinking water is impaired through the presence of disinfection byproducts from treated wastewater effluent and the interactions with bromide and dissolved organic carbon, which may produce potentially harmful disinfection byproducts such as the carcinogenic trihalomethanes and haloacetic acid (Healey et al. 2008). Bromide and organic carbon are natural chemical constituents of the estuarine ecosystem but they exacerbate drinking water quality impairment through discharges, agriculture drainage, or water management, when combined with disinfectants during water treatment processes. Changes to flow or use patterns or discharges to the Delta must be examined for their potential effects to concentrations of these disinfection byproduct precursors and compounds.

Pathogens are another potential concern impairing the Delta for drinking water use. Giardia and Cryptosporidium are common protozoans found in urban runoff and sometimes found to be in exceedance of drinking water standards in the Delta (SWRCB 2007). A TMDL addressing impairment due to pathogens was approved by the USEPA in 2008 to meet the water quality standards in the Stockton Ship Channel.

6.3.3.3.9 Invasive Species

Sacramento-San Joaquin River Delta (central, eastern, northern, northwestern, southern, western portions, the export area, and the Stockton Ship Channel) was placed on the Section 303(d) list approved by the USEPA in 2010 as impaired by invasive species (SWRCB 2011a).

A TMDL addressing impairment due to invasive species is expected to be completed in 2019 in an effort to meet the water quality standards in Sacramento-San Joaquin River Delta (central, eastern, northern, northwestern, southern, western portions, the export area, and the Stockton Ship Channel).

6.3.3.3.10 Unknown Toxicity

Sacramento-San Joaquin River Delta (central, eastern, northern, northwestern, southern, western portions, the export area, and the Stockton Ship Channel) were placed on the Section 303(d) list approved by the USEPA in 2010 as impaired by unknown toxicity (SWRCB 2011a).

A TMDL is expected to be completed in 2019 to protect the beneficial uses of Sacramento-San Joaquin River Delta and its waterways, including impaired warm fresh water habitat.

6.3.3.4 Suisun Bay and Suisun Marsh

Suisun Bay and Suisun Marsh are located in transition zones between upstream fresh water inputs and tidal saline flux from San Francisco Bay. Beneficial uses of these areas are summarized in Table 6.2. Constituents of concern are summarized in Table 6.1.

Historically, the chlorophyll maxima were found to coincide with the mixing (entrapment) zone but recent alterations by invasive species of benthic grazing clams has greatly altered the Suisun Bay food web and these historical patterns (Kimmerer 2004; Jassby et al. 2002). Although turbidity remains high and limiting to primary productivity in Suisun Bay, there has been a long term trend toward increased water clarity. Suisun Bay has low retention time, low salinity (average of 5.8 ppt), low nutrients, and high particulate matter and light attenuation (Cloern and Jassby 2012).

6.3.3.4.1 Salinity

The Suisun Marsh Wetlands was placed on the 303(d) list approved by the USEPA in 2010 for impairment by salinity. The wetlands are also impaired by TDS and chlorides (SWRCB 2011a).

In an effort to protect the beneficial uses, including estuarine habitat, narrative and numeric objectives were specified by the SWRCB in Decision 1641. The CVP and SWP are operated to achieve salinity objectives in the Delta, as described in detail in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations.

The salinity objective in Suisun Bay, X2, which is the location, as measured in kilometers upstream from the Golden Gate bridge, of the 2 ppt isohaline (2.64

mS/cm) was established as part of the Water Quality Control Plan of 1995 (SWRCB 1995). X2 is a constantly fluctuating position in the continuum between the Delta fresh water (salinity less than 2 ppt) upstream and San Francisco Bay tidal influence, downstream (salinity greater than 2 ppt).

6.3.3.4.2 Mercury

Mercury is a constituent of concern for Suisun Bay and Suisun Marsh, which were placed on the 303(d) list in 2010 (SWRCB 2011a). For the Suisun Bay, a TMDL was specified in the San Francisco Bay Mercury TMDL (SFB RWQCB 2013), which was approved by the USEPA in February 2008 and the implementation plan is expected to attain the water quality standard 20 years after the approval. For the Suisun Marsh, a TMDL was specified in the Sacramento-San Joaquin Delta Methylmercury TMDL (CVRWQCB 2010a) and was completed in September 2012 (SFB RWQCB 2012a).

Water quality objectives for Suisun Bay are specified in the San Francisco Bay Mercury TMDL (SFB RWQCB 2013). Suisun Marsh standards, as specified in Suisun Marsh TMDL, are shown in Table 6.25 (SFB RWQCB 2012a). There are future plans to adopt the Suisun Bay standards for the Suisun Marsh as well as implementation plans to improve the water quality in Suisun Marsh.

Table 6.25 Water Quality Objectives for Total Mercury in Suisun Marsh

For the Protection of Marine and Freshwater Aquatic Life	4-day average (adverse effects from acute toxicity[1])	0.25 µg/l
	1-hour average (adverse effects from chronic toxicity)	2.1 µg/l

Source: SFB RWQCB 2012a

1 Applicable to marine aquatic life, where salinity is greater than 10 parts per thousand. The same objectives apply to freshwater aquatic life because the marine objective is more stringent.

6.3.3.4.3 Selenium

Although the Suisun Marsh Wetlands is not identified as an impaired water body for selenium contamination on the 303(d) list in 2010, selenium is identified as a cause for impairment for the adjacent water body, Suisun Bay (SWRCB 2011a).

The impairment of Suisun Bay by selenium can be attributed to exotic species as well as discharge from industrial point sources and natural sources (SWRCB 2011bd). *Corbula (Potamocorbula) amurensis*, a species of clam that is an important food source for sturgeon and certain ducks, is a bioaccumulator for selenium (Beckon and Maurer 2008). This exotic species was first discovered in Suisun Bay in 1986 and became very common by 1990 from San Pablo Bay through Suisun Bay (Cohen 2011). Industrial point sources, such as oil refineries, discharge waste containing selenium to the Suisun Bay (SFB RWQCB 2011).

To best protect the most susceptible fish, white sturgeon, from selenium toxicity, a TMDL for Selenium in the North San Francisco Bay, defined to include also a portion of the Delta, Suisun Bay, Carquinez Strait, San Pablo Bay, and the Central

Bay, is being completed and a Preliminary Project Report was released in 2011 (SFB RWQCB 2011). A range of concentrations for selenium in fish tissue from 6.0 to 8.1 µg/g dry weight was proposed as a numeric target. This range is based on the minimal effects of selenium in whole-body freshwater fish and the 10 percent effect level concentration.

6.3.3.4.4 Nutrients

Suisun Marsh is a water body in the San Francisco Bay that was placed on the Section 303(d) list approved by USEPA in 2010 as impaired by nutrients (SWRCB 2011a).

According to the Final California 2010 Integrated Report (303(d) list/305(b) Report) Supporting Information, nutrients in Suisun Marsh can be attributed to flow regulation/modification and urban runoff/storm sewers (SWRCB 2011bc). More specific sources of nutrients to Suisun Marsh include agricultural, urban, and livestock grazing drainage through tributaries, the Sacramento River and San Joaquin River through the Sacramento-San Joaquin River Delta, nutrient exchange with Suisun Bay, atmospheric deposition, and discharge from the Fairfield Suisun Sewer District wastewater treatment plant (Tetra Tech Inc. and WWR 2013).

Concentrations of ammonia from 2000-2011, in the receiving waters from Boynton, Peytonia, Sheldrake and Chadbourne Sloughs (0-0.4 mg/l), as well as in Suisun Slough (0-0.3mg/l), exceeded the maximum water quality objective concentration for ammonia (Tetra Tech Inc. and WWR 2013). Elevated concentrations of chlorophyll-a, in comparison to concentrations at reference sites at Mallard, suggest possible impairments by nutrients. Other possible impairments of the narrative criteria by nutrients were suggested resulting in excess algal growth in wetlands, elevated organic carbon, and impacts on dissolved oxygen and mercury methylation.

6.3.3.4.5 Dissolved Oxygen

Suisun Marsh Wetlands were placed on the 303(d) list approved by the USEPA in 2010 for dissolved oxygen impairment (SWRCB 2011a). Insufficient dissolved oxygen can alter the well-being of the estuarine habitat, fish spawning, warm freshwater habitat, and wildlife habitat (SFB RWQCB 2013).

Flow regulation and modification, as well as urban runoff and storm sewers dictate the dissolved oxygen levels in the marsh (SWRCB 2011bc). Specific oxygen demanding sources that cause low dissolved oxygen levels are “grazed open areas, nutrient-enriched wastewater discharge from Fairfield-Suisun Sewer District, wastes from boats in Suisun City marina, and tidal marshes,” in addition to tides, delta outflow, agricultural drainage from surrounding watersheds and urban areas, and managed wetlands (Tetra Tech, Inc. and WWR 2013). Slough size and hydrology also influenced the low dissolved oxygen conditions in Suisun Marsh Wetlands (Siegel et al. 2010).

Low dissolved oxygen levels in exceedances of water quality objectives between 2000 and 2011 in Suisun Slough, Montezuma Slough, and Goodyear Slough are presented in Table 6.26 (Tetra Tech, Inc. and WWR 2013).

Table 6.26 Percentage of Observations Exceeding Water Quality Objectives for Dissolved Oxygen

Location	WQO Exceedances	
	7 mg/l	**< 80% Saturation[1]**
Suisun Slough	10 – 40%	2%
Montezuma Slough	< 10%	60 – 68%
Goodyear, Peytonia, and Boynton Sloughs	> 50%	73 – 94%[2]

Source: Tetra Tech, Inc. and WWR 2013

1 3-month median above 80 percent dissolved oxygen saturation

2 Lower Goodyear Slough exceeded the 3-month media above 80 percent dissolved oxygen saturation 48.1 percent of the time

To further protect the beneficial uses of the Suisun Marsh Wetlands from low dissolved oxygen concentrations, water quality objectives more representative of natural conditions are currently being developed (Tetra Tech, Inc. and WWR 2013). A TMDL for Suisun Creek, a tributary of Suisun Marsh Wetlands that is impaired by low dissolved oxygen, is expected to be completed in 2021 (SWRCB 2011bc).

6.3.3.4.6 Organics

Suisun Marsh was placed on the 303(d) list approved by USEPA in 2010 for organic enrichment (SWRCB 2011a). Organic enrichment enhances microbial production and activity, such as the methylation of mercury, and the decomposition of organic matter can cause low dissolved oxygen levels (Tetra Tech, Inc. and WWR 2013).

6.3.3.4.7 Pesticides

Suisun Bay, and other water bodies in the San Francisco Bay area including Carquinez Strait and San Pablo Bay were placed on the Section 303(d) list for pesticides (chlordane, DDT, dieldrin) contamination per the list approved by USEPA in 2010 (SWRCB 2011a). However, according to the 2013 Regional Monitoring Program Report, pesticides (chlordane, DDT, and dieldrin) in the estuary are being considered for delisting (SFEI 2013).

A TMDL for the Diazinon and Pesticide-related Toxicity in Urban Creeks was added as an amendment to the Basin Plan and was approved by the USEPA in 2007 (SFB RWQCB 2005).

6.3.3.4.8 PCBs

Suisun Bay, and several other water bodies within San Francisco Bay area including Carquinez Strait and San Pablo Bay, were placed on the Section 303(d) list for the contamination of PCBs per the list approved by USEPA in 2010 (SWRCB 2011a). The following is applicable to all water bodies specified in the San Francisco Bay PCBs TMDL, including Suisun Bay, Carquinez Strait, and San Pablo Bay (SFB RWQCB 2013).

A TMDL was approved by the USEPA in 2010. The TMDL allows 10 kilograms of PCBs to be discharged to San Francisco Bay per year (SFB RWQCB 2013). It is projected that this load allocation will be achieved in 20 years with implementation of plans and actions for external and internal sources, such as municipal and industrial dischargers, as stated in the San Francisco Bay TMDL.

6.3.3.4.9 Other Constituents of Concern

Suisun Bay was placed on the Section 303(d) list for invasive species contamination per the list approved by USEPA in 2010 (SWRCB 2011a).

Invasive species in Suisun Bay can be attributed to ballast water, fresh or salt water placed on a ship for stability (SWRCB 2011bd). *Corbula (Potamocorbula) amurensis*, a native clam of southern China estuaries, was discovered in Suisun Bay in 1986 and was introduced to San Pablo Bay shortly after (USFWS and NSGCP 1995). This species of clam is important as a food source for sturgeon, diving ducks, etc. and consequently a bioaccumulator of selenium (USFWS 2008). Other species introduced to the Suisun Bay are reported in the *Nonindigenous Aquatic Species in a United States Estuary: A Case Study of the Biological Invasions of the San Francisco Bay and Delta* (USFWS and NSGCP 1995).

Invasive species can affect the beneficial uses of Suisun Bay, as listed in Table 6.2, including estuarine habitat. For the protection of marine aquatic life, a TMDL is expected to be completed in 2019.

Other contaminants in the Suisun Bay include furan compounds and dioxin compounds. These contaminants were placed on Section 303(d) list per the list approved by USEPA in 2010 (SWRCB 2011bd).

6.3.4 Delta Water Quality Issues for CVP and SWP Water Users

The designated beneficial uses and constituents of concern for the study area and for each RWQCB region are described in Section 6.3.1, Beneficial Uses of Surface Waters in the Study Area. In this section, the beneficial uses of water from the Delta are generalized and categorized by purpose of use into those associated with municipal and industrial, agricultural, groundwater recharge, and recycling and blending uses.

6.3.4.1 Municipal and Industrial Uses

The Delta is a source of drinking water supply to over 25 million people, or sixty percent of the state population. The CVP and SWP water users that use water from the Delta as a source of potable water supply for municipal and industrial uses have two main water quality concerns: protection, preservation, and improvement of source water quality; and capability of treatment processes to meet stringent drinking water quality regulatory requirements. To protect public health and safety, water providers apply a multi-barrier approach: seek the highest quality source water available, protect and preserve the source water quality to ensure non-degradation, operate and periodically upgrade drinking water treatment processes, and maintain safe distribution systems.

The Delta, as a drinking water source, is compromised by high levels of naturally occurring and manmade constituents of concern. Some of the naturally occurring constituents, such as organic carbon and nutrients, are necessary components of the Delta ecosystem. Salinity, another natural constituent, is inherent with the tidal cycles of the estuary. Other anthropogenic constituents such as pathogens and contaminants are results of point and non-point source discharges into the Delta.

Water containing organic carbon reacts with chlorine, commonly used as a disinfectant in drinking water treatment processes, to form disinfection byproducts (DBP) such as trihalomethanes and haloacetic acids. Delta waters contain high levels of both dissolved organic compounds and bromide, increasing the formation of DBP. Use of chloramines for disinfection would reduce the production of DBP, but chloramination can lead to the formation of carcinogenic N-nitrosamines, including N-nitrosodimethylamine (NDMA). These interactions complicate the design of drinking water treatment processes and create the necessity to balance and trade off disinfection effectiveness with DBP creation. Balance and tradeoffs are also necessary between source water quality protection and ecosystem restoration actions that could increase the levels of organic carbon.

The Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (Basin Plan) designated drinking water municipal and domestic supply beneficial use for most waters in the Central Valley, including the Delta. It includes narrative objectives for chemical constituents, taste and odor, sediment, suspended material, and toxicity, and numeric objectives for chemical constituents and salinity. The Basin Plan incorporates by reference the primary and secondary maximum contaminant levels specified in Title 22 of the California Code of Regulations for waters designated for municipal uses.

Through the triennial review process, stakeholders prioritized the need for a drinking water policy and identified a number of drinking water constituents of concern including: salt (including bromide), nutrients, organic carbon and pathogens such as *Cryptosporidium* and *Giardia*.

In 2013, the Central Valley RWQCB adopted Resolution No. R5-2013-0098, an amendment to the Basin Plan to establish a drinking water policy for surface waters of the Delta and its upstream tributaries. The amendment was approved by the SWRCB in the same year, and approved by the Office of Administrative Law and US EPA in 2014.

The Amendment modifies the water quality objectives of the Basin Plan to add a narrative water quality objective for *Crytosporidium* and *Giardia*, and clarifies that existing narrative objective for chemical constituents includes drinking water chemical constituents of concern, such as organic carbon. The Amendment also establishes a Drinking Water Policy to maintain high quality of water, anti-degradation, application of water quality objectives, implementation of toxics standards for inland surface waters, enclosed bays, and estuaries, and continued coordinated monitoring, assessment, and reporting of identified drinking water constituents of concern.

6.3.4.1.1 Organic Carbon

Delta water is high in dissolved and suspended organic carbon, due to the high peat soil composition and estuarine environment. Organic carbon combines with disinfectants in drinking water treatment processes to produce DBP that are harmful to human health. In a 1998 study and a 2003 update, expert panels for the California Urban Water Agencies recommended that TOC in the Delta source water should not exceed 3.0 mg/L, in order for Delta-dependent water agencies to be able to meet treated drinking water regulatory requirements. This recommendation was based on an analysis of the various existing and planned treatment processes, residual (distribution systems) disinfection requirements, as well as the interaction among TOC and other DBP precursors.

In the 2013-14 Basin Plan amendment, indicates that the state waters shall not contain chemical constituents in concentrations that adversely affect beneficial uses, and that this includes drinking water chemical constituents of concern, such as organic carbon.

6.3.4.1.2 Bromide and Other Disinfection By-product (DBP) Precursors

Bromide is a naturally occurring constituent in waters subjected to tidal influences such as the Delta. It reacts with ozone, a disinfectant often used for inactivation or removal of *Cryptosporidium* and for controlling taste and odor issues, to form bromate which is a regulated DBP for its cancer-causing potential. The combination of TOC and bromide in Delta waters poses an especially challenging scenario for treatment processes in balancing the need for microbiological removal and minimizing the formation of organically-based brominated DBP. The 1998/2003 expert panels for California Urban Water Agencies recommended that bromide levels should not exceed 50 µg/L in order for Delta-dependent water agencies to be able to meet treated water regulatory requirements.

6.3.4.1.3 Nutrients and Other Discharges

Municipal discharges and agricultural return flows into the Sacramento and San Joaquin river watersheds and the Delta contribute pollutants and constituents of concern that could potentially degrade water quality.

Nutrients such as nitrogen and phosphorus originate from natural sources and from anthropogenic sources including point and non-point source discharges. Although nutrients are necessary for a healthy ecosystem, over enrichment of nitrogen and phosphorus can contribute to eutrophication and toxicity. Eutrophication also results in elevated levels of TOC, a DBP precursor.

In August 2015, USEPA published revisions to the federal Water Quality Standards Regulations required the state to develop implementation methods to conduct analyses if ongoing or future projects would degrade high quality waters. The regulations require analysis of a range of non-degrading or less-degrading alternatives and make a finding that degradation is necessary to accommodate important social or economic development in the area where the waters are located.

The SWRCB's Policy with Respect to Maintaining High Quality of Water in California (Resolution No. 68-16) incorporates the federal antidegradation policy and restricts reductions in water quality even if beneficial uses are protected. The Drinking Water Policy in the 2013-14 Basin Plan amendment stated that drinking water constituents of concern shall continue to be considered when waste discharge facilities conduct antidegradation analyses. The 2013-14 Drinking Water Policy also requires the RWQCBs to consider the necessity for inclusion of monitoring of organic carbon, salinity, and nutrients for waste discharge permit renewals if the facilities are located near drinking water intakes, if a concentration load has significantly increased, and the importance of the data submitted by the discharger to management decisions to protect drinking water.

6.3.4.1.4 Pathogens and Emerging Contaminants

Point and non-point source discharges into Delta waters have the potential to introduce and elevate the levels of pathogens and other contaminants. *Cryptosporidium* and *Giardia* are two main pathogens of concern that are the focus of drinking water regulatory requirements promulgated by USEPA. In addition, other contaminants of emerging concern, particularly pharmaceuticals and personal care products, have been widely distributed and persistent in the environment. These chemicals bio-accumulate and cause endocrine disruption.

The 2013-14 Basin Plan amendment includes a narrative water quality objective for *Cryptosporidium* and *Giardia* within the Sacramento-San Joaquin Delta and its tributaries below the first major dams. Compliance with this objective will be assessed at existing and new public water system intakes to maintain existing levels of pathogens at public water system intakes.

The Basin Plan amendment also includes support of a one-time special study to characterize ambient levels of *Cryptosporidium*, to better understand the relationship between source loading and ambient *Cryptosporidium* concentrations, and to better understand the movement of *Cryptosporidium* through the system.

6.3.4.1.5 Salinity and TDS

Salinity is commonly measured in units of EC or TDS. Salinity standards, in the form of chloride objectives, have been established in the Basin Plan to protect the various beneficial uses. The most restrictive is the 150 mg/L chloride objective for Contra Costa Canal and the City of Antioch intake. The objective was originally established to protect an industrial manufacturing facility that has since closed. In terms of drinking water, bromide is the most critical component of salinity that impacts drinking water treatment processes. No standards have been set for bromide, although there is a MCL for the disinfection byproduct bromate. Secondary MCLs for TDS (500 mg/L), chloride (250 mg/L), and sulfate (250 mg/L) have been set to address cosmetic or aesthetic effects such as staining, mineral deposits, taste, odor, and color. The CV-SALTS Executive Committee is currently considering potential revisions to water quality objectives for secondary MCL, as part of the developing Salt and Nitrate Management Plan for the Central Valley.

Salinity also affects non-potable uses such as industrial processes, irrigation, groundwater recharge, and recycling. High salinity waters may render them infeasible for certain industrial processes, or reduce the efficiency by reducing the number of recirculation cycles. Impacts of salinity on irrigation, groundwater recharge, and recycling are discussed in the following subsections.

Changes in operation of the CVP and SWP could exacerbate salinity and bromide problems, through changes in allowable export pumping windows during the year and for different year types, as well as the operation of the Delta Cross-Channel gates, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations.

6.3.4.2 Agricultural Uses

The main water quality issues related to agricultural use of Delta exported supplies are salinity and drainage, as discussed in the following subsections.

6.3.4.2.1 Salinity, Sodium, and Toxicity

Delta waters are high in salinity due to tidal influence and upstream discharges. High salinity in irrigation water inhibits water and nutrients intake by plants, resulting in yield reduction. Saline conditions could be a result of high salinity source water used for direct irrigation, or saline soil water due to saline water accumulation and poor drainage. Plant uptake of water through osmo-regulation is restricted when the soil water salinity is greater than the internal salinity of the plant. Water with a TDS above 1,500 to 2,600 mg/L (EC greater than 2.25 to 4 mmho/cm) is generally considered problematic for irrigation use on crops with low or medium salt tolerance.

Irrigation water containing high levels of sodium is of special concern because of its potential to create a sodium hazard in the soil. Sodium hazard, expressed as sodium adsorption ratio, is the phenomenon when sodium is adsorbed and becomes attached to soil particles, rendering the soil hard and compact when dry and increasingly impervious to water penetration. Fine textured soils high in clay content are most vulnerable to the sodium hazard.

High salinity in irrigation water could also result in plant toxicity due to accumulation of ions in the leaves. The most common ions which cause toxicity are chloride, sodium, and boron. Boron is particularly troublesome because toxicity can occur in very low concentrations, despite the fact that boron is an essential plant nutrient. Boron can also accumulate in the soil.

Sulfate salts affect sensitive crops by limiting the uptake of calcium and increasing the adsorption of sodium and potassium, upsetting the cationic balance within the plant. High concentrations of potassium may introduce a magnesium deficiency and iron chlorosis.

Different crops have different toleration for salinity, with forage crops being the most resistant and fruit crops being the most sensitive. Crops are also most sensitive to salinity during seed germination, and more tolerant during later growth stages. Changes in salinity of Delta waters due to seasonal fluctuations or different year types may affect crops, depending on the timing within the growth cycle. To protect salt sensitive crops during the irrigation season, the EC overall objectives in the San Joaquin River and the interior southern Delta are generally at 0.7 mS/cm (700 µS/cm) during the irrigation season (April to August) and at 1.0 mS/cm for the remainder of the year.

Generally, salinity in groundwater is higher than surface water in the San Joaquin Valley. Changing from irrigating with surface water to groundwater, due to shortages of CVP and/or SWP water supplies, could exacerbate salinity issues.

6.3.4.2.2 Agricultural Drainage

The Central Valley RWQCB initiated the Irrigated Lands Regulatory Program (ILRP) in 2003 to prevent agricultural runoff containing pesticides, fertilizers, salts, pathogens, and sediment from impairing surface waters. Waste discharge requirements were subsequently developed and adopted to address irrigated agricultural discharges throughout the Central Valley, in order to protect both surface water and groundwater for all beneficial uses. The waste discharge requirements replaced pre-2003 waivers and previous interim regulatory requirements under a Conditional Waiver of Waste Discharge Requirements. All commercial irrigated lands, including nurseries and managed wetlands, are required to obtain regulatory coverage by joining a coalition group, or obtaining coverage as an individual grower under general waste discharge requirements, or obtaining an individual permit.

The recently adopted waste discharge requirements have been expanded to include discharges to groundwater, in order to address the critical need to protect this drinking water source from contaminants such as nitrate that are associated with fertilizer application. The waste discharge requirements are tailored to known threats to water quality and specific geographic areas or commodities.

According to the Central Valley RWQCB, there are about 35,000 growers in the Central Valley and nearly 5 million acres of land that are part of water quality coalition groups. The coalition groups conduct water quality monitoring and analysis, perform vulnerability assessments, prepare regional plans to address water quality problems, determine the effectiveness of management actions, and perform education and outreach to growers. Coalitions are required to prepare Water Quality Management Plans anytime water quality objectives have been exceeded more than once in three years. The growers are required to implement management practices to protect surface and groundwater, especially in areas where monitoring has identified problems associated with irrigated agriculture such as the pesticides chlorpyrifos and diazinon, indicators of pathogens such as *e. coli*, or nitrates. Growers are required to conduct farm evaluations to determine the effectiveness of farm practices in protecting water quality. Nutrient management is a key element for all growers. A certified nitrogen management plan is required for growers in areas where groundwater is known to be severely impacted by nitrates, pesticides or other constituents associated with agriculture.

6.3.4.3 Groundwater Recharge Uses

In addition to direct use for municipal, industrial, and agricultural purposes, some of the CVP and SWP water from the Delta is used for groundwater recharge purposes through direct application or indirect potable recharge by blending with recycled water. The quality of the applied water could affect hydrogeological properties of the aquifer, or impair the quality of groundwater for subsequent use.

Hydrogeological properties of the aquifer could be affected by precipitation reactions between the recharge water and native soil material or groundwater, causing mechanical blockage of aquifer pores. Ion exchange reactions could adversely affect the shrink/swell properties of some clays present in an aquifer. Sodium adsorption is particularly of concern due to the high salinity of Delta water.

Chemical and microbial contaminants in the recharge water could build up in the aquifer and impair the subsequent use of the groundwater. Secondarily treated domestic wastewaters and many industrial wastewaters, urban stormwater drainage, agricultural and rural stormwater runoff, and irrigation return waters contain high concentrations of a wide variety of inorganic and organic, dissolved, particulate, and colloidal contaminants that can adversely impact groundwater and aquifer quality. Nonconventional and emergent contaminants in pharmaceuticals and body care products may not have been removed through conventional secondary treatment. Furthermore, chloramination of wastewater effluents especially during water reuse processes could create NDMA, a known carcinogen. For some CVP and SWP water users, the CVP and/or SWP water supplies are used to dilute some of these potential contamintants to protect groundwater quality.

6.3.4.4 Water Recycling Use

Salinity in Delta waters reduces the utility of the water for reuse or blending purposes by CVP and SWP water users. A higher salinity source water exacerbates the increase in salinity from use and reuse, reducing the applicability of the recycled water for non-potable purposes such as landscape and agricultural irrigation or industrial cooling and reuse. Residential use of water could add 200 to 300 mg/L of TDS to the wastewater stream. Conventional wastewater treatment processes are designed to remove suspended solids but not dissolved solids. Depending on the TDS levels of the source water, the TDS levels in recycled water could reach beyond the threshold of market acceptance for irrigation. TDS removal or demineralization would require an advanced treatment process and add to the cost of recycling.

6.3.4.5 Blending Use

Some SWP water users in Southern California rely on Delta water exported from the SWP to blend with the higher TDS water from the Colorado River. Water imported through the Colorado River Aqueduct has an average TDS of 650 mg/L, and has exceeded 900 mg/L during drought events. Delta water imported through the SWP has a lower TDS by comparison, with an average TDS of 250 to 325 mg/L. The real time TDS levels fluctuate significantly due to variations in hydrology, tidal cycles, and project operations. Article 19 of the SWP long-term water supply contracts contains a water quality objective for TDS of below 440 ppm for monthly averages, and below 220 ppm for 10-year averages. These objectives were set in the 1960s when SWP deliveries were thought to be more assured. Metropolitan Water District of Southern California has used these SWP delivered water quality objectives to set a salinity-by-blending objective of 500 mg/L for its blended supply. Reduced SWP deliveries would pose challenges in meeting this blending objective.

6.3.4.6 San Luis Reservoir Low-Point Issues

As described in Chapter 5, Surface Water Resources and Water Supplies, the San Luis Reservoir provides off-stream storage for CVP water used by Santa Clara Valley Water District and San Benito County Water District. These districts withdraw their CVP supplies from the Upper Pacheco Intake at the San Luis Reservoir. This supply is at risk when water elevations in San Luis Reservoir reach very low levels during late summer and early fall. High temperatures combined with low water levels foster algae growth to as much as 35 feet thick on the water surface. Algae captured in the intake and conveyed to the CVP water users is not suitable for municipal water treatment or agricultural drip irrigation systems. As water levels continue to drop below the level of the intake, water supply to these CVP water users ceases.

The Santa Clara Valley Water District has partnered with Reclamation and the San Luis and Delta-Mendota Water Authority to complete the San Luis Low Point Improvement Project. The project purpose is to identify a feasible alternative that will address the uncertainty of CVP delivery schedules and the water supply reliability problems associated with the low-point issues.

6.3.5 Drought Impacts on Water Quality

California is currently in the fourth consecutive year of a severe drought, with precipitation way below average and record high temperatures. The availability of water supplies throughout the state have declined substantially as described in Section 5.3.4, Surface Water Resources and Water Supplies during Droughts. In addition, there are chronic and significant shortages in supplies and historically low groundwater levels, as described in Chapter 7, Groundwater Resources and Groundwater Quality. Drought conditions affect many Delta water quality constituents, including changes in temperatures and dissolved oxygen conditions in the lower San Joaquin River, temperature in the Sacramento River, and salinity in the Delta.

6.3.5.1 Water Quality Conditions in the Lower San Joaquin River

The San Joaquin River watershed in particular has experienced severely dry conditions, with water year 2012 classified as dry and water years 2013-2015 classified as critically dry. Lack of precipitation has resulted in historically low reservoir storage levels, creating significant concerns about low flows, high temperatures, low dissolved oxygen conditions and other factors that have significant effects on steelhead and fall-run Chinook Salmon.

As described in Section 5.3.4, Surface Water Resources and Water Supplies during Droughts, Reclamation and DWR filed a Temporary Urgency Change Petition (TUCP) with the SWRCB on January 23, 2015, seeking to make changes to their water right permits and license for the CVP and SWP. The TUCP sought changes to D-1641 requirements on flow-dependent and operational water quality objectives. The TUCP was approved in part on February 3, 2015, subject to conditions, and modified on March 5, 2015 and April 6, 2015. Reclamation submitted a request on May 21, 2015 to modify and renew the TUCP Order, which was approved on July 3, 2015 and modified on August 4, 2015 with changes effective through November 30, 2015.

The August 4, 2015 Order conditionally approved a change to Reclamation's water rights to modify the Stanislaus River dissolved oxygen requirement from 7.0 mg/L to 5.0 mg/L at and below Ripon on the Stanislaus River. It also included other conditions, including the development, coordinated implementation, evaluation, and update of operations plans that would affect flows, temperatures and dissolved oxygen conditions, to ensure that the change can be made without unreasonable effects on fish, wildlife, or other instream beneficial uses, and to ensure that the change is in the public interest.

6.3.5.2 Temperature Conditions in the Lower San Joaquin River

Reclamation files an annual Sacramento River Temperature Management Plan to guide the release of water from Shasta Lake in order to maintain downstream water temperatures to protect the fisheries during the higher temperature months of summer and fall. In 2014, temperature targets were not achieved in the upper reaches of the Sacramento River late in the fall, despite Reclamation's efforts.

In early 2015, Reclamation developed a release plan in conjunction with DWR, USFWS, NMFS, CDFW, SWRCB, and others to meet the CVP authorized purposes and regulatory requirements to the extent possible. The plan was submitted and provisionally approved by the SWRCB on May 14, 2015. On May 29, 2015, Reclamation informed the SWRCB that the proposed temperature target will unlikely be met, due to faulty equipment used to obtain temperature data for modeling. The SWRCB suspended the plan in June while Reclamation developed and submitted a revised Temperature Plan on June 25, 2015. On July 1, 2015, NMFS provided conditional concurrence with the revised plan. On July 7, 2015, the SWRCB conditionally approved the June 25, 2015 plan, placing numerous monitoring, consultation, and update requirements on Reclamation, as well as correlating the Temperature Plan with conditions in the July 3, 2015 approved TUCP filed by Reclamation and DWR.

6.3.5.3 Delta Salinity Conditions

As described in Section 5.3.4, Surface Water Resources and Water Supplies during Droughts, in early 2015, as a result of very low precipitation and diminished reservoir storage, DWR planned and installed an emergency drought barrier on West False River in the Delta to help repel salt water intrusion into the central Delta and to minimize the amount of upstream reservoir releases. The barrier installation was completed in early June. Removal began on September 8, 2015 and must be completed by mid-November to provide capacity for wet weather flows in the winter season and to comply with fisheries protection requirements.

In June and July 2015, some of the salinity objectives were not met, despite the drought barrier and other project operations to mitigate for the effects of the severe drought. Exceedances were reported by Reclamation and DWR at: the South Delta agricultural objective at San Joaquin River near Brandt Bridge compliance station, the two western Delta agricultural objectives of 14-day running average EC values at Sacramento River at Three Mile Slough and San Joaquin River at Jersey Point, and the 30-day running average EC value at Old River near Middle River.

Salinity in CVP and SWP water supplies has increased since the onset of the drought.

6.3.5.4 Municipal and Industrial Water Users Responses to Drought-related Water Quality Impacts

With low surface water runoff, increased temperature, and concentrated nutrient levels due to the drought, algae growth in surface water proliferated, leading to increased turbidity, taste and odor issues, as well as increased potential for algal cyanotoxins from the blue-green algae, *Microcystis*. Urban water agencies that have alternative supply sources use blending, coupled with changes in treatment processes such as increased use of ozone, to address the taste and odor issues. Some of the larger urban agencies are participating in studies to investigate alternative treatment processes to address algal toxin issues. Other studies raised concern with respect to changes in pH due to low flows and their effects on toxicity and bioaccumulation of ionizable contaminants. The Metropolitan Water District of Southern California announced plans to apply copper sulfate to treat algae at Lake Skinner, Lake Mathews, and Diamond Valley Lake in accordance with its NPDES permit.

Many urban water agencies accelerated their investments in recycled water development during the current drought. Most notably, a lot of these investments are focused on advanced treatment processes for indirect, as well as direct, potable reuse. For example, the Santa Clara Valley Water District began operations of the 8 million gallon/day Silicon Valley Advanced Water Purification Center in 2014, to test and demonstrate its advanced treatment processes in producing highly purified recycled water that meets drinking water standards. Advanced treated recycled water has historically been used to blend with tertiary-treated recycled water to reduce the level of total dissolved solids for expanded industrial and irrigation use, thereby offsetting potable demand during droughts.

6.4 Impact Analysis

This section describes the potential mechanisms and analytical methods for change in surface water quality; results of the impact analysis; potential mitigation measures; and cumulative effects.

6.4.1 Potential Mechanisms for Change and Analytical Methods

As described in Chapter 4, Approach to Environmental Analysis, the impact analysis considers changes in surface water quality conditions related to changes in CVP and SWP operations under the alternatives as compared to the No Action Alternative and Second Basis of Comparison.

Changes in CVP and SWP operations under the alternatives as compared to the No Action Alternative and Second Basis of Comparison could result in changes to surface water quality due to changes in river flows and surface water deliveries. Based on the discussion above, the following water quality changes are further analyzed in the Evaluation of Alternatives section.

As described in Section 6.3 Affected Environment, there are numerous constituents of concern that have been identified in the study area. These components are not all critical in each region and may not be all affected by changes in CVP and SWP operations considered in the alternatives of this EIS. The groups of constituents that could be affected by implementation of the alternatives has been identified through consideration of constituents of concern described in Section 6.3, Affected Environment, and the anticipated implementation of TMDLs by 2030. These constituents were grouped into major categories, as shown in Table 6.27. The constituents that already have approved TMDLs in certain regions are not further analyzed for those regions, as it is expected that the TMDL will be implemented by 2030. A complete list of TMDLs and the anticipated completion dates is provided in Table 6.1.

Table 6.27 List of Surface Water Quality Constituents Considered for this Analysis

Constituent/Parameter Group	Individual Constituents/Parameters
Water Temperature	Water Temperature
Salinity Indicators	EC, TDS, Chloride, Bromide, Delta X2
Nutrients	Nitrate, phosphorus
Mercury	Mercury, methylmercury
Selenium	Selenium
Dissolved Oxygen	Dissolved Oxygen
Other Constituents	Pesticides, PCBs, DOC/TOC, Boron, Trace Metals, Pathogens, TSS, Turbidity, Unknown Toxicity

Each constituent group is further discussed below, to determine whether changes would occur due to implementation of the alternatives.

6.4.1.1 Changes in Water Temperature

Changes in CVP and SWP operations would change water temperatures in rivers downstream of CVP and SWP reservoirs. Changes in water temperatures are presented in Appendix 6B, Surface Water Temperature Modeling. However, the effects of change in temperature are related to the changes on aquatic habitat. Therefore, analysis of changes in temperature is presented in Chapter 9, Fish and Aquatic Resources.

6.4.1.2 Changes in Salinity

Changes in salinity due to changes in CVP and SWP operations would be focused in the Delta. Salinity indicators generally considered in this analysis include electrical conductivity, total dissolved solids, chloride, bromide, and X2.

The DSM2, a one-dimensional hydrodynamic and water quality simulation model, is used to evaluate changes in salinity (as represented by EC) in the Delta and at the CVP/SWP export locations. CalSim II outputs are used to evaluate changes in location of X2 in the Delta.

6.4.1.3 Changes in Mercury/Methylmercury Concentrations

Changes in CVP and SWP operations under the alternatives could affect mercury concentrations in the Delta and Suisun Marsh. The changes in CVP and SWP operations would not affect mercury concentrations in the tributaries to the Sacramento and San Joaquin rivers.

A modeling framework is used to evaluate changes in methylmercury concentrations in the Delta reaches and qualitatively estimate mercury concentration changes at the San Luis Reservoir and O’Neill Forebay.

The methylmercury impacts analysis uses CalSim II, DSM2, and the Central Valley Regional Water Quality Control Board Total Maximum Daily Load model (RWQCB model) to assess and quantify effects of the alternatives on the long-term operations and the environment, as described in Appendix 6C, Methylmercury Model Documentation.

The QUAL module of DSM2 is used to simulate source water finger printing which can determine the relative contributions of water sources to the volume at any specified location. DSM2 water quality and volumetric fingerprinting results are used to assess changes in concentration of methylmercury in Delta waters. CalSim II, DSM2 (water), and the RWQCB model (fish tissue) are used in sequence to estimate the effects of CVP and SWP operations on water and fish tissue quality in the Delta.

6.4.1.4 Changes in Selenium Concentrations

Changes in CVP and SWP operations under the alternatives could affect selenium concentrations in the San Joaquin River, Delta, and Suisun Marsh. Selenium also is of a concern in the Southern California Region because the use of water supplies from both the Delta and the Colorado River.

A suite of modeling tools is used to evaluate changes in selenium concentrations in the Delta reaches and in the San Francisco Bay, based on the western Delta model outputs. The selenium impacts analysis uses CalSim II, DSM2, and Delta-specific selenium bioaccumulation modeling to assess and quantify effects of the alternatives on the long-term operations and the environment. Appendix 6D, Selenium Model Documentation, provides information about the development and calibration of a Delta-wide bioaccumulation model for selenium in fish, use of outputs from that model to estimate bioaccumulation in bird eggs and fish fillets, and modeling of selenium bioaccumulation in sturgeon living in the western Delta using inputs from other models. Modeling assumptions for the selenium analysis are also provided in that appendix.

The selenium impact analysis focuses on evaluation of changes to selenium concentrations in tissues that affect the health of fish as well as wildlife and humans consuming fish in the Delta.

CalSim II, DSM2, and bioaccumulation modeling are used in sequence to estimate the effects of CVP and SWP operations on water quality relative to selenium in the Delta. The DSM2-QUAL module simulates one-dimensional source tracking in the Delta. Results from DSM2 are multiplied by source concentrations to determine annual average waterborne selenium concentrations in the Delta for all year types. Output from the DSM2-QUAL model (expressed as percent inflow from different sources) is used in combination with the available measured waterborne selenium concentrations to model concentrations of selenium at locations throughout the Delta. These modeled waterborne selenium concentrations are used in the relationship model to estimate bioaccumulation of selenium in whole-body fish and in bird eggs.

6.4.1.5 Changes in Nutrient Concentrations

Nutrients generally considered in this analysis include nitrate and phosphorus. The two main anthropogenic sources of these constituents are urban point sources (wastewater effluent), and agricultural non-point sources (agricultural runoff and return flows of fertilizers mixed in irrigation water). By 2030, wastewater treatment plants that discharge into the Sacramento and San Joaquin rivers watersheds and the Delta that are currently implementing nutrient removal projects will have completed those projects. Agricultural non-point source discharges are regulated under the Long-Term Irrigated Lands Regulatory Program (ILRP) Waste Discharge Requirements, which mandate monitoring of nutrients in the major agricultural reaches and the implementation of Best Management Practices to reduce nutrient discharges to streams, and controlling fertilizer application and management. Since nutrient loadings would be managed through regulatory processes by 2030, it is anticipated that nutrient conditions would be similar under the No Action Alternative, Alternatives 1 through 5, and the Second Basis of Comparison. Therefore, changes in nutrients are not evaluated in this EIS.

6.4.1.6 Changes in Dissolved Oxygen Concentrations

Dissolved oxygen has been found to be a parameter of concern primarily in the lower Klamath River, Sacramento-San Joaquin River Delta, and the Suisun Marsh. By 2030, it is anticipated that TMDLs would be implemented to address the dissolved oxygen issues. Since dissolved oxygen conditions would be managed through regulatory processes by 2030, it is anticipated that dissolved oxygen conditions would similar under the No Action Alternative, Alternatives 1 through 5, and the Second Basis of Comparison. Therefore, changes in dissolved oxygen are not evaluated in this EIS.

6.4.1.7 Changes in Other Constituents

Conditions for other water quality constituents are expected to be similar under the No Action Alternative, Alternatives 1 through 5, and the Second Basis of Comparison because critical factors that affect the sources, transport mechanisms or chemical transformations are not expected to be affected by changes in CVP and SWP operations. Therefore, changes in the other constituents are not analyzed in this EIS.

6.4.1.8 Effects Related to Water Transfers

Historically water transfer programs have been developed on an annual basis. The demand for water transfers is dependent upon the availability of water supplies to meet water demands. Water transfer transactions have increased over time as CVP and SWP water supply availability decreased, especially during drier water years.

Parties seeking water transfers generally acquire water from sellers who have available surface water who can make the water available through releasing previously stored water, pump groundwater instead of using surface water (groundwater substitution); crop idling; or substituting crops that uses less water in order to reduce normal consumptive use of surface water.

Water transfers using CVP and SWP Delta pumping plants and south of Delta canals generally occur when there is unused capacity in these facilities. These conditions generally occur in drier water year types when the flows from upstream reservoirs plus unregulated flows are adequate to meet the Sacramento Valley water demands and the reduced CVP and SWP export allocations. In non-wet years, the CVP and SWP water allocations would be less than full contract amounts; therefore, capacity may be available in the CVP and SWP conveyance facilities to move water from other sources.

Projecting future water quality conditions related to water transfer activities is difficult because of the wide variability in sources of transfer water, conveyance, and recipients involved in each specific water transfer action. Use of the transfer water would change each year due to changing hydrological conditions, CVP and SWP water availability, specific local agency operations, and local cropping patterns. Reclamation recently prepared a long-term regional water transfer environmental document which evaluated potential changes in conditions related to water transfer actions (Reclamation 2014c). Results from this analysis were used to inform the impact assessment of potential effects of water transfers under the alternatives as compared to the No Action Alternative and the Second Basis of Comparison.

6.4.2 Conditions in Year 2030 without Implementation of Alternatives 1 through 5

This EIS includes two bases of comparison, as described in Chapter 3, Description of Alternatives: the No Action Alternative and the Second Basis of Comparison. Both of these bases are evaluated at 2030 conditions. Changes that would occur over the next 15 years without implementation of the alternatives are not analyzed in this EIS. Changes to water quality that are assumed to occur by 2030 under the No Action Alternative and the Second Basis of Comparison are summarized in this section and included in all alternatives. Many of the changed conditions would occur in the same manner under both the No Action Alternative and the Second Basis of Comparison.

6.4.2.1 Common Changes in Conditions under the No Action Alternative and Second Basis of Comparison

Conditions in 2030 would be different than existing conditions due to:

- Climate change and sea level rise
- General plan development throughout California, including increased water demands in portions of Sacramento Valley
- Implementation of reasonable and foreseeable water resources management projects to provide water supplies

6.4.2.1.1 Effects due to Climate Change and Sea Level Rise

It is anticipated that climate change would result in more short-duration high-rainfall events and less snowpack runoff in the winter and early spring months. The reservoirs would be full more frequently by the end of April or May by 2030 than in recent historical conditions. However, as the water is released in the spring, there would be less snowpack to refill the reservoirs. This condition would reduce reservoir storage and available water supplies, including water supplies released to maintain freshwater conditions in the western Delta and at the CVP and SWP Delta intakes. Ambient temperatures are also expected to increase. Therefore, water temperatures in the CVP and SWP reservoirs and in the rivers downstream of the reservoirs are expected to increase by 2030 under the No Action Alternative as compared to recent historical conditions.

6.4.2.1.2 Effects due to Reasonable and Foreseeable Projects and Programs

Under the No Action Alternative and the Second Basis of Comparison, land uses in 2030 would occur in accordance with adopted general plans. Development under the general plans would change water quality, especially near municipal areas.

The No Action Alternative and the Second Basis of Comparison assumes completion of water resources management and environmental restoration projects that would have occurred without implementation of Alternatives 1 through 5, including regional and local recycling projects, surface water and groundwater storage projects, conveyance improvement projects, and desalination projects, as described in Chapter 3, Description of Alternatives. The No Action Alternative and the Second Basis of Comparison also assumes implementation of actions included in the 2008 U.S. Fish and Wildlife Service (USFWS) Biological Opinion (BO) and 2009 National Marine Fisheries Service (NMFS) BO that would have been implemented without the BOs by 2030, as described in Chapter 3, Description of Alternatives. These projects would include several projects that could affect surface water quality in beneficial and adverse manners, including restoration of more than 10,000 acres of intertidal and associated subtidal wetlands in Suisun Marsh and Cache Slough; and at least 17,000 to 20,000 acres of seasonal floodplain restoration in Yolo Bypass.

The reasonable and foreseeable projects also would include issuance and implementation of TMDL programs and other programs to improve water quality, including those that address salinity, mercury, and selenium.

Potential Changes in Salinity Indicators

In the Central Valley, changes in salinity under the No Action Alternative and the Second Basis of Comparison as compared to recent historical conditions are anticipated primarily to occur in the Delta. The salinity in the Delta is anticipated to increase with projected sea level rise; and therefore, the region of the Delta influenced by daily tidal fluctuations will increase, and the increased tidal mixing may result in salt transport further upstream. The average water depth in the Delta will increase, allowing for increased gravitational circulation and upstream transport of salinity further into the Delta. The increased salinity potentially will decrease the flexibility to meet regulatory requirements at compliance locations, municipal and industrial water intakes, and export facilities.

Potential Changes in Mercury Concentrations

In the Central Valley, mercury concentrations in the Sacramento River watershed would be similar under the No Action Alternative and the Second Basis of Comparison as compared to recent historical conditions. Programs would be implemented to reduce the sources of mercury into water bodies by 2030; however, the results of those programs are not anticipated to change mercury concentrations prior to 2030.

Changes in mercury in the Yolo Bypass are also anticipated under the No Action Alternative and the Second Basis of Comparison as floodplain restoration is implemented, as compared to recent historical conditions.

Under the No Action Alternative and the Second Basis of Comparison, it is anticipated that mercury concentrations in fish tissue within the Delta will be either similar or greater than recent historical conditions. Phase 1 of the Delta Mercury Program mandated by the CVRWQCB is currently being completed to protect people eating one meal per week of larger fish from the Delta, including Largemouth Bass. This program also would reduce wildlife exposure to excess mercury. Phase 1 is focused on studies and pilot projects to develop and evaluate management practices to control methylmercury from mercury sources in the Delta and Yolo Bypass; and to reduce total mercury loading to the San Francisco Bay. Following completion of Phase 1 in 2019, Phase 2 will be implemented through 2030. Phase 2 will focus on methylmercury control programs and reduction programs for total inorganic mercury. Due to the length of these studies and limited time for implementation of recommendations, it is not anticipated that changes in methylmercury or total mercury concentrations in fish tissue would be reduced by 2030 under the No Action Alternative and the Second Basis of Comparison as compared to recent historical conditions.

The No Action Alternative and the Second Basis of Comparison include the same projected tidal wetland and floodplain restoration within or adjacent to the Delta. These projects considered in the No Action Alternative and the Second Basis of Comparison have undergone environmental compliance and include methods to reduce mercury loading. For example, in Suisun Marsh, tidal wetland restoration activities will include cooperation with regional monitoring and research efforts, and sediment and fish monitoring. The collected information would be used adaptively to correct long-term construction and management plans and activities associated with tidal wetland restoration (Reclamation et al. 2011).

Potential Changes in Selenium Concentrations

Selenium is a constituent of concern in the San Joaquin Valley and the Delta, and TMDLs have been adopted for the San Joaquin River from Mud Slough to Merced River, Grasslands Marshes, Agatha Canal, and Mud Slough. It is assumed that water quality concerns for selenium in those reaches will be addressed before 2030. TMDLs are anticipated prior to 2030 for Panoche Creek and Mendota Pool. However, it is assumed that these TMDLs for water quality issues related to selenium may not be fully implemented by 2030.

It is expected that a TMDL may be developed separately for the Delta. To increase the database for evaluation of constituents of concern in the Delta, a large number of fish tissue samples were collected from the Sacramento and San Joaquin River watersheds and the Delta between 2000 and 2007 for selenium analysis. As part of the Strategic Workplan for Activities in the San Francisco Bay/Sacramento–San Joaquin Delta Estuary (State Water Resources Control Board 2008b), archived Largemouth Bass samples were analyzed for selenium to determine the primary source of the selenium being bioaccumulated in bass in the Delta and whether selenium concentrations in bass were above recommended criteria for the protection of human and wildlife health (Foe 2010). There were no differences in selenium concentrations in Largemouth Bass caught in the Sacramento River at Rio Vista and in the San Joaquin River at Vernalis in 2000, 2005, and 2007. However, because the TMDL is not yet under development, it is assumed that it would not be in place by 2030 under the No Action Alternative and the Second Basis of Comparison.

Reclamation is actively engaged with the Grassland Area Farmers who discharge subsurface agricultural drainage waters through the Grassland Bypass Project, which is a significant source of selenium to the San Joaquin River and to the Delta. Reclamation and the Grassland Area Farmers are continuing to reduce the amount of agricultural drainage water produced in the Grassland Drainage Area, preventing the discharge of this water into local Grassland wetland water supply channels, and improving the quality of water in the San Joaquin River. The Grassland Bypass Project is based upon an agreement between Reclamation and the San Luis and Delta-Mendota Water Authority to use a 28-mile segment of the San Luis Drain to convey agricultural subsurface drainage water from the Grassland Drainage Area to Mud Slough (North), a tributary of the San Joaquin River. An extensive monitoring program (e.g., San Francisco Estuary Institute [SFEI] 2013) continues to document the effectiveness of actions such as source control and other measures being taken by the Grassland Area Farmers. These actions by the Grassland Area Farmers are described in Chapter 2 of SFEI (2013). Briefly, these activities have included the Grassland Bypass Project and the San Joaquin River Improvement Project, formation of a regional drainage entity, newsletters and other communication with the farmers, a monitoring program, using State Revolving Fund loans for improved irrigation systems, installing and using drainage recycling systems to mix subsurface drainage water with irrigation supplies under strict limits, tiered water pricing and a tradable loads programs.

6.4.3 Evaluation of Alternatives

Alternatives 1 through 5 have been compared to the No Action Alternative; and the No Action Alternative and Alternatives 1 through 5 have been compared to the Second Basis of Comparison.

During review of the numerical modeling analyses used in this EIS, an error was determined in the CalSim II model assumptions related to the Stanislaus River operations for the Second Basis of Comparison, Alternative 1, and Alternative 4 model runs. Appendix 5C includes a comparison of the CalSim II model run results presented in this chapter and CalSim II model run results with the error corrected. Appendix 5C also includes a discussion of changes in the comparison of groundwater conditions for the following alternative analyses.

- No Action Alternative compared to the Second Basis of Comparison
- Alternative 1 compared to the No Action Alternative
- Alternative 3 compared to the Second Basis of Comparison
- Alternative 5 compared to the Second Basis of Comparison.

6.4.3.1 No Action Alternative

The No Action Alternative is compared to the Second Basis of Comparison.

6.4.3.1.1 Potential Changes in Salinity Indicators

Salinity in the Sacramento River at Emmaton would be lower in September through January, higher in June, and similar in all other months over long-term average conditions under the No Action Alternative as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Table 6E.2.4.

Salinity in the San Joaquin River at Vernalis would be lower in April and October, and higher in all other months under the No Action Alternative as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Table 6E.15.4.

Salinity in the San Joaquin River at Jersey Point would be lower in September through January, higher in June, and similar in all other months, for long-term average conditions under the No Action Alternative as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Table 6E.3.4.

Salinity in the western Delta at Port Chicago, Chipps Island, and Collinsville would be substantially lower in September through January, moderately lower February through May, higher in June, and similar in all other months, for long-term average conditions under the No Action Alternative as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Table 6E.6.4, 6E.4.4, and 6E.2.4.

Salinity at the CVP Contra Costa Canal and Jones pumping plants and the SWP Banks Pumping Plant intakes in the Delta would be lower in September through January, and higher in all other months for long-term average conditions under the No Action Alternative as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Tables 6.E.11.4, 6E.7.4, and 6E.8.4. Salinity at the Contra Costa Water District Old River and Middle River intakes also would be lower in September through January, and higher in all other months for long-term average conditions under the No Action Alternative as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Tables 6E.12.4 and 6E.13.4. Changes in salinity at the intakes would influence the salinity in water delivered in the San Joaquin Valley which could influence salinity in water bodies that receive agricultural return flows from CVP and SWP water users. Chloride and bromide concentrations at the intakes are expected to change in a similar manner to other salinity indicators.

Another indication of salinity is the measurement of X2. X2 decreases with increases in Delta outflow as freshwater from the Central Valley flows towards San Francisco Bay. Under the No Action Alternative, Delta outflow would increase and X2 would move towards the west as compared to the Second Basis of Comparison, as shown in Table C.16.4 and Figures C.16.1.1 through C.16.1.8 and C.16.2.1 through C.16.2.8 in Appendix 5A, Section C, CalSim II and DSM2 Modeling Results. X2 distances would be lower in September through May, and similar in all other months in long-term average conditions under the No Action Alternative as compared to the Second Basis of Comparison.

6.4.3.1.2 Potential Changes in Mercury Concentrations

Changes in mercury from the rivers result in changes in mercury concentrations in fish used for human consumption in the Delta, including Largemouth Bass, as summarized in Tables 6.28 and 6.29 for long-term average conditions and dry and critical dry years, respectively. All values exceed the threshold of 0.24 milligram/kilogram wet weight (mg/kg ww) for mercury.

Table 6.28 Changes in Mercury Concentrations 350-millimeter Largemouth Bass over the Long-term Average Conditions under the No Action Alternative as Compared to the Second Basis of Comparison

Delta Location	No Action Alternative (mg/kg ww)	Second Basis of Comparison (mg/kg ww)	Changes
San Joaquin River at Stockton	1.00	0.99	0.1%
San Joaquin River at Turner Cut	0.89	0.87	3%
San Joaquin River at San Andreas Landing	0.59	0.58	3%
San Joaquin River at Jersey Point	0.57	0.54	5%
Victoria Canal	0.85	0.82	4%
Sacramento River at Emmaton	0.50	0.49	2%
San Joaquin River at Antioch	0.50	0.47	7%
Montezuma Slough at Hunter Cut and Beldon's Landing (Suisun Marsh)	0.35	0.32	7%
SWP Barker Slough Pumping Plant Intake	0.56	0.56	1%
CVP Contra Costa Pumping Plant Intake	0.73	0.68	6%
SWP Banks Pumping Plant Intake	0.79	0.75	5%
CVP Jones Pumping Plant Intake	0.83	0.79	3%

Notes:

Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical dry years values calculated using 1987-1991 results from DSM2 model.

Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

mg/kg – milligram/kilogram; ww – wet weight

Table 6.29 Changes in Mercury Concentrations 350-millimeter Largemouth Bass in Dry and Critical Dry Years under the No Action Alternative as Compared to the Second Basis of Comparison

Delta Location	No Action Alternative (mg/kg ww)	Second Basis of Comparison (mg/kg ww)	Changes
San Joaquin River at Stockton	1.06	1.06	0.3%
San Joaquin River at Turner Cut	0.84	0.81	4%
San Joaquin River at San Andreas Landing	0.54	0.53	3%
San Joaquin River at Jersey Point	0.52	0.50	4%
Victoria Canal	0.82	0.76	7%
Sacramento River at Emmaton	0.48	0.47	2%
San Joaquin River at Antioch	0.43	0.41	5%
Montezuma Slough at Hunter Cut and Beldon's Landing (Suisun Marsh)	0.28	0.26	5%
SWP Barker Slough Pumping Plant Intake	0.59	0.57	2%
CVP Contra Costa Pumping Plant Intake	0.67	0.62	8%
SWP Banks Pumping Plant Intake	0.75	0.69	8%
CVP Jones Pumping Plant Intake	0.82	0.77	7%

Notes:

Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical dry years values calculated using 1987-1991 results from DSM2 model.

Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

mg/kg – milligram/kilogram; ww – wet weight

6.4.3.1.3 Potential Changes in Selenium Concentrations

It is anticipated that the selenium loadings would be similar under the No Action Alternative and the Second Basis of Comparison; and that selenium concentrations in the San Joaquin River also would be similar.

Selenium in the water column at various locations in the Delta under No Action Alternative and the Second Basis of Comparison are shown in Appendix 6D, Selenium Model Documentation. Selenium in the water column at the three western Delta locations under No Action Alternative would be identical to conditions under the Second Basis of Comparison, as shown in Appendix 6D, Table 6D.16. Selenium in the water column would be below the NTR criterion of 5 µg/L for the San Francisco Bay. Similarly, they would be below the draft USEPA (2014b) criterion for lentic aquatic systems (1.3 µg/L).

In the western Delta and at the Barker Slough Pumping Plant intake, the selenium would be similar (within 5 percent change) under the No Action Alternative and the Second Basis of Comparison.

Selenium at the Contra Costa Pumping Plant intake would be similar under the No Action Alternative and Second Basis of Comparison, as shown in Table 6D.9 of Appendix 6D. Selenium at the Jones and Banks pumping plant intakes under the No Action Alternative would be slightly higher than Second Basis of Comparison, as shown in Appendix 6D, Table 6D.9.

Estimated selenium concentration in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) at all locations in the Delta under the No Action Alternative would be similar as under the Second Basis of Comparison, as shown in Appendix 6D, Table 6D.10. As shown in Appendix 6D, Table 6D.13, Exceedance Quotients (EQs) computed with respect to the applicable benchmarks show that selenium concentrations in biota under the No Action Alternative would be below the thresholds identified for ecological risk.

For sturgeon in the western Delta, modeling also suggests that whole-body concentrations would be similar under the No Action Alternative and the Second Basis of Comparison (Appendix 6D, Table 6D.17), and the EQs would be similar (Appendix 6D, Table 6D.18). Low Toxicity Threshold EQs for selenium concentrations in sturgeon in the western Delta would remain under 1.0 for long-term average conditions, and slightly exceed 1.0 (indicating a higher probability for adverse effects) for drought years at the three western Delta locations under both the No Action Alternative and the Second Basis of Comparison (Table 6D.18 of Appendix 6D). Estimated EQs for High Toxicity Threshold at all locations are less than 1.0 under all hydrologic conditions.

6.4.3.1.4 Effects Related to Cross Delta Water Transfers

Potential effects to water quality could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c). Potential effects to water quality were identified as:

- Potential for sediment and other constituents to be transported from crop idled lands into adjacent water bodies.
- Water transfer practices could change reservoir storage or stream flow patterns in a manner that would affect water quality, including upstream temperatures and Delta water quality.
- Use of transferred water could increase drainage flows in the purchaser's service areas.

The analysis indicated that these potential impacts would not be substantial because the amount of land subject to crop changes in the seller's and purchaser's service areas would be within the historical range of irrigated lands and crop idled lands. The groundwater substitution practices would be implemented with monitoring and mitigation programs to avoid long-term adverse impacts, including impacts to water quality. The water transfers would not be allowed to occur if the program harmed other water users or the environment, including changes to water quality in the rivers or the Delta. Therefore, water quality conditions would be similar with and without the water transfers.

Under the No Action Alternative, the timing of cross Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Under the Second Basis of Comparison, water could be transferred throughout the year without an annual volumetric limit. Overall, the potential for cross Delta water transfers would be less under the No Action Alternative than under the Second Basis of Comparison.

6.4.3.2 Alternative 1

As described in Chapter 3, Description of Alternatives, Alternative 1 is identical to the Second Basis of Comparison. As described in Chapter 4, Approach to Environmental Analysis, Alternative 1 is compared to the No Action Alternative and the Second Basis of Comparison. However, because water quality factors under Alternative 1 are identical to water quality factors under the Second Basis of Comparison; Alternative 1 is only compared to the No Action Alternative.

6.4.3.2.1 Alternative 1 Compared to the No Action Alternative

Potential Changes in Salinity Indicators

Salinity in the Sacramento River at Emmaton would be higher in September through January, lower in June, and similar in all other months over long-term average conditions under Alternative 1 as compared to the No Action Alternative, as summarized in Appendix 6E, Table 6E.2.1.

Salinity in the San Joaquin River at Vernalis would be higher in April and October, lower in May through June, lower in November through February and similar in March and July through September and higher in all other months under Alternative 1 as compared to the No Action Alternative, as summarized in Appendix 6E, Table 6E.15.1.

Salinity in the San Joaquin River at Jersey Point would be higher in September through January, lower in June, and similar in all other months, for long-term average conditions under Alternative 1 as compared to the No Action Alternative, as summarized in Appendix 6E, Table 6E.3.1.

Salinity in the Delta at Port Chicago, Chipps Island, and Collinsville would be higher in September through January, moderately higher February through May, lower in June, and similar in all other months, for long-term average conditions under Alternative 1 as compared to the No Action Alternative, as summarized in Appendix 6E, Tables 6E.6.1, 6E.4.1, and 6E.2.1.

Salinity at the CVP Contra Costa Canal and Jones pumping plants and the SWP Banks Pumping Plant intakes in the Delta would be higher in September through January, and lower in all other months for long-term average conditions under Alternative 1 as compared to the No Action Alternative, as summarized in Appendix 6E, Tables 6E.11.1, 6E.7.1, and 6E.8.1. Salinity at the Contra Costa Water District Old River and Middle River intakes also would be higher in September through January, and lower in all other months, for long-term average conditions under Alternative 1 as compared to the No Action Alternative, as summarized in Appendix 6E, Tables 6E.12.1 and 6E.13.1. Changes in salinity at the intakes would influence the salinity in water delivered in the San Joaquin Valley which could influence salinity in water bodies that receive agricultural return flows from CVP and SWP water users. Chloride and bromide concentrations at the intakes are expected to change in a similar manner to other salinity indicators.

X2 decreases with increases in Delta outflow as freshwater from the Central Valley flows towards San Francisco Bay. Under Alternative 1, Delta outflow would decrease and X2 would move towards the east as compared to the No Action Alternative, as shown in Table C.16.1 and Figures C.16.1.1 through C.16.1.8 and C.16.2.1 through C.16.2.8 in Appendix 5A, Section C, CalSim II and DSM2 Modeling Results. X2 distances would be higher in September through May, and similar in all other months in long-term average conditions under Alternative 1 as compared to the No Action Alternative.

Potential Changes in Mercury Concentrations

Changes in mercury from the rivers result in changes in mercury concentrations in fish used for human consumption in the Delta, including Largemouth Bass, as summarized in Tables 6.30 and 6.31 for long-term average conditions and dry and critical dry years, respectively. All values exceed the threshold of 0.24 milligram/ kilogram wet weight (mg/kg ww) for mercury.

Table 6.30 Changes in Mercury Concentrations 350-millimeter Largemouth Bass over the Long-term Average Conditions under Alternative 1 as Compared to the No Action Alternative

Delta Location	Alternative 1 (mg/kg ww)	No Action Alternative (mg/kg ww)	Changes
San Joaquin River at Stockton	0.99	1.00	0%
San Joaquin River at Turner Cut	0.87	0.89	-3%
San Joaquin River at San Andreas Landing	0.58	0.59	-3%
San Joaquin River at Jersey Point	0.54	0.57	-4%
Victoria Canal	0.82	0.85	-4%
Sacramento River at Emmaton	0.49	0.50	-2%
San Joaquin River at Antioch	0.47	0.50	-6%
Montezuma Slough at Hunter Cut and Beldon's Landing (Suisun Marsh)	0.32	0.35	-6%
SWP Barker Slough Pumping Plant Intake	0.56	0.56	0%
CVP Contra Costa Pumping Plant Intake	0.68	0.73	-6%
SWP Banks Pumping Plant Intake	0.75	0.79	-5%
CVP Jones Pumping Plant Intake	0.79	0.83	-4%

Notes:

Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical dry years values calculated using 1987-1991 results from DSM2 model.

Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

mg/kg – milligram/kilogram; ww – wet weight

Table 6.31 Changes in Mercury Concentrations 350-millimeter Largemouth Bass in Dry and Critical Dry Years under the Alternative 1 as Compared to the No Action Alternative

Delta Location	Alternative 1 (mg/kg ww)	No Action Alternative (mg/kg ww)	Changes
San Joaquin River at Stockton	1.06	1.06	0%
San Joaquin River at Turner Cut	0.81	0.84	-4%
San Joaquin River at San Andreas Landing	0.53	0.54	-3%
San Joaquin River at Jersey Point	0.50	0.52	-4%
Victoria Canal	0.76	0.82	-6%
Sacramento River at Emmaton	0.47	0.48	-2%
San Joaquin River at Antioch	0.41	0.43	-5%
Montezuma Slough at Hunter Cut and Beldon's Landing (Suisun Marsh)	0.26	0.28	-5%
SWP Barker Slough Pumping Plant Intake	0.57	0.59	-2%
CVP Contra Costa Pumping Plant Intake	0.62	0.67	-7%
SWP Banks Pumping Plant Intake	0.69	0.75	-8%
CVP Jones Pumping Plant Intake	0.77	0.82	-6%

Notes:

Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical dry years values calculated using 1987-1991 results from DSM2 model.

Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

mg/kg – milligram/kilogram; ww – wet weight

Potential Changes in Selenium Concentrations

It is anticipated that the selenium loadings would be similar under Alternative 1 as compared to the No Action Alternative; and that selenium concentrations in the San Joaquin River also would be similar.

Selenium in the water column at various locations in the Delta under Alternative 1 as compared to the No Action Alternative are shown in Appendix 6D, Selenium Model Documentation. Selenium in the water column at the three western Delta locations under Alternative 1 would be identical to conditions under the No Action Alternative, as shown in Appendix 6D, Table 6D.16. Selenium in the water column would be below the NTR criterion of 5 µg/L for the San Francisco Bay. Similarly, they would be below the draft USEPA (2014b) criterion for lentic aquatic systems (1.3 µg/L).

In the western Delta and at the Barker Slough Pumping Plant intake, selenium in the water column would be similar under Alternative 1 as compared to the No Action Alternative.

Selenium at the Contra Costa Pumping Plant intake would be similar under Alternative 1 as compared to the No Action Alternative, as shown in Table 6D.9 of Appendix 6D. Selenium at the Jones and Banks pumping plant intakes under Alternative 1 would be lower than under the No Action Alternative, as shown in Appendix 6D, Table 6D.9.

Estimated selenium concentration in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) at all locations in the Delta under Alternative 1 would be similar as under the No Action Alternative, as shown in Appendix 6D, Table 6D.10. As shown in Appendix 6D, Table 6D.13, EQs computed with respect to the applicable benchmarks show that selenium concentrations in biota under Alternative 1 would be below the thresholds identified for ecological risk.

For sturgeon in the western Delta, modeling also suggests that whole-body concentrations would be similar under Alternative 1 and the No Action Alternative (Appendix 6D, Table 6D.17), and the EQs would be similar (Appendix 6D, Table 6D.18). Low Toxicity Threshold EQs for selenium concentrations in sturgeon in the western Delta would remain under 1.0 for long-term average conditions, and slightly exceed 1.0 (indicating a higher probability for adverse effects) for drought years at the three western Delta locations under Alternative 1 and the No Action Alternative (Table 6D.18 of Appendix 6D). Estimated EQs for High Toxicity Threshold at all locations are less than 1.0 under all hydrologic conditions.

Effects Related to Cross Delta Water Transfers

Potential effects to water quality could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions

would occur during implementation of cross Delta water transfers under Alternative 1 and the No Action Alternative, and that impacts on water quality would not be substantial in the seller's service area due to implementation requirements of the transfer programs.

Under Alternative 1, water could be transferred throughout the year without an annual volumetric limit. Under the No Action Alternative, the timing of cross Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Overall, the potential for cross Delta water transfers would be increased under Alternative 1 as compared to the No Action Alternative.

6.4.3.2.2 Alternative 1 Compared to the Second Basis of Comparison

Alternative 1 is identical to the Second Basis of Comparison.

6.4.3.3 Alternative 2

The CVP and SWP operations under Alternative 2 are identical to the CVP and SWP operations under the No Action Alternative; therefore, Alternative 2 is only compared to the Second Basis of Comparison.

6.4.3.3.1 Alternative 2 Compared to the Second Basis of Comparison

The CVP and SWP operations under Alternative 2 are identical to the CVP and SWP operations under the No Action Alternative. Therefore, changes to surface water quality under Alternatives 2 as compared to the Second Basis of Comparison would be the same as the impacts described in Section 6.4.3.1, No Action Alternative.

6.4.3.4 Alternative 3

As described in Chapter 3, Description of Alternatives, CVP and SWP operations under Alternative 3 are similar to the Second Basis of Comparison and Alternative 1 with modified Old and Middle River flow criteria. As described in Chapter 4, Approach to Environmental Analysis, Alternative 3 is compared to the No Action Alternative and the Second Basis of Comparison.

6.4.3.4.1 Alternative 3 Compared to the No Action Alternative

Potential Changes in Salinity Indicators

Salinity in the Sacramento River at Emmaton would be higher in September through January, lower in June, and similar in all other months over long-term average conditions under Alternative 3 as compared to the No Action Alternative, as summarized in Appendix 6E, Table 6E.2.2.

Salinity in the San Joaquin River at Vernalis would be higher in February through July and in October, lower in November through December, and similar in other months under Alternative 3 as compared to the No Action Alternative, as summarized in Appendix 6E, Table 6E.15.2.

Salinity in the San Joaquin River at Jersey Point would be higher in September through January, lower in June, and similar in all other months, for long-term average conditions under Alternative 3 as compared to the No Action Alternative, as summarized in Appendix 6E, Table 6E.3.2.

Salinity in the Delta at Port Chicago, Chipps Island, and Collinsville would be higher in September through December, moderately higher January and April, and similar in all other months, for long-term average conditions under Alternative 3 as compared to the No Action Alternative, as summarized in Appendix 6E, Tables 6E.6.2, 6E.4.2, and 6E.2.2.

Salinity at the CVP Jones Pumping Plant and the SWP Banks Pumping Plant intakes in the Delta would be higher in September through January, and lower or similar in all other months for long-term average conditions under Alternative 3 as compared to the No Action Alternative, as summarized in Appendix 6E, Table 6E.7.2 and Table 6E.8.2. Salinity at the CVP Contra Costa Canal Pumping Plant and at the Contra Costa Water District Old River and Middle River intakes would be higher in September through January, lower in February through June, and similar in July and August for long-term average conditions under Alternative 3 as compared to the No Action Alternative, as summarized in Appendix 6E, Tables 6E.11.2, 6E.12.2, and 6E.13.2. Changes in salinity at the intakes would influence the salinity in water delivered in the San Joaquin Valley which could influence salinity in water bodies that receive agricultural return flows from CVP and SWP water users. Chloride and bromide concentrations at the intakes are expected to change in a similar manner to other salinity indicators.

X2 decreases with increases in Delta outflow as freshwater from the Central Valley flows towards San Francisco Bay. Under Alternative 3, Delta outflow would decrease and X2 would move towards the east as compared to the No Action Alternative, as shown in Table C.16.2 and Figures C.16.1.1 through C.16.1.8 and C.16.2.1 through C.16.2.8 in Appendix 5A, Section C, CalSim II and DSM2 Modeling Results. X2 distances would be higher in September through December and in April and May, and similar in all other months in long-term average conditions under Alternative 3 as compared to the No Action Alternative.

Potential Changes in Mercury Concentrations

Changes in mercury from the rivers result in changes in mercury concentrations in fish used for human consumption in the Delta, including Largemouth Bass, as summarized in Tables 6.32 and 6.33 for long-term average conditions and dry and critical dry years, respectively. All values exceed the threshold of 0.24 milligram/kilogram wet weight (mg/kg ww) for mercury.

Table 6.32 Changes in Mercury Concentrations 350-millimeter Largemouth Bass over the Long-term Average Conditions under Alternative 3 as Compared to the No Action Alternative

Delta Location	Alternative 3 (mg/kg ww)	No Action Alternative (mg/kg ww)	Changes
San Joaquin River at Stockton	1.00	1.00	1%
San Joaquin River at Turner Cut	0,88	0.89	-2%
San Joaquin River at San Andreas Landing	0.58	0.59	-3%
San Joaquin River at Jersey Point	0.55	0.57	-4%
Victoria Canal	0.83	0.85	-2%
Sacramento River at Emmaton	0.49	0.50	-2%
San Joaquin River at Antioch	0.48	0.50	-6%
Montezuma Slough at Hunter Cut and Beldon's Landing (Suisun Marsh)	0.33	0.35	-6%
SWP Barker Slough Pumping Plant Intake	0.56	0.56	0%
CVP Contra Costa Pumping Plant Intake	0.69	0.73	-5%
SWP Banks Pumping Plant Intake	0.77	0.79	-3%
CVP Jones Pumping Plant Intake	0.81	0.83	-3%

Notes:

Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical dry years values calculated using 1987-1991 results from DSM2 model.

Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

mg/kg – milligram/kilogram; ww – wet weight

Table 6.33 Changes in Mercury Concentrations 350-millimeter Largemouth Bass in Dry and Critical Dry Years under the Alternative 3 as Compared to the No Action Alternative

Delta Location	Alternative 3 (mg/kg ww)	No Action Alternative (mg/kg ww)	Changes
San Joaquin River at Stockton	1.07	1.06	1%
San Joaquin River at Turner Cut	0.82	0.84	-3%
San Joaquin River at San Andreas Landing	0.53	0.54	-2%
San Joaquin River at Jersey Point	0.51	0.52	-2%
Victoria Canal	0.79	0.82	-3%
Sacramento River at Emmaton	0.47	0.48	-1%
San Joaquin River at Antioch	0.42	0.43	-3%
Montezuma Slough at Hunter Cut and Beldon's Landing (Suisun Marsh)	0.27	0.28	-3%
SWP Barker Slough Pumping Plant Intake	0.58	0.59	-1%
CVP Contra Costa Pumping Plant Intake	0.64	0.67	-4%
SWP Banks Pumping Plant Intake	0.72	0.75	-4%
CVP Jones Pumping Plant Intake	0.80	0.82	-3%

Notes:

Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical dry years values calculated using 1987-1991 results from DSM2 model.

Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

mg/kg – milligram/kilogram; ww – wet weight

Potential Changes in Selenium Concentrations

It is anticipated that the selenium loadings would be similar under Alternative 3 as compared to the No Action Alternative; and that selenium concentrations in the San Joaquin River also would be similar.

Selenium in the water column at various locations in the Delta under Alternative 3 as compared to the No Action Alternative are shown in Appendix 6D, Selenium Model Documentation. Selenium in the water column at the three western Delta locations under Alternative 3 would be similar to conditions under the No Action Alternative, as shown in Appendix 6D, Table 6D.9. Selenium in the water column would be below the NTR criterion of 5 µg/L for the San Francisco Bay. Similarly, they would be below the draft USEPA (2014b) criterion for lentic aquatic systems (1.3 µg/L).

In the western Delta and at the Barker Slough Pumping Plant intake, selenium in the water column would be similar under Alternative 3 as compared to the No Action Alternative.

Selenium at the Contra Costa Pumping Plant intake would be similar under Alternative 3 as compared to the No Action Alternative, as shown in Table 6D.9 of Appendix 6D. Selenium at the Jones and Banks pumping plant intakes under Alternative 3 would be lower than under the No Action Alternative, as shown in Appendix 6D, Table 6D.9.

Estimated selenium concentration in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) at all locations in the Delta under Alternative 3 would be similar as under the No Action Alternative, as shown in Appendix 6D, Table 6D.10. As shown in Appendix 6D, Table 6D.14, EQs computed with respect to the applicable benchmarks show that selenium concentrations in biota under Alternative 3 would be below the thresholds identified for ecological risk.

For sturgeon in the western Delta, modeling also suggests that whole-body concentrations would be similar under Alternative 3 and the No Action Alternative (Appendix 6D, Table 6D.17), and the EQs would be similar (Appendix 6D, Table 6D.18). Low Toxicity Threshold EQs for selenium concentrations in sturgeon in the western Delta would remain under 1.0 for long-term average conditions, and slightly exceed 1.0 (indicating a higher probability for adverse effects) for drought years at the three western Delta locations under Alternative 3 and the No Action Alternative (Table 6D.18 of Appendix 6D). Estimated EQs for High Toxicity Threshold at all locations are less than 1.0 under all hydrologic conditions.

Effects Related to Cross Delta Water Transfers

Potential effects to water quality could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions

would occur during implementation of cross Delta water transfers under Alternative 3 and the No Action Alternative, and that impacts on water quality would not be substantial in the seller's service area due to implementation requirements of the transfer programs.

Under Alternative 3, water could be transferred throughout the year without an annual volumetric limit. Under the No Action Alternative, the timing of cross Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Overall, the potential for cross Delta water transfers would be increased under Alternative 3 as compared to the No Action Alternative.

6.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison

Potential Changes in Salinity Indicators

Salinity in the Sacramento River at Emmaton would be higher in October through November and June, lower in December through March and July through September, and similar in April and May over long-term average conditions under Alternative 3 as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Table 6E.2.5.

Salinity in the San Joaquin River at Vernalis would be higher in November through March and May through June, and similar in all other months under Alternative 3 as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Table 6E.15.5.

Salinity in the San Joaquin River at Jersey Point would be higher in October through November and June through August, lower in December through March and September, and similar in April and May for long-term average conditions under Alternative 3 as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Table 6E.3.5.

Salinity in the western Delta at Port Chicago, Chipps Island, and Collinsville would be lower in December through April and July through September, higher in May and June, and similar in all other months, for long-term average conditions under Alternative 3 as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Tables 6E.6.5, 6E.4.5, and 6E.2.5.

Salinity at the CVP Contra Costa Canal intake would be lower in December through February, as summarized in Appendix 6E, Table 6E.11.5. Salinity at Jones Pumping Plant and the SWP Banks Pumping Plant intakes in the Delta would be higher in January through May, lower in June, and similar in all other months for long-term average conditions under Alternative 3 as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Table 6E.7.5 and Table 6E.8.5. Salinity at the Contra Costa Water District Old River and Middle River intakes also would be higher in January through April, lower in May and June, and similar in all other months, for long-term average conditions under Alternative 3 as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Tables 6E.12.5 and 6E.13.5. Changes in salinity at the intakes would influence the salinity in water delivered in the San Joaquin Valley which could influence salinity in water bodies that receive agricultural return flows from CVP and SWP water users.

X2 decreases with increases in Delta outflow as freshwater from the Central Valley flows towards San Francisco Bay. Under Alternative 3, Delta outflow generally would increase and X2 would move towards the west as compared to the Second Basis of Comparison, as shown in Table C.16.5 and Figures C.16.1.1 through C.16.1.8 and C.16.2.1 through C.16.2.8 in Appendix 5A, Section C, CalSim II and DSM2 Modeling Results. X2 distances would be lower (towards the west) in December through April and July through September, higher in May and June (towards the east), and similar in all other months in long-term average conditions under Alternative 3 as compared to the Second Basis of Comparison.

Potential Changes in Mercury Concentrations

Changes in flows in the rivers result in similar changes to erosional inputs and resuspension of both inorganic and methylmercury fractions. Changes in mercury from the rivers result in changes in mercury concentrations in fish used for human consumption in the Delta, including Largemouth Bass, as summarized in Tables 6.34 and 6.35 for long-term average conditions and dry and critical dry years, respectively. All values exceed the threshold of 0.24 milligram/kilogram wet weight (mg/kg ww) for mercury.

Table 6.34 Changes in Mercury Concentrations 350-millimeter Largemouth Bass over the Long-term Average Conditions under Alternative 3 as Compared to the Second Basis of Comparison

Delta Location	Alternative 3 (mg/kg ww)	Second Basis of Comparison (mg/kg ww)	Changes
San Joaquin River at Stockton	1.00	0.99	1%
San Joaquin River at Turner Cut	0,88	0.87	1%
San Joaquin River at San Andreas Landing	0.58	0.58	0%
San Joaquin River at Jersey Point	0.55	0.54	1%
Victoria Canal	0.83	0.82	2%
Sacramento River at Emmaton	0.49	0.49	0%
San Joaquin River at Antioch	0.48	0.47	1%
Montezuma Slough at Hunter Cut and Beldon's Landing (Suisun Marsh)	0.33	0.32	1%
SWP Barker Slough Pumping Plant Intake	0.56	0.56	0%
CVP Contra Costa Pumping Plant Intake	0.69	0.68	1%
SWP Banks Pumping Plant Intake	0.77	0.75	2%
CVP Jones Pumping Plant Intake	0.81	0.79	2%

Notes:

Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical dry years values calculated using 1987-1991 results from DSM2 model.

Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

mg/kg – milligram/kilogram; ww – wet weight

Table 6.35 Changes in Mercury Concentrations 350-millimeter Largemouth Bass in Dry and Critical Dry Years under Alternative 3 as Compared to the Second Basis of Comparison

Delta Location	Alternative 3 (mg/kg ww)	Second Basis of Comparison (mg/kg ww)	Changes
San Joaquin River at Stockton	1.07	1.06	1%
San Joaquin River at Turner Cut	0.82	0.81	1%
San Joaquin River at San Andreas Landing	0.53	0.53	1%
San Joaquin River at Jersey Point	0.51	0.50	2%
Victoria Canal	0.79	0.76	3%
Sacramento River at Emmaton	0.47	0.47	0%
San Joaquin River at Antioch	0.42	0.41	2%
Montezuma Slough at Hunter Cut and Beldon’s Landing (Suisun Marsh)	0.27	0.26	2%
SWP Barker Slough Pumping Plant Intake	0.58	0.57	2%
CVP Contra Costa Pumping Plant Intake	0.64	0.62	4%
SWP Banks Pumping Plant Intake	0.72	0.69	4%
CVP Jones Pumping Plant Intake	0.80	0.77	4%

Notes:

Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical dry years values calculated using 1987-1991 results from DSM2 model.

Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

mg/kg – milligram/kilogram; ww – wet weight

Potential Changes in Selenium Concentrations

It is anticipated that the selenium loadings would be similar under Alternative 3 and the Second Basis of Comparison; and that selenium concentrations in the San Joaquin River also would be similar.

Selenium in the water column at various locations in the Delta under Alternative 3 and the Second Basis of Comparison are shown in Appendix 6D, Selenium Model Documentation. Selenium in the water column at the three western Delta locations under Alternative 3 would be identical to conditions under the Second Basis of Comparison, as shown in Appendix 6D, Table 6D.16. Selenium in the water column would be below the NTR criterion of 5 µg/L for the San Francisco Bay. Similarly, they would be below the draft USEPA (2014b) criterion for lentic aquatic systems (1.3 µg/L).

In the western Delta and at the Barker Slough Pumping Plant intake, the selenium would be similar under Alternative 3 and the Second Basis of Comparison.

Selenium at the Contra Costa Pumping Plant and Banks Pumping Plant intakes would be similar under Alternative 3 and Second Basis of Comparison, as shown in Appendix 6D, Table 6D.9. Selenium at the Jones Pumping Plant intake under Alternative 3 would be slightly higher than Second Basis of Comparison, as shown in Appendix 6D, Table 6D.9.

Estimated selenium concentration in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) at all locations in the Delta under Alternative 3 would be similar as under the Second Basis of Comparison, as shown in Appendix 6D, Table 6D.11. As shown in Appendix 6D, Table 6D.14, EQs computed with respect to the applicable benchmarks show that selenium concentrations in biota under Alternative 3 would be below the thresholds identified for ecological risk.

For sturgeon in the western Delta, modeling also suggests that whole-body concentrations would be similar under Alternative 3 and the Second Basis of Comparison (Appendix 6D, Table 6D.17), and the EQs would be similar (Appendix 6D, Table 6D.18). Low Toxicity Threshold EQs for selenium concentrations in sturgeon in the western Delta would remain under 1.0 for long-term average conditions, and slightly exceed 1.0 (indicating a higher probability for adverse effects) for drought years at the three western Delta locations under both Alternative 3 and Second Basis of Comparison (Table 6D.18 of Appendix 6D). Estimated EQs for High Toxicity Threshold at all locations are less than 1.0 under all hydrologic conditions.

Effects Related to Cross Delta Water Transfers

Potential effects to water quality could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions would occur during implementation of cross Delta water transfers under

Alternative 3 and the Second Basis of Comparison, and that impacts on water quality would not be substantial in the seller's service area due to implementation requirements of the transfer programs.

Under Alternative 3 and the Second Basis of Comparison, water could be transferred throughout the year without an annual volumetric limit. Overall, the potential for cross Delta water transfers would be similar under Alternative 3 and the Second Basis of Comparison.

6.4.3.5 Alternative 4

Water quality under Alternative 4 would be identical to the conditions under the Second Basis of Comparison; therefore, Alternative 4 is only compared to the No Action Alternative.

6.4.3.5.1 Alternative 4 Compared to the No Action Alternative

The CVP and SWP operations under Alternative 4 are identical to the CVP and SWP operations under the Second Basis of Comparison and Alternative 1. Therefore, changes in water quality under Alternative 4 as compared to the No Action Alternative would be the same as the impacts described in Section 12.4.3.2.1, Alternative 1 Compared to the No Action Alternative.

6.4.3.6 Alternative 5

As described in Chapter 3, Description of Alternatives, CVP and SWP operations under Alternative 5 are similar to the No Action Alternative with modified Old and Middle River flow criteria and New Melones Reservoir operations. As described in Chapter 4, Approach to Environmental Analysis, Alternative 5 is compared to the No Action Alternative and the Second Basis of Comparison.

6.4.3.6.1 Alternative 5 Compared to the No Action Alternative

Potential Changes in Salinity Indicators

Salinity in the Sacramento River at Emmaton would be lower in May through September, and similar in all other months over long-term average conditions under Alternative 5 as compared to the No Action Alternative, as summarized in Appendix 6E, Table 6E.2.3.

Salinity in the San Joaquin River at Vernalis would be lower in April and May, and similar in all other months under Alternative 5 as compared to the No Action Alternative, as summarized in Appendix 6E, Table 6E.15.3.

Salinity in the San Joaquin River at Jersey Point would be lower in December through February, higher in June through August, and similar in all other months, for long-term average conditions under Alternative 5 as compared to the No Action Alternative, as summarized in Appendix 6E, Table 6E.3.3.

Salinity in the Delta at Port Chicago, Chipps Island, and Collinsville would be lower in April through June, and similar in all other months, for long-term average conditions under Alternative 5 as compared to the No Action Alternative, as summarized in Appendix 6E, Tables 6E.6.3, 6E.4.3, and 6E.2.3.

Salinity at the Jones pumping plants and the SWP Banks Pumping Plant intakes in the Delta would be lower in May and slightly higher in June through September, and similar in all other months for long-term average conditions under Alternative 5 as compared to the No Action Alternative, as summarized in Appendix 6E, Table 6E.7.3 and Table 6E.8.3. Salinity at the CVP Contra Costa Canal intake and at the Contra Costa Water District Old River and Middle River intakes also would be higher in April through September, and similar in all other months, for long-term average conditions under Alternative 5 as compared to the No Action Alternative, as summarized in Appendix 6E, Tables 6E.11.3, 6E.12.3, and 6E.13.3. Changes in salinity at the intakes would influence the salinity in water delivered in the San Joaquin Valley which could influence salinity in water bodies that receive agricultural return flows from CVP and SWP water users. Chloride and bromide concentrations at the intakes are expected to change in a similar manner to other salinity indicators.

X2 decreases with increases in Delta outflow as freshwater from the Central Valley flows towards San Francisco Bay. Under Alternative 5, Delta outflow would increase and X2 would move towards the west as compared to the No Action Alternative, as shown in Table C.16.3 and Figures C.16.1.1 through C.16.1.8 and C.16.2.1 through C.16.2.8 in Appendix 5A, Section C, CalSim II and DSM2 Modeling Results. X2 distances would be lower (towards the west) in April and May, and similar in all other months in long-term average conditions under Alternative 5 as compared to the No Action Alternative.

Potential Changes in Mercury Concentrations

Changes in flows in the rivers result in similar changes in erosional inputs and resuspension of both inorganic and methylmercury fractions. Changes in mercury from the rivers results in changes in mercury concentrations in fish used for human consumption in the Delta, including Largemouth Bass, as summarized in Tables 6.36 and 6.37 for long-term average conditions and dry and critical dry years, respectively. All values exceed the threshold of 0.24 milligram/kilogram wet weight (mg/kg ww) for mercury.

Table 6.36 Changes in Mercury Concentrations 350-millimeter Largemouth Bass over the Long-term Average Conditions under Alternative 5 as Compared to the No Action Alternative

Delta Location	Alternative 5 (mg/kg ww)	No Action Alternative (mg/kg ww)	Changes
San Joaquin River at Stockton	1.00	1.00	0%
San Joaquin River at Turner Cut	0.89	0.89	0%
San Joaquin River at San Andreas Landing	0.55	0.59	1%
San Joaquin River at Jersey Point	0.57	0.57	1%
Victoria Canal	0.85	0.85	0%
Sacramento River at Emmaton	0.50	0.50	0%
San Joaquin River at Antioch	0.51	0.50	1%
Montezuma Slough at Hunter Cut and Beldon's Landing (Suisun Marsh)	0.35	0.35	1%
SWP Barker Slough Pumping Plant Intake	0.56	0.56	0%
CVP Contra Costa Pumping Plant Intake	0.74	0.73	2%
SWP Banks Pumping Plant Intake	0.79	0.79	0%
CVP Jones Pumping Plant Intake	0.83	0.83	0%

Notes:

Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical dry years values calculated using 1987-1991 results from DSM2 model.

Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

mg/kg – milligram/kilogram; ww – wet weight

Table 6.37 Changes in Mercury Concentrations 350-millimeter Largemouth Bass in Dry and Critical Dry Years under the Alternative 5 as Compared to the No Action Alternative

Delta Location	Alternative 5 (mg/kg ww)	No Action Alternative (mg/kg ww)	Changes
San Joaquin River at Stockton	1.05	1.06	0%
San Joaquin River at Turner Cut	0.85	0.84	1%
San Joaquin River at San Andreas Landing	0.55	0.54	2%
San Joaquin River at Jersey Point	0.53	0.52	2%
Victoria Canal	0.82	0.82	0%
Sacramento River at Emmaton	0.49	0.48	1%
San Joaquin River at Antioch	0.44	0.43	2%
Montezuma Slough at Hunter Cut and Beldon's Landing (Suisun Marsh)	0.28	0.28	0%
SWP Barker Slough Pumping Plant Intake	0.58	0.59	0%
CVP Contra Costa Pumping Plant Intake	0.70	0.67	5%
SWP Banks Pumping Plant Intake	0.74	0.75	-1%
CVP Jones Pumping Plant Intake	0.82	0.82	1%

Notes:

Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical dry years values calculated using 1987-1991 results from DSM2 model.

Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

mg/kg – milligram/kilogram; ww – wet weight

Potential Changes in Selenium Concentrations

It is anticipated that the selenium loadings would be similar under Alternative 5 as compared to the No Action Alternative; and that selenium concentrations in the San Joaquin River also would be similar.

Selenium in the water column at various locations in the Delta under Alternative 5 as compared to the No Action Alternative are shown in Appendix 6D, Selenium Model Documentation. Selenium in the water column at the three western Delta locations under Alternative 5 would be similar to conditions under the No Action Alternative, as shown in Appendix 6D, Table 6D.16. Selenium in the water column would be below the NTR criterion of 5 µg/L for the San Francisco Bay. Similarly, they would be below the draft USEPA (2014b) criterion for lentic aquatic systems (1.3 µg/L).

In the western Delta and at the Barker Slough Pumping Plant intake, selenium in the water column would be similar under Alternative 5 as compared to the No Action Alternative.

Selenium at the Contra Costa Pumping Plant and Banks Pumping Plant intakes would be higher under Alternative 5 as compared to the No Action Alternative, as shown in Table 6D.9 of Appendix 6D. Selenium at the Jones Pumping Plant intake under Alternative 5 would be similar to conditions under the No Action Alternative, as shown in Appendix 6D, Table 6D.9.

Estimated selenium concentration in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) at all locations in the Delta under Alternative 5 would be similar as under the No Action Alternative, as shown in Appendix 6D, Table 6D.12. As shown in Appendix 6D, Table 6D.15, Exceedance Quotients (EQs) computed with respect to the applicable benchmarks show that selenium concentrations in biota under Alternative 5 would be below the thresholds identified for ecological risk.

For sturgeon in the western Delta, modeling also suggests that whole-body concentrations would be higher under Alternative 5 than under the No Action Alternative (Appendix 6D, Table 6D.17), and the EQs would be similar (Appendix 6D, Table 6D.18). Low Toxicity Threshold EQs for selenium concentrations in sturgeon in the western Delta would remain under 1.0 for long-term average conditions, and slightly exceed 1.0 (indicating a higher probability for adverse effects) for drought years at the three western Delta locations under Alternative 5 and the No Action Alternative (Table 6D.18 of Appendix 6D). Estimated EQs for High Toxicity Threshold at all locations are less than 1.0 under all hydrologic conditions.

Effects Related to Cross Delta Water Transfers

Potential effects to water quality could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions

would occur during implementation of cross Delta water transfers under Alternative 5 and the No Action Alternative, and that impacts on water quality would not be substantial in the seller's service area due to implementation requirements of the transfer programs.

Under Alternative 5 and the No Action Alternative, the timing of cross Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Overall, the potential for cross Delta water transfers would be similar under Alternative 5 and the No Action Alternative.

6.4.3.6.2 Alternative 5 Compared to the Second Basis of Comparison

Potential Changes in Salinity Indicators

Salinity in the Sacramento River at Emmaton would be lower in September through January, higher in June, and similar in all other months over long-term average conditions under Alternative 5 as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Table 6E.2.6.

Salinity in the San Joaquin River at Vernalis would be lower in April through May and October, higher in November through March, and similar in all other months under Alternative 5 as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Table 6E.15.6.

Salinity in the San Joaquin River at Jersey Point would be lower in September through January, higher in July and August, and similar in all other months for long-term average conditions under Alternative 5 as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Table 6E.3.6.

Salinity in the western Delta at Port Chicago, Chipps Island, and Collinsville would be lower in all months for long-term average conditions under Alternative 5 as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Tables 6E.6.6, 6E.4.6, and 6E.2.6.

Salinity at Jones Pumping Plant and the SWP Banks Pumping Plant intakes in the Delta would be lower in September through January, and higher in all other months for long-term average conditions under Alternative 5 as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Table 6E.7.6 and Table 6E.8.6. Salinity at the CVP Contra Costa Canal intake and the Contra Costa Water District Old River and Middle River intakes also would be lower in September through January and higher in February through August for long-term average conditions under Alternative 5 as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Tables 6E.11.6, 6E.12.6, and 6E.13.6. Changes in salinity at the intakes would influence the salinity in water delivered in the San Joaquin Valley which could influence salinity in water bodies that receive agricultural return flows from CVP and SWP water users.

X2 decreases with increases in Delta outflow as freshwater from the Central Valley flows towards San Francisco Bay. Under Alternative 5, Delta outflow generally would increase and X2 would move towards the west, especially in September through May, as compared to the Second Basis of Comparison, as shown in in Table C.16.6 and Figures C.16.1.1 through C.16.1.8 and C.16.2.1 through C.16.2.8 in Appendix 5A, Section C, CalSim II and DSM2 Modeling Results.

Potential Changes in Mercury Concentrations

Changes in mercury from the rivers result in changes in mercury concentrations in fish used for human consumption in the Delta, including Largemouth Bass, as summarized in Tables 6.38 and 6.39 for long-term average conditions and dry and critical dry years, respectively. All values exceed the threshold of 0.24 milligram/kilogram wet weight (mg/kg ww) for mercury.

Table 6.38 Changes in Mercury Concentrations 350-millimeter Largemouth Bass over the Long-term Average Conditions under Alternative 5 as Compared to the Second Basis of Comparison

Delta Location	Alternative 5 (mg/kg ww)	Second Basis of Comparison (mg/kg ww)	Changes
San Joaquin River at Stockton	1.00	0.99	0%
San Joaquin River at Turner Cut	0.89	0.87	3%
San Joaquin River at San Andreas Landing	0.55	0.58	4%
San Joaquin River at Jersey Point	0.57	0.54	5%
Victoria Canal	0.85	0.82	4%
Sacramento River at Emmaton	0.50	0.49	3%
San Joaquin River at Antioch	0.51	0.47	7%
Montezuma Slough at Hunter Cut and Beldon's Landing (Suisun Marsh)	0.35	0.32	7%
SWP Barker Slough Pumping Plant Intake	0.56	0.56	1%
CVP Contra Costa Pumping Plant Intake	0.74	0.68	8%
SWP Banks Pumping Plant Intake	0.79	0.75	5%
CVP Jones Pumping Plant Intake	0.83	0.79	5%

Notes:

Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical dry years values calculated using 1987-1991 results from DSM2 model.

Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

mg/kg – milligram/kilogram; ww – wet weight

Table 6.39 Changes in Mercury Concentrations 350-millimeter Largemouth Bass in Dry and Critical Dry Years under Alternative 5 as Compared to the Second Basis of Comparison

Delta Location	Alternative 5 (mg/kg ww)	Second Basis of Comparison (mg/kg ww)	Changes
San Joaquin River at Stockton	1.05	1.06	0%
San Joaquin River at Turner Cut	0.85	0.81	4%
San Joaquin River at San Andreas Landing	0.55	0.53	4%
San Joaquin River at Jersey Point	0.53	0.50	5%
Victoria Canal	0.82	0.76	7%
Sacramento River at Emmaton	0.49	0.47	3%
San Joaquin River at Antioch	0.44	0.41	7%
Montezuma Slough at Hunter Cut and Beldon's Landing (Suisun Marsh)	0.28	0.26	7%
SWP Barker Slough Pumping Plant Intake	0.58	0.57	2%
CVP Contra Costa Pumping Plant Intake	0.70	0.62	13%
SWP Banks Pumping Plant Intake	0.74	0.69	7%
CVP Jones Pumping Plant Intake	0.82	0.77	7%

Notes:

Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical dry years values calculated using 1987-1991 results from DSM2 model.

Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

mg/kg – milligram/kilogram; ww – wet weight

Potential Changes in Selenium Concentrations

It is anticipated that the selenium loadings would be similar under Alternative 5 and the Second Basis of Comparison; and that selenium concentrations in the San Joaquin River also would be similar.

In the Delta, selenium concentrations are related to the movement of flows from the San Joaquin River and the accumulation in certain areas of the Delta due to tidal flow patterns.

Selenium in the water column at various locations in the Delta under Alternative 5 and the Second Basis of Comparison are shown in Appendix 6D, Selenium Model Documentation. Selenium in the water column at the three western Delta locations under Alternative 5 would be similar to conditions under the Second Basis of Comparison, as shown in Appendix 6D, Table 6D.16. Selenium in the water column would be below the NTR criterion of 5 µg/L for the San Francisco Bay. Similarly, they would be below the draft USEPA (2014b) criterion for lentic aquatic systems (1.3 µg/L).

In the western Delta and at the Barker Slough Pumping Plant intake, the selenium would be similar under Alternative 5 and the Second Basis of Comparison. There would be small increases in selenium along the Sacramento River at Emmaton under Alternative 5 as compared to the Second Basis of Comparison.

Selenium at the Contra Costa Pumping Plant, Jones Pumping Plant, and Banks Pumping Plant intakes would be higher under Alternative 5 than Second Basis of Comparison, as shown in Appendix 6D, Table 6D.9.

Estimated selenium concentration in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) at all locations in the Delta under Alternative 5 would be similar as under the Second Basis of Comparison, as shown in Appendix 6D, Table 6D.12. As shown in Appendix 6D, Table 6D.13, EQs computed with respect to the applicable benchmarks show that selenium concentrations in biota under Alternative 5 would be below the thresholds identified for ecological risk.

For sturgeon in the western Delta, modeling also suggests that whole-body concentrations would be higher under Alternative 5 than the Second Basis of Comparison (Appendix 6D, Table 6D.17), and the EQs would be similar (Appendix 6D, Table 6D.18). Low Toxicity Threshold EQs for selenium concentrations in sturgeon in the western Delta would remain under 1.0 for long-term average conditions, and slightly exceed 1.0 (indicating a higher probability for adverse effects) for drought years at the three western Delta locations under both Alternative 5 and Second Basis of Comparison (Table 6D.18 of Appendix 6D). Estimated EQs for High Toxicity Threshold at all locations are less than 1.0 under all hydrologic conditions.

Effects Related to Cross Delta Water Transfers

Potential effects to water quality could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions would occur during implementation of cross Delta water transfers under Alternative 5 and the Second Basis of Comparison, and that impacts on water quality would not be substantial in the seller's service area due to implementation requirements of the transfer programs.

Under Alternative 5, the timing of cross Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Under the Second Basis of Comparison, water could be transferred throughout the year without an annual volumetric limit. Overall, the potential for cross Delta water transfers would be reduced under Alternative 5 as compared to the Second Basis of Comparison.

6.4.3.7 Summary of Environmental Consequences

The results of the environmental consequences of implementation of Alternatives 1 through 5 as compared to the No Action Alternative and the Second Basis of Comparison are presented in Tables 6.40 and 6.41.

It should be noted that since concentrations of nutrients, dissolved oxygen, and other constiuents of current concern (except salinity, mercury, and selenium) would be managed through regulatory processes by 2030, it is assumed that concentrations of these constituents would be similar under the No Action Alternative, Alternatives 1 through 5, and the Second Basis of Comparison, as described in Section 6.4.1., Potential Mechanisms of Change and Analytical Methods.

Environmental effects associated with changes in water temperatures are related to impacts on biological resources (as described in Chapter 9, Fish and Aquatic Resources. Therefore, the, potential impacts of the action alternatives related to changes in water temperature, including changes resulting from including reasonably and foreseeable actions are presented in Chapter 9.

Table 6.40 Comparison of Alternatives 1 through 5 to No Action Alternative

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	Salinity increases near Emmaton in almost all months (5 to 377 percent), particularly in September, October and November of wet and above normal years; decreases in June except for June of critical years; and is similar in wet and above normal of spring months (February through May); and dry and critical years of August and September. Salinity increases near Antioch (5 to 265 percent) in almost all months except it decreases in June of wet, above normal, and below normal years (7 to 14 percent) and when it is similar in February, March, and April of wet years, July and August, and September of below normal, dry and critically dry years. Salinity increases near CVP and SWP intakes (6 to 36 percent) in October, November, and December (and January for only SWP), decreases (5 to 22 percent) in February through June, and is similar in other months. Salinity increases near Contra Costa Water District intakes (8 to 65 percent) in October through January and September of wet and above normal years, decreases (5 to 32 percent) March through May and June of wet, above normal, and below normal years, and is similar in other months. Changes in Contra Costa Water District intakes are different for each location. Please refer to Appendix 6E for a detailed summary of the changes in salinity. Salinity increases (5 to 96 percent) near Port Chicago October through February, April, March of below normal, dry, and critically dry years, and September of wet and above normal years; and is similar in other months. Similar mercury concentrations in Largemouth Bass in most of the Delta; and a 6 percent decrease near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough over the long-term conditions. Similar selenium concentrations in whole body fish, bird eggs, and fish fillets.	Coordination of CVP and SWP operations between Reclamation, DWR, USFWS, and NMFS to reduce salinity near the CVP, SWP, Contra Costa Water District, and Antioch intakes and near Emmaton.

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 2	Water quality conditions would be the same as under the No Action Alternative.	None needed
Alternative 3	Salinity increases near Emmaton (7 to 378 percent) October through January and September of wet and above normal years, in September, October and November of wet and above normal years; decreases (7 and 8 percent) in June of above normal years and September of below normal years, and is similar in all other months. Salinity increases near Antioch (6 to 262 percent) in almost all months except it is similar in March, July, August, below normal, dry, and critically dry years of September, and wet, above normal, and dry years of February. Salinity increases near CVP intakes (6 to 29 percent) in October, November, and December, decreases (5 to 13 percent) in June, and is similar in other months. Salinity increases near SWP intakes (5 to 41 percent) in October, November, December, and January, decreases (5 to 19 percent) in April through June, and is similar in other months. Salinity increases near Contra Costa Water District intakes (6 to 76 percent) in October through December, January of above normal, below normal, and dry years, and September of wet and above normal years; decreases (5 to 34 percent) April through June; and is similar in other months. Salinity increases (6 to 95 percent) near Port Chicago October through January, April, and May, June and September of wet and above normal years; and is similar in other months. Similar mercury concentrations in Largemouth Bass in most of the Delta; and a 6 percent decrease near San Joaquin River at Antioch and Montezuma Slough over the long-term conditions. Similar selenium concentrations in whole body fish, bird eggs, and fish fillets.	Coordination of CVP and SWP operations between Reclamation, DWR, USFWS, and NMFS to reduce salinity near the CVP, SWP, Contra Costa Water District, and Antioch intakes.
Alternative 4	Same effects as described for Alternative 1 compared to the No Action Alternative.	None needed
Alternative 5		None needed

Alternative	Potential Change	Consideration for Mitigation Measures
	Salinity near Emmaton is similar in all months except it increases (6 and 8 percent) January and February and decreases (6 to 15 percent) in April through June of critically dry years. Salinity decreases (9 to 20 percent) near Antioch in April and May of below normal, dry, and critically dry years and June of critically dry years; increases (7 percent) in February of critically dry years; and is similar in all other months. Salinity is similar near CVP and SWP intakes in most months, and increases (8 to 12 percent) in June of dry and critically dry years. Salinity increases near Contra Costa Water District intakes (6 to 40 percent) in April, May, and June of below normal, dry, and critical years; and is similar in other months. Changes in Contra Costa Water District intakes are different for each location. Please refer to Appendix 6E for a detailed summary of the changes in salinity. Salinity near Port Chicago is similar in all months except it decreases (5 to 8 percent) in April and May of dry and critical years. Similar mercury concentrations in Largemouth Bass throughout the Delta. Similar selenium concentrations in whole body fish, bird eggs, and fish fillets.	

Notes:

1 In general, D-1641 Delta salinity standards are met in all alternatives except for few dry and critical years where there is no stored fresh water available for release The differences in salinity between alternatives mostly point to results of other operations beyond meeting the D-1641 salinity standards; such as whether or not reservoirs are releasing to meet 2008 USFWS Biological Opinion Action 4 (Fall X2), Delta Cross Channel operations, or whether or not south Delta exports are allowed in a particular month. As a result, changes in salinity for each location in Delta shows wide month to month variation between alternatives. Please refer to Appendix 6E for detailed comparison of salinity between the alternatives.

2 Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools, incremental differences of 5 percent or less between alternatives and the Second Basis of Comparison are considered to be “similar.”

Table 6.41 Comparison of No Action Alternative and Alternatives 1 through 5 to Second Basis of Comparison

Alternative	Potential Change	Consideration for Mitigation Measures
No Action Alternative	Salinity decreases near Emmaton in almost all months (5 to 79 percent), particularly in September, October and November of wet and above normal years; increases (9 to 21 percent) in June except for June of critical years; and is similar in wet and above normal of spring months (February through May); and dry and critical years of August and September. Salinity decreases near Antioch (5 to 73 percent) in almost all months except it increases (7 to 16 percent) in June of wet, above normal, and below normal years; and is similar in February, March, and April of wet years, July and August, and September of below normal, dry and critically dry years. Salinity decreases near CVP and SWP intakes (6 to 28 percent) in October, November, and December (and January for only SWP), increases (5 to 23 percent) in February through June, and is similar in other months. Salinity decreases near Contra Costa Water District intakes (7 to 42 percent) in October through January and September of wet and above normal years, increases (5 to 47 percent) March through May and June of wet, above normal, and below normal years, and is similar in other months. Changes in Contra Costa Water District intakes are different for each location. Please refer to Appendix 6E for a detailed summary of the changes in salinity. Salinity decreases (6 to 49 percent) near Port Chicago October through May, and September of wet and above normal years; and is similar in other months. Similar mercury concentrations in Largemouth Bass in the most of the Delta; and a 7 percent increase near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough over the long-term conditions. Similar selenium concentrations in whole body fish, bird eggs, and fish fillets.	Not considered for this comparison.

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	No effects on public health issues.	Not considered for this comparison.
Alternative 2	Same effects as described for No Action Alternative as compared to the Second Basis of Comparison.	Not considered for this comparison.
Alternative 3	Salinity increases near Emmaton (5 to 35 percent) in June except for critically dry years; decreases (5 to 24 percent) in December and January of above normal years, January through March and July through September of below normal years, January, February, and July of dry years, and March of critically dry years; and it is similar in all other months. Salinity increases near Antioch (8 to 20 percent) in June except critically dry years and in May of wet years; decreases (7 to 40 percent) in January through April, and is similar in all other months. Salinity is similar near CVP and SWP intakes except for increase (5 to 23 percent) mostly in February through May of dry and critically dry years. Salinity increases near Contra Costa Water District intakes (5 to 16 percent) in March and April of dry and critically dry years; decreases (5 to 23 percent) in December, January and February of dry and critically dry years; and is similar in other months. Changes in Contra Costa Water District intakes are different for each location. Please refer to Appendix 6E for a detailed summary of the changes in salinity. Salinity decreases (5 to 25 percent) near Port Chicago January through March; increases (7 to 9 percent) in June of wet, above normal, and below normal years; and is similar in other months. Similar mercury concentrations in Largemouth Bass throughout the Delta. Similar selenium concentrations in whole body fish, bird eggs, and fish fillets.	Not considered for this comparison.
Alternative 4	No effects on water quality issues.	Not considered for this comparison.
Alternative 5	Salinity decreases near Emmaton in almost all months (5 to 79 percent), particularly in September, October and November of wet and above normal	Not considered for this comparison.

Alternative	Potential Change	Consideration for Mitigation Measures
	years; increases (7 to 21 percent) in June except for June of critical years; and is similar in wet and above normal of spring months (February through May); and dry and critical years of August and September. Salinity decreases near Antioch (5 to 73 percent) in almost all months except it increases (7 to 14 percent) in June of wet, above normal, and below normal years; and is similar in February, March, and April of wet years, July and August, and September of below normal, dry and critically dry years. Salinity decreases near CVP and SWP intakes (5 to 28 percent) in October, November, and December (and January for only SWP), increases (5 to 26 percent) in February through June, and is similar in other months. Salinity decreases near Contra Costa Water District intakes (7 to 41 percent) in October through January and September of wet and above normal years, increases (5 to 63 percent) March through June, and is similar in other months. Changes in Contra Costa Water District intakes are different for each location. Please refer to Appendix 6E for a detailed summary of the changes in salinity. Salinity decreases (5 to 49 percent) near Port Chicago October through May, and September of wet and above normal years; and is similar in other months. Similar mercury concentrations in Largemouth Bass in the most of the Delta; and a 7 percent increase near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough over the long-term conditions. Similar selenium concentrations in whole body fish, bird eggs, and fish fillets.	

Notes:

1 In general, D-1641 Delta salinity standards are met in all alternatives except for few dry and critical years where there is no stored fresh water available for release The differences in salinity between alternatives mostly point to results of other operations beyond meeting the D-1641 salinity standards; such as whether or not reservoirs are releasing to meet 2008 USFWS Biological Opinion Action 4 (Fall X2), Delta Cross Channel operations, or whether or not south Delta exports are allowed in a particular month. As a result, changes in salinity for each location in Delta shows wide month to

month variation between alternatives. Please refer to Appendix 6E for detailed comparison of salinity between the alternatives.

2 Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools, incremental differences of 5 percent or less between alternatives and the Second Basis of Comparison are considered to be "similar."

6.4.3.8 Potential Mitigation Measures

Mitigation measures are presented in this section to avoid, minimize, rectify, reduce, eliminate, or compensate for adverse environmental effects of Alternatives 1 through 5 as compared to the No Action Alternative. Mitigation measures were not included to address adverse impacts under the alternatives as compared to the Second Basis of Comparison because this analysis was included in this EIS for information purposes only.

Environmental effects associated with changes in water temperatures are related to impacts on biological resources (as described in Chapter 9, Fish and Aquatic Resources. Therefore, mitigation measures related to changes in temperatures as compared to the No Action Alternative conditions are presented in Chapter 9.

6.4.3.8.1 Salinity Water Quality Conditions

Implementation of Alternatives 1 through 5 would not result in adverse impacts to mercury and selenium concentrations as compared to the No Action Alternative. Therefore, no mitigation measures are required for these constituents.

Implementation of Alternatives 1, 3, and 4 would result in adverse impacts to salinity concentrations as compared to the No Action Alternative. A potential mitigation measure to reduce these effects would be:

- Coordination of CVP and SWP operations between Reclamation, DWR, USFWS, and NMFS to reduce salinity near the CVP, SWP, Contra Costa Water District, and Antioch intakes.

Under the No Action Alternative and Alternatives 1 through 5, it is anticipated that the ongoing real-time decision making meetings between Reclamation, DWR, USFWS, and NMFS would continue in a manner similar to that described in Section 3A.3 of Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. Under this mitigation measure, a specific agenda item would be added to the groups' actions to reduce salinity impacts on the beneficial uses in the Delta. Potential changes could be to modify intake operations in accordance with real-time flows, observations related to fish presence, and real-time water quality observations.

6.4.3.9 Cumulative Effects Analysis

As described in Chapter 3, the cumulative effects analysis considers projects, programs, and policies that are not speculative; and are based upon known or reasonably foreseeable long-range plans, regulations, operating agreements, or other information that establishes them as reasonably foreseeable.

The cumulative effects analysis Alternatives 1 through 5 for Water Quality are summarized in Table 6.42.

Table 6.42 Summary of Cumulative Effects on Water Quality of Alternatives 1 through 5 as Compared to the No Action Alternative

Scenarios	Actions	Cumulative Effects of Actions
Past & Present, and Future Actions included in the No Action Alternative and in All Alternatives in Year 2030	Consistent with Affected Environment conditions plus: Actions in the 2008 USFWS BO and 2009 NMFS BO that Would Have Occurred without implementation of the BOs, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives), including climate change and sea level rise Actions not included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives): - Implementation of Federal and state policies and programs, including Clean Water Act (e.g.,Total Maximum Daily Loads); Safe Drinking Water Act; Clean Air Act; and flood management programs - Trinity River Restoration Program. - Central Valley Project Improvement Act programs - Iron Mountain Mine Superfund Site - Dutch Slough Tidal Marsh Restoration - Suisun Marsh Habitat Management, Preservation, and Restoration Plan Implementation - Tidal Wetland Restoration: Yolo Ranch, Northern Liberty Island Fish Restoration Project, Prospect Island Restoration Project, and Calhoun Cut/Lindsey Slough Tidal Habitat Restoration Project - San Joaquin River Restoration Program - Stockton Deep Water Ship Channel Dissolved Oxygen Project - Grasslands Bypass Project - Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) - Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities	<u>These effects would be the same in all alternatives.</u> Climate change and sea level rise area anticipated to increase salinity in the Delta and expand the region of the Delta influenced by tidal fluctuations. Water quality programs to reduce nutrient loadings from wastewater treatment plant effluent and other point source discharges under the TMDLs would be fully implemented by 2020; and it is anticipated that nutrient concentrations would be reduced by 2030. Programs to meet TMDLs related to dissolved oxygen, pesticides, mercury, selenium, and other constituents of concern are anticipated to be fully defined and implemented in the early 2020s to reduce, but not necessarily meet TMDL objectives, by 2030. These programs include projects to reduce effects of agricultural drainage. Tidal restoration programs would change salinity gradients in the Delta, including increased salinity in the western and central Delta, depending upon the location of the tidal restoration lands. Estuarine tidal restoration could reduce constituents from runoff of adjacent upland areas, depending upon the location of the restored lands.

Scenarios	**Actions**	**Cumulative Effects of Actions**
	(projects with completed environmental documents)	
Future Actions considered as Cumulative Effects Actions in All Alternatives in Year 2030	Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives): - Bay-Delta Water Quality Control Plan Update - FERC Relicensing Projects - Bay Delta Conservation Plan (including the California WaterFix alternative) - EcoRestore - Irrigated Lands Regulatory Program - San Luis Reservoir Low Point Improvement Project - *Westlands Water District v. United States Settlement* - Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects that did not have completed environmental documents during preparation of the EIS)	<u>These effects would be the same in all alternatives.</u> Some of the future reasonably foreseeable actions are anticipated to reduce water quality issues, including Bay-Delta Water Quality Control Plan Update, FERC Relicensing Projects, agricultural drainage programs, and San Luis Reservoir Low Point Improvement Project. Future reasonably foreseeable actions related to tidal restoration projects could increase salinity and mercury water quality issues.
No Action Alternative with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO	Implementation of No Action Alternative would result in increased salinity in the western and central Delta due to climate change and sea level rise. Numerous projects would be implemented by 2030 to reduce water quality issues related to nutrients, agricultural drainage, and other discharges of constituents of concern by 2030. Depending upon the location of tidal restoration lands, salinity in the No Action Alternative could increase in the western and interior Delta.
Alternatives 1 and 4 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternatives 1 and 4 with reasonably foreseeable actions would increase salinity in the western and interior Delta as compared to the No Action Alternative with these added actions. Other water quality conditions under Alterantives 1 through 4 with reasonably foreseeable actions would be similar to conditions under the No Action Alternative with the added actions.

Scenarios	Actions	Cumulative Effects of Actions
Alternative 2 with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions No implementation of structural improvements or other actions that require further study to develop a more detailed action description.	Implementation of Alternative 2 with reasonably foreseeable actions would result in the same conditions as under the No Action Alternative with the added actions.
Alternative 3 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant) Slight increase in positive Old and Middle River flows in the winter and spring months	Implementation of Alternative 3 with reasonably foreseeable actions would increase salinity in the western and interior Delta as compared to the No Action Alternative with the added actions. Other water quality conditions under Alterantive 3 with reasonably foreseeable actions would be similar to conditions under the No Action Alternative with the added actions.
Alternative 5 with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO Positive Old and Middle River flows and increased Delta outflow in spring months	Implementation of Alternative 5 with reasonably foreseeable actions would result in similar salinity conditions as compared to the No Action Alternative with the added actions. Other water quality conditions under Alterantive 5 with with reasonably foreseeable actions would be similar to conditions under the No Action Alternative with the added actions.

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Chapter 6

Surface Water Quality Figures

The following figures are included in Chapter 6, Surface Water Quality.

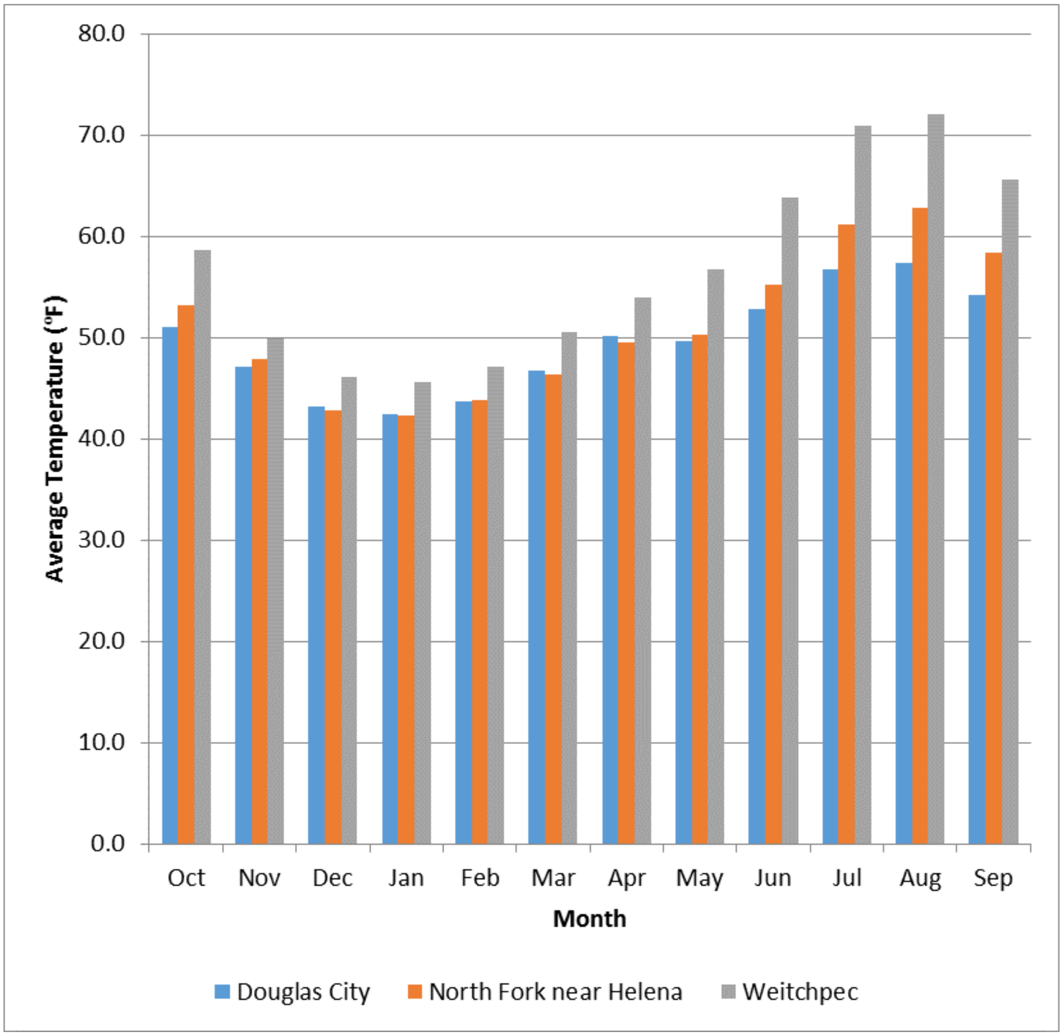
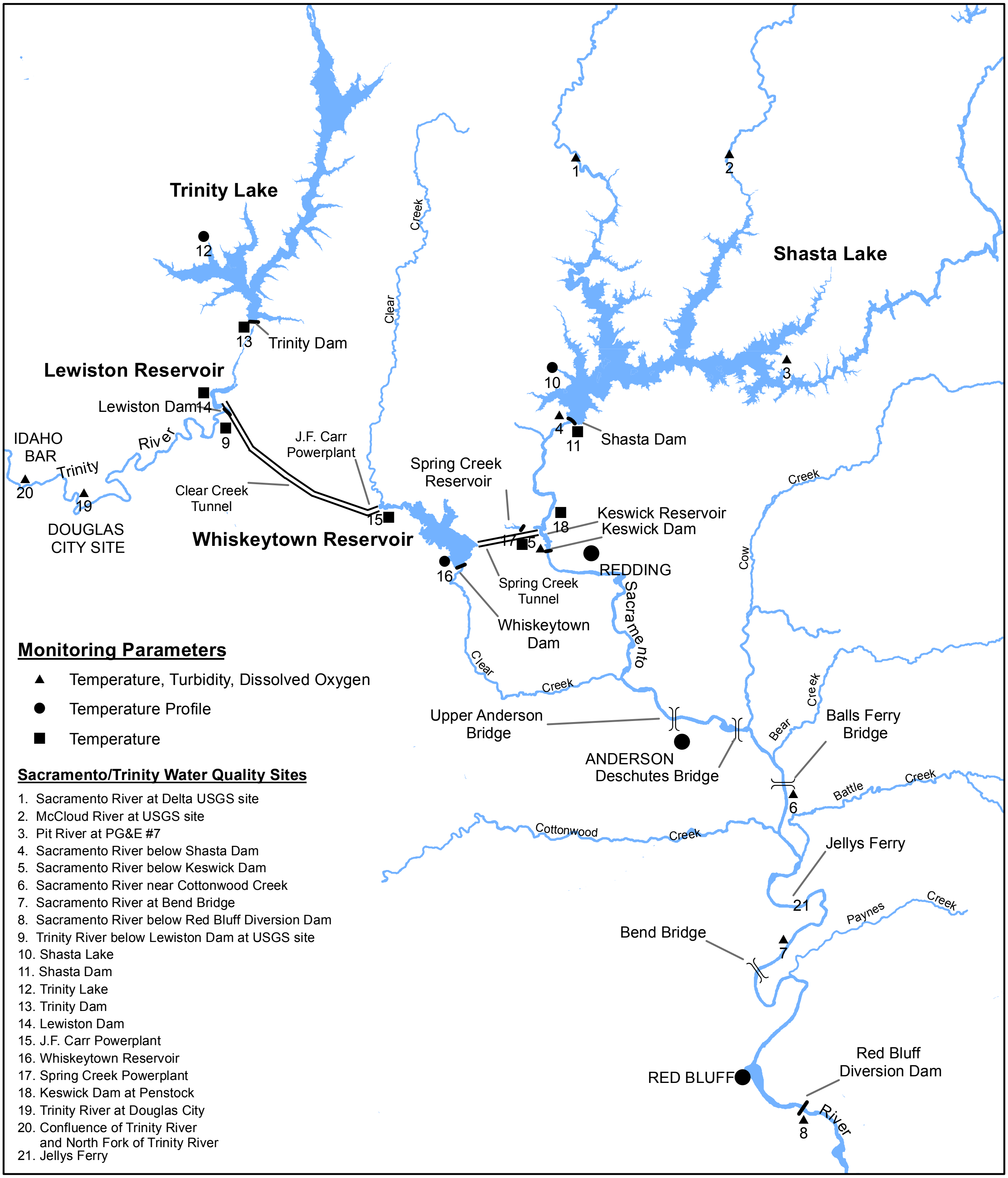


Figure 6.1 Monthly Average of Water Temperatures Recorded at Trinity River Compliance Locations (2001-2012)



Monitoring Parameters

▲ Temperature, Turbidity, Dissolved Oxygen

● Temperature Profile

■ Temperature

Sacramento/Trinity Water Quality Sites

1. Sacramento River at Delta USGS site
2. McCloud River at USGS site
3. Pit River at PG&E #7
4. Sacramento River below Shasta Dam
5. Sacramento River below Keswick Dam
6. Sacramento River near Cottonwood Creek
7. Sacramento River at Bend Bridge
8. Sacramento River below Red Bluff Diversion Dam
9. Trinity River below Lewiston Dam at USGS site
10. Shasta Lake
11. Shasta Dam
12. Trinity Lake
13. Trinity Dam
14. Lewiston Dam
15. J.F. Carr Powerplant
16. Whiskeytown Reservoir
17. Spring Creek Powerplant
18. Keswick Dam at Penstock
19. Trinity River at Douglas City
20. Confluence of Trinity River and North Fork of Trinity River
21. Jellys Ferry

Figure 6.2 Water Quality Compliance Stations Along Trinity River and Upper Sacramento River

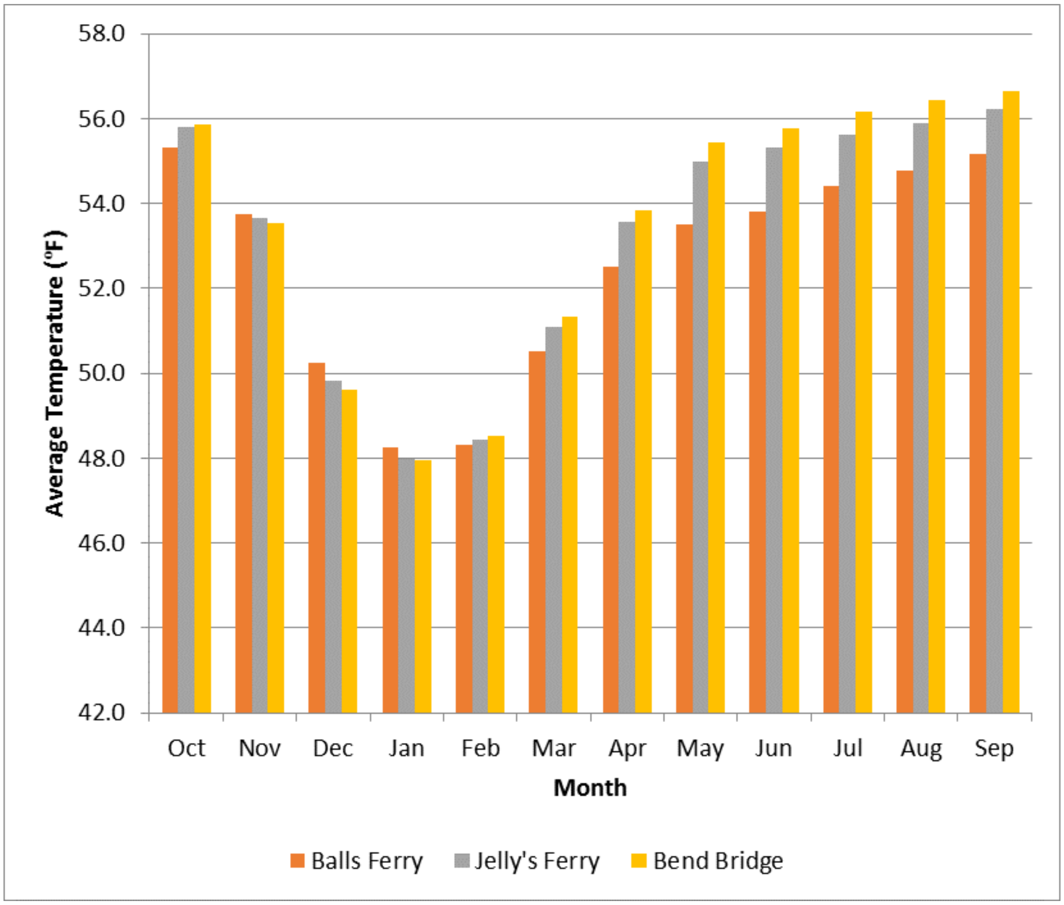


Figure 6.3 Monthly Average of Water Temperatures Recorded at Sacramento River Compliance Locations (2001-2012)

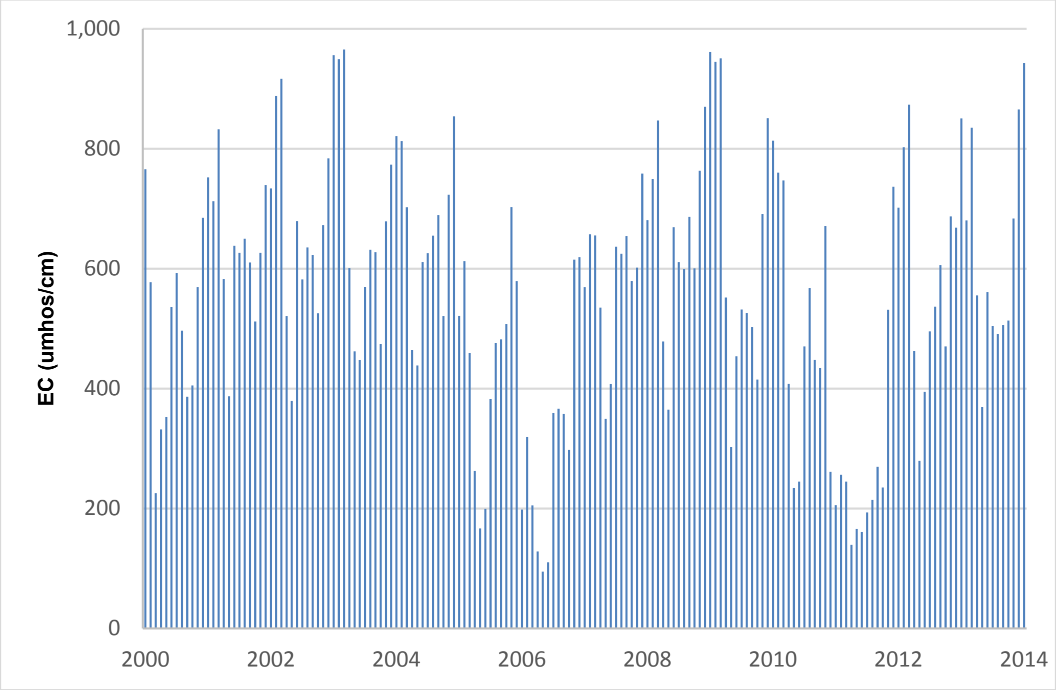


Figure 6.4 Monthly Average Specific Conductance in San Joaquin River at Vernalis (Reclamation 2013e)

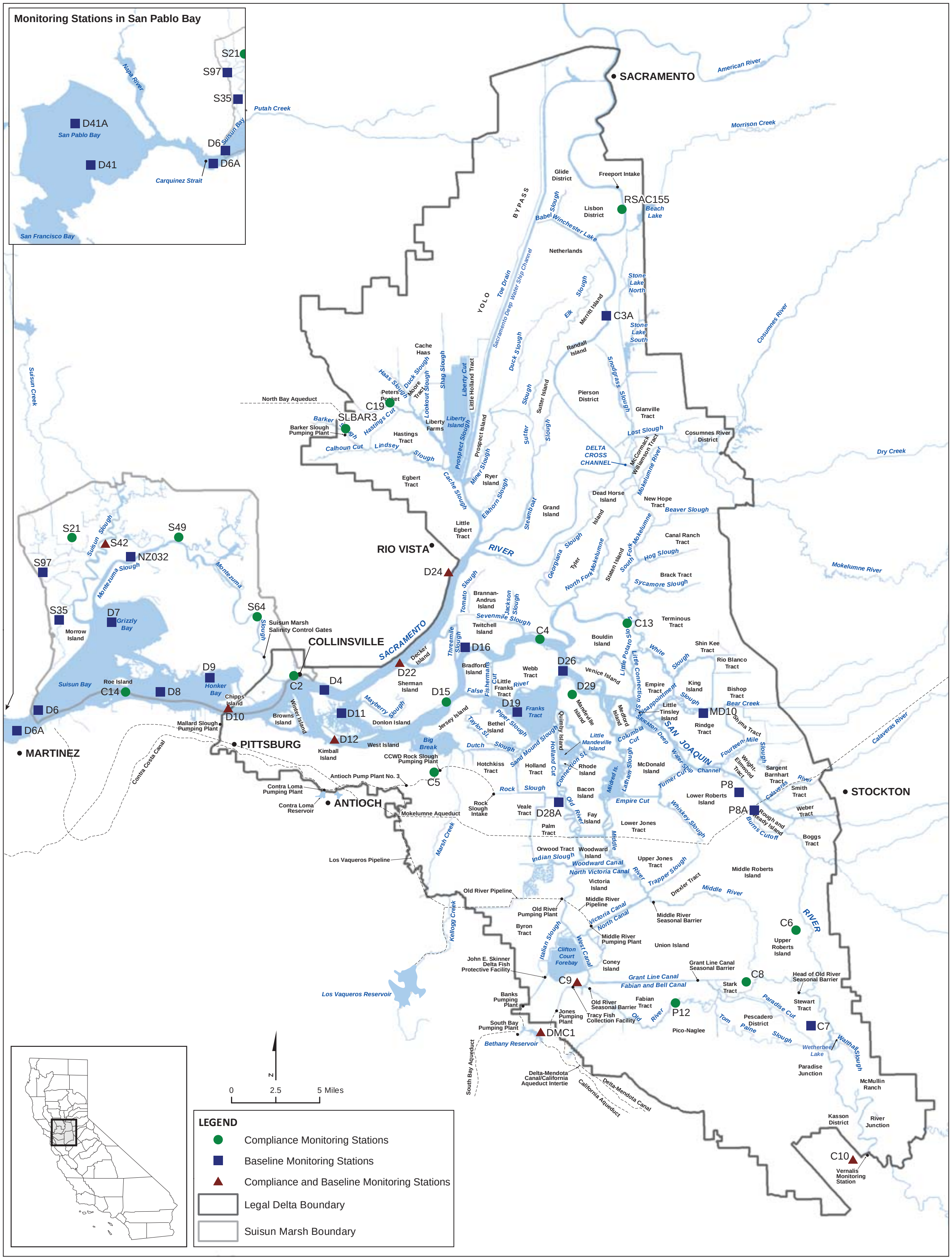


Figure 6.5. Water Quality Compliance Stations in the Delta

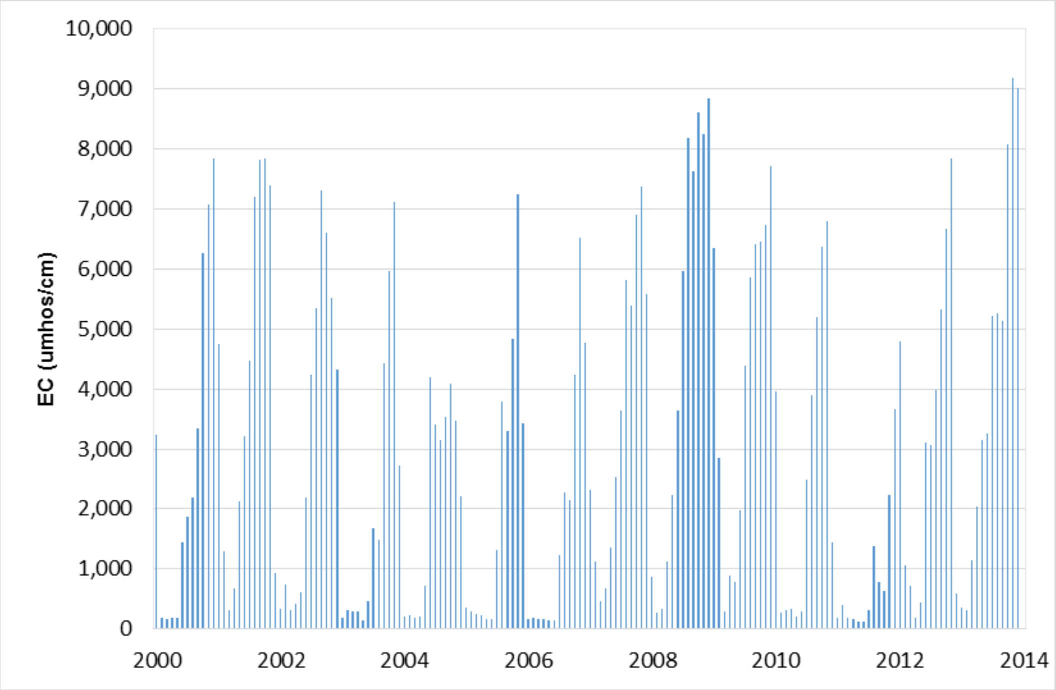


Figure 6.6 Monthly Average Specific Conductance in Sacramento River at Collinsville (Reclamation 2013e)

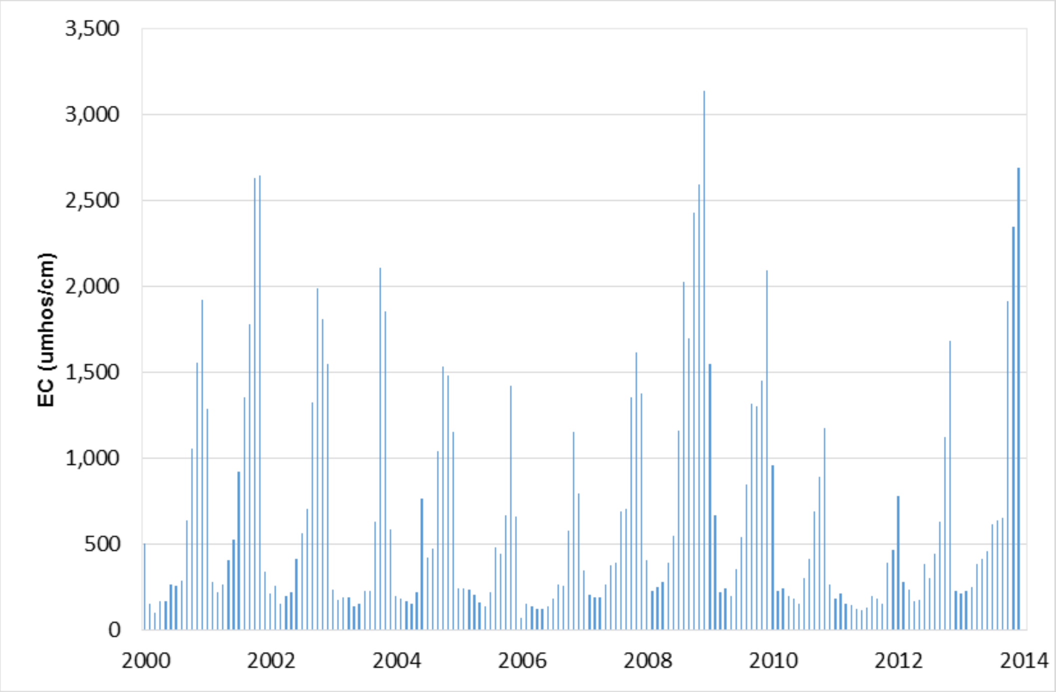


Figure 6.7 Monthly Average Specific Conductance in Sacramento River at Emmaton (Reclamation 2013e)

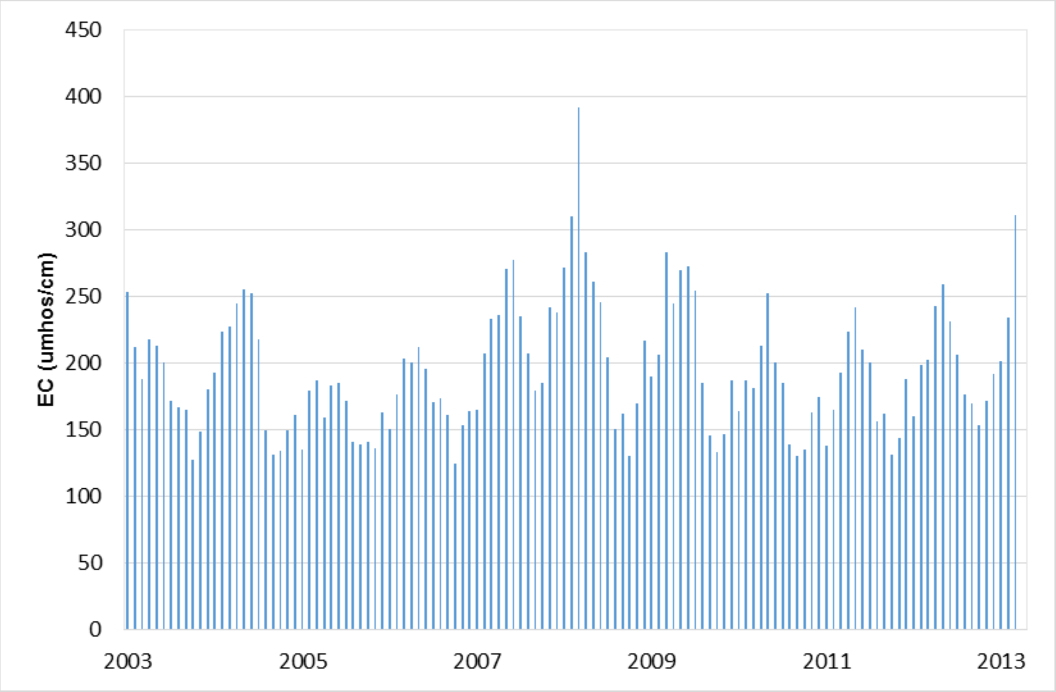


Figure 6.8 Monthly Average Specific Conductance in Sacramento River at Rio Vista (Reclamation 2013e)

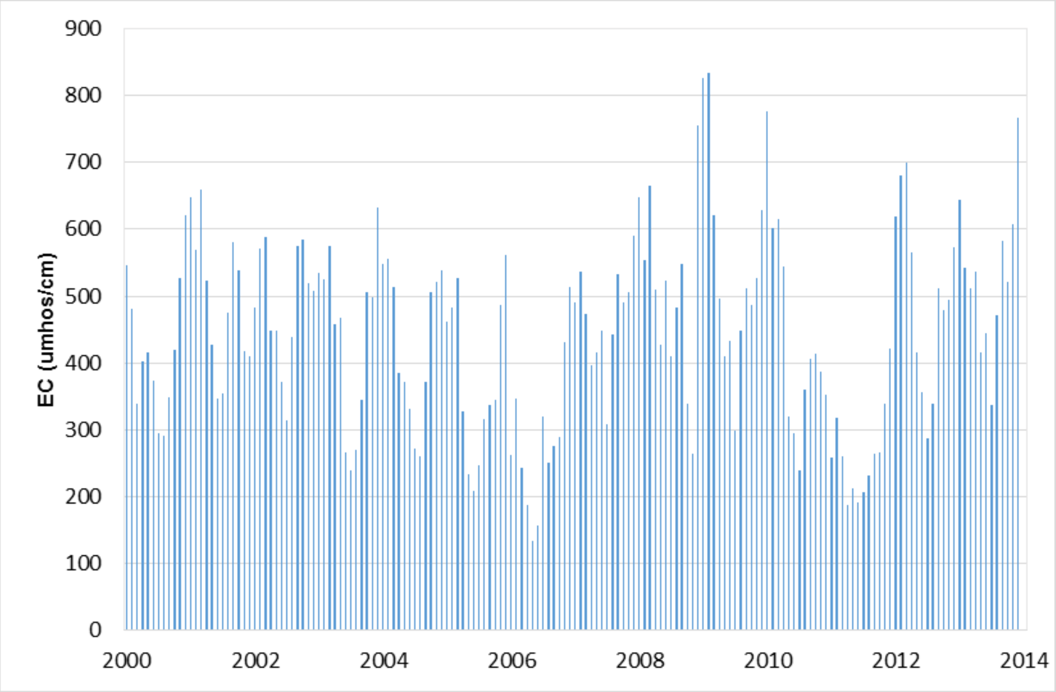


Figure 6.9 Monthly Average Specific Conductance at Delta Mendota Canal Intake (Reclamation 2013e)

Chapter 7

Groundwater Resources and Groundwater Quality

7.1 Introduction

This chapter describes groundwater resources and groundwater quality in the study area, and potential changes that could occur as a result of implementing the alternatives evaluated in this Environmental Impact Statement (EIS). Implementation of the alternatives could affect groundwater resources through potential changes in operation of the Central Valley Project (CVP) and State Water Project (SWP) and ecosystem restoration.

7.2 Regulatory Environment and Compliance Requirements

Potential actions that could be implemented under the alternatives evaluated in this EIS could affect groundwater resources in the areas along the rivers impacted by changes in the operations of CVP or SWP reservoirs and in the vicinity of and lands served by CVP and SWP water supplies. Groundwater basins that may be affected by implementation of the alternatives are in the Trinity River Region, Central Valley Region, San Francisco Bay Area Region, Central Coast Region, and Southern California Region.

Actions located on public agency lands or implemented, funded, or approved by Federal and state agencies would need to be compliant with appropriate Federal and state agency policies and regulations, as summarized in Chapter 4, Approach to Environmental Analyses.

Several of the state policies and regulations described in Chapter 4 have resulted in specific institutional and operational conditions in California groundwater basins, including the basin adjudication process, California Statewide Groundwater Elevation Monitoring Program (CASGEM), California Sustainable Groundwater Management Act (SGMA), and local groundwater management ordinances, as summarized below.

7.2.1 Groundwater Basin Adjudication

Basin adjudications are determined through court decisions or pre-court mediation on litigation that determines the groundwater rights of all the groundwater users overlying the basins. The court identifies the extractors or well owners and the amount of groundwater those well owners are allowed to extract, and appoints a Watermaster whose role is to ensure that the basin is managed in accordance with the court's decree. The Watermaster must report periodically to the court. There are currently 23 adjudicated groundwater basins in California, most of which are located in Southern California. Table 7.1 lists the adjudicated groundwater basins located in the study area.

Table 7.1 Adjudicated Groundwater Basins in the Study Area

Basin Name	Date of Final Court Decision	County
Antelope Valley Groundwater Basin	Under way	Kern and Los Angeles
Beaumont – Upper Santa Ana Groundwater Basin	2004	Riverside
Brite Groundwater Basin	1970	Kern
Central Subbasin of the Coastal Plain of Los Angeles Basin	1965	Los Angeles
Chino Subbasin of the Upper Santa Ana Valley Basin	1978	Riverside and San Bernardino
Cucamonga Subbasin of the Upper Santa Ana Valley Basin	1978	San Bernardino
Cummings Valley Groundwater Basin	1972	Kern
Goleta Groundwater Basin	1989	Santa Barbara
San Jacinto Groundwater Basin	2013	Riverside
Los Osos Valley Groundwater Basin	Under way	San Luis Obispo
Mojave Basin Area (Lower Mojave River Valley, Middle Mojave River Valley, Upper Mojave River Valley, El Mirage Valley, and Lucerne Valley groundwater basins)	1996	San Bernardino
San Gabriel Valley Groundwater Basin – excluding Raymond Groundwater Basin	1973	Los Angeles
San Gabriel Valley Groundwater Basin – Puente Narrows	1985	Los Angeles
Raymond Groundwater Basin	1944	Los Angeles
Rialto-Colton Subbasin of the Upper Santa Ana Valley Basin	1961	San Bernardino
Santa Margarita River Watershed – Santa Margarita Valley, Temecula Valley, and Cahuilla Valley groundwater basins	1966*	Riverside and San Diego
Santa Maria Valley Groundwater Basin	2008	San Luis Obispo and Santa Barbara
Santa Paula Subbasin of the Santa Clara River Valley Groundwater Basin	1996	Ventura
Six Basins Area in upper Santa Ana Valley	1998	Los Angeles and San Bernardino
Tehachapi Valley West Basin and Tehachapi Valley East Basin	1973	Kern

Basin Name	Date of Final Court Decision	County
Upper Los Angeles River Area– San Fernando Valley Groundwater Basin	1979	Los Angeles
Warren Valley Groundwater Basin	1977	San Bernardino
West Coast Subbasin of the Coastal Plain of Los Angeles Basin	1961	Los Angeles
Western San Bernardino – Upper Santa Ana Groundwater Basin	1969	San Bernardino

Sources: DWR 2003a, 2014a; LOCSD 2013

Note:

* Santa Margarita Watershed Adjudication addresses both groundwater and surface water if water contributes to Santa Margarita River and its tributaries flows (SMRW 2014). The agreements include interlocutory judgements for Murrieta-Temecula Groundwater Basin that describes non-Indian water rights subject to court jurisdiction, land and water rights not subject to court jurisdiction, reserved water rights for the Pechanga Reservation, and appropriative storage and diversion rights in conjunction with use of groundwater by the Vail Company.

7.2.2 California Statewide Groundwater Elevation Monitoring Program

Senate Bill X7-6, enacted in November 2009, mandates a statewide groundwater elevation monitoring program to track seasonal and long-term trends in groundwater elevations in California’s groundwater basins defined in Bulletin 118. This amendment to Division 6 of the Water Code, specifically Part 2.11 Groundwater Monitoring, requires the collaboration between local monitoring entities and California Department of Water Resources (DWR) to collect groundwater elevation data. The law requires local agencies to monitor and report the groundwater elevation in the basins. To achieve this goal, DWR developed the CASGEM Program to establish a permanent, locally-managed program of regular and systematic monitoring in all of the state’s alluvial groundwater basins.

DWR is required to establish a priority schedule for monitoring groundwater basins, and to report to the Legislature on the findings from these investigations (Water Code section 10920 et. seq). The 2012 CASGEM Status Report to the Legislature describes that more than 400 monitoring entities have been identified and water level data are being submitted to DWR (DWR 2012). The prioritization of basins is to identify, evaluate, and determine the need for additional groundwater level monitoring. The prioritization approach includes the following eight criteria.

- Overlying population in the groundwater basin
- Projected growth of the overlying population
- Number of public water supply wells

- Total number of water supply wells
- Irrigated acreage overlying the groundwater basin
- Reliance on groundwater as the primary source of water by the overlying land uses
- Impacts on groundwater, including overdraft, subsidence, saline intrusion, and other water quality degradation
- Any other information relevant to the groundwater conditions

Groundwater basins designations in the study area are described for each basin in the following subsection of this chapter (DWR 2014e).

7.2.3 Sustainable Groundwater Management Act

In September 2014, the SGMA was enacted. The SGMA establishes a new structure for locally managing California's groundwater in addition to existing groundwater management provisions established by Assembly Bill (AB) 3030 (1992), Senate Bill (SB) 1938 (2002), and AB 359 (2011), as well as SBX7-6 (2009).

The SGMA includes the following key elements:

- Provides for the establishment of a Groundwater Sustainability Agency (GSA) by one or more local agencies overlying a designated groundwater basin or subbasin identified in DWR Bulletin 118-03
- Requires all DWR Bulletin 118 groundwater basins found to be of "high" or "medium" priorities to prepare Groundwater Sustainability Plans (GSPs)
- Provides for the proposed revisions, by local agencies, to the boundaries of a DWR Bulletin 118 basin, including the establishment of new subbasins
- Provides authority for DWR to adopt regulations to evaluate GSPs, and review the GSPs for compliance every 5 years
- Requires DWR to establish best management practices and technical measures for GSAs to develop and implement GSPs
- Provides regulatory authority to the State Water Resources Control Board (SWRCB) for developing and implementing interim groundwater management plans under certain circumstances (such as lack of compliance with development of GSPs by GSAs)

The SGMA defines sustainable groundwater management as "the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results." Undesirable results are defined as any of the following effects.

- Chronic lowering of groundwater levels (not including overdraft during a drought if a basin is otherwise managed)
- Significant and unreasonable reduction of groundwater storage

- Significant and unreasonable seawater intrusion
- Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies
- Significant and unreasonable land subsidence that substantially interferes with surface land uses
- Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water

Based on basin priority definitions defined by DWR’s CASGEM program in June 2014 and confirmed in January 2015, the SGMA requires the formation of GSPs by 2020 or 2022. GSPs for medium and high priority basins identified subject to critical conditions of overdraft are required by 2022. All other high and medium priority basins must complete a GSP by 2020. Updates to CASGEM-defined June 2014 designated priorities are possible and can affect GSP deadline requirements. Sustainable groundwater operations must be achieved within 20 years following completion of the GSPs.

7.2.4 Regional and Local Groundwater Ordinances

Many counties within the study area considered in this EIS have adopted or are considering groundwater ordinances. The ordinances primarily address well installation, groundwater extraction, and export of the groundwater to areas outside the basin of origin. Local county groundwater ordinances vary by authority, agency, or region but typically involve permitting for well installation, and provisions to limit or prevent groundwater overdraft, to regulate transfers, and to protect groundwater quality.

Table 7.2 provides a list of substantial county groundwater ordinances within the study area that could affect groundwater supply availability.

Table 7.2 County Groundwater Ordinances in the Study Area with a Summary of Regulations

County	Ordinance Number and Title	Description
Trinity	County Code Title 15: Buildings and Construction, Chapter 15.20: Water wells.	Well standards.
Trinity and Humboldt	Hoopa Valley Tribal Council Title 37: Pollution Discharge Prohibition Ordinance	Regulates surface water and groundwater operations.
Humboldt	County Code Title VI: Water and Sewage, Division 3: Wells.	Well standards.
	Hoopa Valley Tribe: Not identified at this time.	Not applicable.
Del Norte	County Code Title 7: Health and Welfare Chapter 32: Regulations of Wells and Preservation of Groundwater.	Well standards.

County	Ordinance Number and Title	Description
Shasta	County Code Title 18: Environment 18.08: Groundwater Management.	Requires permit for groundwater extraction for use outside county.
Shasta	County Code Title 8: Health and Safety, 8.56: Water Wells.	Well standards.
Plumas	County Code Title 6: Sanitation and Health, Chapter 8: Water Wells.	Well standards. Groundwater management plans have been adopted in Plumas County, but not in the vicinity of the study area.
Tehama	County Code Title 9: Health and Safety, Chapter 9.40: Aquifer Protection.	Prohibits groundwater from being exported out of county. Requires permit to use groundwater from wells on a parcel on other parcels of land.
Tehama	County Code Title 9: Health and Safety, Chapter 9.42: Well Construction, Rehabilitation, Repair and Destruction.	Well standards.
Glenn	County Code Title 20: Water 20.030: Groundwater Coordinated Resource Management Plan.	Basin Management Objectives and monitoring network to detect changes in groundwater level, quality, land subsidence; and defines acceptable ranges of groundwater levels.
	County Code Title 20: Water, 20.080: Water Well Drilling Permits and Standards.	Well standards.
Colusa	County Code Chapter 43: Groundwater Management.	Requires permit for groundwater extraction for use outside county.
	County Code Chapter 35: Well Standards.	Well standards.
Butte	County Code Chapter 33A: Basin Management.	Basin Management Objectives for: groundwater quality and groundwater levels, and other protections to reduce land subsidence.
	County Code Chapter 23B: Water Wells.	Well standards.
Yuba	County Code Title VII: Health and Sanitation, Chapter 7.03: Water wells.	Well standards.

County	Ordinance Number and Title	Description
Sutter	County Code Section 700: Health and Sanitation, Chapter 765: Water Wells.	Well standards.
Placer	County Code Chapter 13: Public Services, Article 13.08: Water Wells.	Well standards.
El Dorado	County Code Title 8: Health and Safety, Chapter 8.39: Well Standards.	Well standards. Groundwater management plans have been adopted in El Dorado County, but not in the vicinity of the study area.
Sacramento	County Code Title 6: Health and Sanitation, Chapter 6.28: Wells and Pumps.	Well standards.
Yolo	County Code Title 10: Environment Chapter 7: Groundwater.	Requires permit for groundwater extraction for use outside of the county.
	County Code Title 6: Sanitation and Health, Chapter 8: Water Quality, Article 10: Standards, Criteria, and Regulations of Wells.	Well standards.
Solano	County Code Chapter 13.6: Injection Wells.	Restricts operation of injection wells.
	County Code Chapter 13.10: Well Standards.	Well standards.
Napa	County Code Title 13: Waters, Sewers, and Public Services Chapter 13.15: Groundwater Conservation.	Regulates the use of groundwater.
	County Code Title 13: Waters, Sewers, and Public Services Chapter 13.12: Wells.	Well standards.
San Joaquin	County Code Title 5: Health and Sanitation, Division 4: Wells and Well Drilling.	Well standards.
	County Code Title 5: Health and Sanitation, Division 8: Groundwater.	Requires permit for groundwater use outside of the county.
Stanislaus	County Code Title 9: Health and Safety, Chapter 9.37: Groundwater Mining and Export Prevention.	Regulates groundwater use and prohibits export of water outside of the county (except as noted in the requirements).
	County Code Title 9: Health and Safety, Chapter 9.36: Water Wells.	Well standards.

County	Ordinance Number and Title	Description
Madera	County Code Title 13: Waters and Sewers, V Groundwater Exportation, Groundwater Banking, and Importation of Foreign Water, for Purposes of Groundwater Banking, to Areas of Madera County which are Outside of Local Water Agencies that Deliver Water to Lands Within their Boundaries. Chapter 13.1: Rules and Regulations Pertaining to Groundwater Banking—Importation of Foreign Water, for the Purpose of Groundwater Banking, to Areas of Madera County which are Outside of Local Water Agencies that Deliver Water to Lands within their Boundaries—Exportation of Groundwater Outside the County.	Regulates development of groundwater banking, including importation of groundwater to be stored in the groundwater bank, and exportation of groundwater for use outside of the county; and prohibits groundwater injection.
	County Code Title 13: Waters and Sewers, I: Water, Chapter 13.52: Well Standards.	Well standards.
Merced	County Code Title 9: General Health and Safety, Chapter 9.28: Wells.	Well standards.
Fresno	County Code Title 14: Waters and Sewers, Chapter 14.03: Groundwater Management.	Regulates groundwater use outside of the county.
	County Code Title 14: Waters and Sewers, Chapter 14.04: Well Regulations – General Provisions.	Well standards.
	County Code Title 14: Waters and Sewers Chapter 14.08: Well Construction, Pump Installation and Well Destruction Standards.	Well standards.
Tulare	County Code Part IV: Health, Safety, and Sanitation, Chapter 13: Well.	Well standards.
Kings	County Code Chapter 14A: Water Wells.	Well standards.
Kern	County Code Title 14: Utilities Chapter 14.08: Water Supply Systems, Article III: Well Standards.	Well standards.
Contra Costa	County Code Title 4: Health and Safety, Chapter 414: Waterways and Water Supply, Chapter 414-4: Water supply.	Well standards.
Alameda	County Code Title 6: Health and Safety, Chapter 6.88: Water Wells.	Well standards.

County	Ordinance Number and Title	Description
Santa Clara	Santa Clara Valley Water District Act (California Water Code Appendix, Chapter 60).	Santa Clara Valley Water District is the designated agency to manage water within Santa Clara County, including groundwater management to recharge the basin, conserve water, increase water supply, and prevent waste or diminution of the water supply.
	Santa Clara Valley Water District Well Ordinance 90-1.	Well standards.
San Benito	County Code Title 15: Public Works, Chapter 5.05: Water, Article I: Groundwater Aquifer Protections.	Regulates use of groundwater on non-contiguous parcels with separate owners than parcel with well, injection of groundwater, and operations that could adversely affect other groundwater users or the groundwater aquifer.
	County Code Title 15: Public Works, Chapter 5.05: Water, Article III: Well Standards.	Well standards.
San Luis Obispo	County Code Title 8: Health and Sanitation, Chapter 8.40: Construction, Repair, Modification and Destruction of Wells.	Well standards.
Santa Barbara	County Code Chapter 34A: Wells.	Well standards.
Ventura	County Code Division 4: Public Health, Chapter 8: Water, Article 1: Groundwater Conservation.	Well standards.
Los Angeles	County Code Title 11: Health and Safety, Chapter: 11.38 Water and Sewers, Part 2: Water and Water Wells.	Well standards.
Orange	County Code Title 4: Health and Sanitation and Animal Regulations, Division 5: Water Conservation, Article 3 Construction and Abandonment of Water Wells.	Well standards.

County	Ordinance Number and Title	Description
San Diego	County Code Title 6: Health and Sanitation, Division 7: Water and Water Supplies, Chapter 4: Wells.	Well standards.
	County Code Title 6: Health and Sanitation, Division 7: Water and Water Supplies, Chapter 7: Groundwater.	Regulates actions for the protection, preservation, and maintenance of groundwater resources.
Riverside	County Code Title 13: Public Services, Chapter 13.20: Water Wells.	Well standards.
San Bernardino	County Code Title 3: Health and Sanitation, Division 3: Environmental Health, Chapter 6: Domestic Water Sources and Systems, Article 3: Water Wells.	Well standards.
	County Code Title 3: Health and Sanitation, Division 3: Environmental Health, Chapter 6: Domestic Water Sources and Systems, Article 5: Desert Groundwater Management.	Regulates groundwater basins not adjudicated by judicial decree; and wells not within the boundaries of the Mojave Water Agency and public water agencies within the Morongo Basin, incorporated areas, or Federal lands. This section does not apply to wells used for existing mining operations, small agricultural operations, small wells, or replacement wells of similar size to abandoned wells. This section does not apply to areas with a groundwater management plan and a memorandum of understanding with the county.

Sources: Trinity County 2014; Hoopa Valley Tribe 2008; Humboldt County 2014; Del Norte County 2014; Shasta County 2014 a, b; Plumas County 2014; Tehama County 2014; Glenn County 2014; Colusa County 2014 a, b; Butte County 2014 a, b; Yuba County 2014; Sutter County 2014; Placer County 2014; El Dorado County 2014; Sacramento County 2014; Yolo County 2014; Solano County 2014; Napa County 2014; San Joaquin County 2014; Stanislaus County 2014; Madera County 2014; Merced County 2014; Fresno County 2014; Tulare County 2014; Kings County 2014; Kern County 2014; Contra Costa County 2014; Alameda County 2014; SCVWD 2014 a, b; San Benito County 2014; San Luis Obispo County 2014a; Santa Barbara County 2014; Ventura County 2014; Los Angeles County 2014a; Orange County 2014; San Diego County 2014; Riverside County 2014; San Bernardino County 2014

7.3 Affected Environment

This section describes groundwater resources that could be potentially affected by the implementation of the alternatives considered in this EIS. Changes in groundwater resources due to changes in CVP and SWP operations may occur in the Trinity River, Central Valley, San Francisco Bay Area, Central Coast, and Southern California regions.

Groundwater occurs throughout the study area. However, the groundwater resources that could be directly or indirectly affected through implementation of the alternatives analyzed in this EIS are related to groundwater basins which include users of CVP and SWP water supplies that also use groundwater, and areas along the rivers downstream of CVP or SWP reservoirs that use groundwater supplies. Therefore, the following description of the affected environment is limited to these areas and does not include groundwater basins or subbasins that area not directly or indirectly affected by changes in CVP and SWP operations.

7.3.1 Overview of California Groundwater Resources

As described in Chapter 5, Surface Water Resources and Water Supplies, groundwater is a vital resource in California. Groundwater supplied about 37 percent of the state’s average agricultural, municipal, and industrial water needs between 1998 and 2010, and 40 percent or more during dry and critical water years in that period (DWR 2013i). About 20 percent of the nation’s groundwater demand is supplied from the Central Valley aquifers, making it the second-most-pumped aquifer system in the United States (USGS 2009). The three Central Valley hydrologic regions (Tulare Lake, San Joaquin River, and Sacramento River) account for about 75 percent of the state’s average annual groundwater use (DWR 2013i).

The DWR has delineated 515 distinct groundwater systems throughout the state, as described in Bulletin 118-03 (DWR 2003a), that are considered to be the most important groundwater basins. These basins and subbasins have various degrees of supply reliability considering yield, storage capacity, and water quality, and are typically alluvial, or non-consolidated (non-fractured rock) aquifers. Figure 7.1 shows the statewide occurrence of groundwater in the groundwater basins and subbasins identified by DWR as Bulletin 118 basins. A majority of the descriptions provided herein are summarized form DWR Bulletin 118 reports.

The importance of groundwater as a resource varies regionally. The Central Coast has the most reliance on groundwater to meet its local uses, with more than 80 percent of the agricultural, municipal, and industrial water supplies by groundwater in an average year. The central and southern San Joaquin Valley (described as the Tulare Lake Area of the San Joaquin Valley Groundwater Basin in this chapter) groundwater use, on average, meets about 50 percent of the total water supplies. The Sacramento Valley and northern portion of the San Joaquin Valley Groundwater Basin use groundwater to meet approximately 30 and 40 percent of the agricultural, municipal, and industrial water demand, respectively. In the coastal areas of Southern California, groundwater use varies from less than 10 percent in western San Diego County to between 35 and 50 percent of the agricultural, municipal, and industrial water supplies in counties along the coast western Ventura, Los Angeles, and Riverside counties and Orange County, on an annual average basis. In the inland areas of Southern California, groundwater use varies from approximately 45 to over 90 percent of the agricultural, municipal, and industrial water supplies (DWR 2013).

A comprehensive assessment of overdraft in all of the state's groundwater basins has not been conducted since Bulletin 118-80 was published in 1980, but overdraft is estimated at between 1 to 2 million acre-feet annually (DWR 2003a). In DWR's Bulletin 118-80 (DWR 1980), an assessment of critically overdrafted basins was conducted, as shown in Figure 7.2. This assessment identified 11 basins in critical condition of overdraft. Based on SGMA requirements, the state must identify basins subject to critical conditions of overdraft in 2015, publish the final list in 2016, and use this list in the Bulletin 118 Interim Update 2017. This revised list is being finalized at the same time as this EIS document is finalized. This revised draft list added three basins in the EIS study area that are considered in critical conditions of overdraft (DWR 2015):

- Merced (5-22.04): Subsidence in El Nido area of 0.6 to 1.0 ft/year
- Delta-Mendota ((5-22.07): Significant, on-going and irreversible subsidence
- Westside (5-22.09): Significant, on-going and irreversible subsidence

In the past 20 years, specific groundwater studies have been conducted by regional water agencies or the U.S. Geological Survey (USGS) to update the statewide survey conducted by DWR in 1980 (USGS 2000a, 2006, 2008, 2009, 2012, 2014). The results of many of those studies are discussed in the following subsections of this chapter.

7.3.2 Trinity River Region

The Trinity River Region includes the area along the Trinity River from Trinity Lake to the confluence with the Klamath River; and along the Klamath River from the confluence with the Trinity River to the Pacific Ocean.

Most usable groundwater in the Trinity River Region occurs in widely scattered alluvium filled valleys, such as those immediately adjacent to the Trinity River. These valleys contain only small quantities of recoverable groundwater, and, therefore, are not considered a major source. A number of shallow wells adjacent to the river provide water for domestic purposes (Reclamation et al. 2006a; NCRWQCB et al. 2009). Groundwater present in these alluvial valleys is in close hydraulic connection with the Trinity River and its tributaries. Both groundwater discharge to surface streams as well as leakage of steam flow to underlying aquifers are expected to occur at various locations.

The Bulletin 118-03 (DWR 2003a, 2004do, 2004dp) identified only two groundwater basins underlying the Trinity River Region in the Study Area, Hoopa

Valley and Lower Klamath River Valley groundwater basins, as shown in Figure 7.3. These groundwater basins are small, isolated, valley-fill aquifers that provide a very limited quantity of groundwater to satisfy local domestic, municipal, and agricultural needs. Groundwater pumped from these aquifer systems is used strictly for local supply.

As described in Chapter 5, Surface Water Resources and Water Supplies, several communities use infiltration galleries along the Trinity River and the tributaries to convey surface water to groundwater wells, including the Lewiston Community Services District, Lewiston Valley Water Company, and Lewiston Park Mutual Water Company (NCRWQCB et al. 2009).

Groundwater within the Hoopa Valley Indian Reservation occurs along alluvial terraces (Hoopa Valley Tribe 2008). The aquifers are approximately 10 to 80 feet deep. Some of the shallow wells are productive only during winter and early spring months.

The Lower Klamath River Valley Groundwater Basin extends over 7,030 acres in Del Norte and Humboldt counties, including areas along the Lower Klamath River (Reclamation 2010a). Groundwater along the Lower Klamath River occurs in alluvial fans near the confluences of major tributaries and along terrace and floodplain deposits adjacent to the river (Yurok Tribe 2012). The aquifers range in depth from 10 to 80 feet and are used by some members of the community.

The Hoopa Valley and Lower Klamath River Valley groundwater basins were designated by the CASGEM program as very low and low priorities, respectively.

Groundwater quality is suitable for many beneficial uses in the region. In other locations, the groundwater can include naturally occurring metals, including manganese, cadmium, zinc, and barium (Hoopa Valley Tribe 2008). Other groundwater quality issues include nitrate contamination (DWR 2013i). Groundwater and surface water contamination is suspected at several former and existing mill sites that historically used wood treatment chemicals. Discharges of pentachlorophenol, polychlorodibenzodioxins, and polychlorodibenzofurans have likely occurred due to the poor containment practices typically used in historical wood treatment applications. Additional investigation, sampling and monitoring, and enforcement actions have been limited by the insufficient resources that exist to address this historical toxic chemical problem (NCRWQCB 2005).

7.3.3 Central Valley Region

The Central Valley Region extends from above Shasta Lake to the Tehachapi Mountains, and includes the Sacramento Valley, San Joaquin Valley, Delta, and Suisun Marsh.

Groundwater for the Central Valley Region is described in relation to the basins described by DWR in Bulletin 118-03 (DWR 2003a). The overall area includes the Sacramento Valley Basin which extends through the Sacramento Valley, and the San Joaquin Valley Groundwater Basin (including the Tulare Lake Area, which extends through the San Joaquin Valley). The Delta and Suisun Marsh area are located partially in the Sacramento Valley Basin and partially in the

San Joaquin Valley Groundwater Basin. The Delta and Suisun Marsh area is described separately because of its distinct characteristics as an estuary at the confluence of the Sacramento and the San Joaquin rivers.

7.3.3.1 Sacramento Valley

The Sacramento Valley includes the Redding Groundwater Basin and the Sacramento Valley Groundwater Basin. The Sacramento Valley Groundwater Basin is one of the largest groundwater basins in the state, and extends from Redding in the north to the Delta in the south (USGS 2009).

Approximately one-third of the Sacramento Valley's urban and agricultural water needs are met by groundwater (DWR 2003a). The portion of the water diverted for irrigation but not actually consumed by crops or other vegetation becomes recharge to the groundwater aquifer or flows back to surface waterways.

Overall, the Sacramento Groundwater Basin is approximately balanced with respect to annual recharge and pumping demand. However, there are several locations showing early signs of persistent drawdown, suggesting limitations due to increased groundwater use in dry years. Locations of persistent drawdown include: Glenn County, areas near Chico in Butte County, northern Sacramento County, and portions of Yolo County.

The water quality of groundwater in the Sacramento Valley is generally good, as described below for individual basins. Several areas have localized aquifers with high nitrate, total dissolved solids (TDS) or boron concentrations. High nitrate concentrations frequently occur due to residuals from agricultural operations or septic systems. High TDS, a measure of salinity, concentration can be an indicator of brackish or connate water when it occurs in high concentrations. High boron concentration usually is associated with naturally occurring deposits.

7.3.3.1.1 Overview of Groundwater Basins in the Sacramento Valley

The Sacramento Valley includes the Redding Groundwater Basin and the Sacramento Valley Groundwater Basin. The Redding Groundwater Basin is situated in the extreme northern end of the valley and is a separate, isolated groundwater basin, but due to similarities in geology and stratigraphy is discussed as part of the overall Sacramento Valley. It is bordered by the Coast Ranges on the west, and by the Cascade Range and Sierra Nevada mountains on the east.

The Sacramento Valley Groundwater Basin has been divided into 17 subbasins by DWR, as shown in Figure 7.4, based on groundwater characteristics, surface water features, and political boundaries (DWR 2003a). However, from a hydrologic standpoint, these individual groundwater subbasins have a high degree of hydraulic connection because the rivers do not always act as barriers to groundwater flow. Therefore, the Sacramento Valley Groundwater Basin functions primarily as a single laterally extensive alluvial aquifer, rather than numerous discrete, smaller groundwater subbasins.

For discussion purposes, and due to their common characteristics, the Sacramento Valley is further sub-divided into the Upper Sacramento Valley, the Lower

Sacramento Valley West of the Sacramento River, and the Lower Sacramento Valley East of the Sacramento River.

General Hydrogeology of the Sacramento Valley

Freshwater in the Sacramento Valley Groundwater Basin occurs within the continental deposits. Hydrogeologic units containing freshwater along the eastern portion of the basin, primarily occur in the Tuscan and Mehrten formations, and are derived from the Sierra Nevada. Toward the southeastern portion of the Sacramento Valley, the Mehrten formation is overlain by sediments of the Laguna, Riverbank, and Modesto formations, which also originated in the Sierra Nevada. The primary hydrogeologic unit in the western portion of the Sacramento Valley is the Tehama formation, which was derived from the Coast Ranges. In most of the Sacramento Valley, these deeper units are overlain by younger alluvial and floodplain deposits. Generally, groundwater flows inward from the edges of the basin toward the Sacramento River, then in a southerly direction parallel to the river. Depth to groundwater throughout most of the Sacramento Valley averages about 30 feet below the ground surface, with shallower depths along the Sacramento River and greater depths along the basin margins. Wells developed in the sediments of the valley provide excellent supply to irrigation, municipal, and domestic uses. The deepest elevation of the base of freshwater in the Sacramento Valley ranges between 400 feet and 3,350 feet below mean sea level (Berkstresser 1973). The location where the base of freshwater is the deepest occurs in the Delta near Rio Vista. Near the valley margins and the Sutter Buttes, the base of freshwater is relatively shallow; suggesting that the base of freshwater may coincide with bedrock or connate water trapped in shallower deposits close to the basin margins (Berkstresser 1973).

Today, groundwater levels are generally in balance valley-wide, with pumping matched by recharge from the various sources annually. Some locales show the early signs of persistent drawdown, especially in areas where water demands are met primarily, and in some locales exclusively, by groundwater. These areas include portions of the far west side of the Sacramento Valley in Glenn County, portions of Butte County near Chico, in portions of Yolo County, and in the northern Sacramento County area. The persistent areas of drawdown could be early signs that the limits of sustainable groundwater use have been reached in these areas. Due to the drought that started in 2011, surface water supplies have declined and new wells have been installed. Between January and October 2014, over 100 water supply wells were drilled in both Shasta and Butte counties (DWR 2014d).

Land subsidence in the Sacramento Valley has resulted from inelastic deformation (non-recoverable changes) of fine-grained sediments related to groundwater withdrawal. Areas of subsidence from groundwater level declines have been measured in the Sacramento Valley at several locations. Subsidence monitoring was established following several studies in the 1990s that indicated more than four feet of subsidence since 1954 in some areas, such as in Yolo County (Ikehara 1994). Initial data from the Yolo County extensometers indicated subsidence in the Zamora area, which has subsequently been confirmed with a countywide global positioning system network installed in 1999 and monitored in 2002 and 2005. Subsidence up to 0.4 feet occurred between 1999 and 2005 in the Zamora area (Frame Surveying and Mapping 2006). The Zamora area does not currently use CVP or SWP water supplies. However, this area was designated as part of the CVP Sacramento Valley Irrigation Canals service area in the Reclamation Act of 1950 and as amended in the Reclamation Act of 1980 and Central Valley Project Improvement Act.

7.3.3.1.2 Upper Sacramento Valley

The Upper Sacramento Valley includes the Redding Groundwater Basin and upper portions of the Sacramento Valley Groundwater Basin (DWR 2003a). The Redding Groundwater Basin extends from approximately Redding in Shasta County through the northern portions of Tehama County. The portions of the Sacramento Valley Groundwater Basin in the Upper Sacramento Valley are located primarily in Tehama County with small portions extending into Glenn County near Orland and Butte County near Chico in the south. The geology of this area is dominated by the Tuscan and Tehama Formations. The hydrology of this area is dominated by numerous smaller drainages that originate in the Sierra Nevada, Cascade, and Coast Ranges and drain to the Sacramento River (DWR 2003a).

Hydrogeology and Groundwater Conditions

The Redding Groundwater Basin comprises the northernmost part of the Sacramento Valley and is bordered by the Klamath Mountains to the north, the Coast Ranges to the west, the Cascade Mountains to the east, and the Red Bluff Arch to the south. This basin consists of a sediment-filled, symmetrical, southward-dipping trough formed by folding of the marine sedimentary basement rock. These deposits are overlain by a thick sequence of inter-bedded, continentally-derived, sedimentary, and volcanic deposits of Late Tertiary and Quaternary age. The primary fresh water-bearing deposits in the basin are the Pliocene age volcanic deposits of the Tuscan Formation and the Pliocene age continental deposits of the Tehama Formation (DWR 2003a, 2003b, 2004a, 2004b, 2004c, 2004d, 2004e, 2004f).

The Tehama Formation consists of unconsolidated to moderately consolidated coarse and fine-grained sediments derived from the Coast Ranges to the west. The Tehama Formation is up to 4,000 feet thick and varies in depth from a few feet to several hundred feet below the land surface, with depth generally increasing to the east towards the Sacramento River (DWR 2003a, 2004a, 2004b, 2004c, 2004d, 2004e, 2004f). The Tuscan formation is derived from the Cascade Range to the east and is primarily composed of volcaniclastic sediments.

The Redding Groundwater Basin includes six subbasins: Anderson, Rosewood, Bowman, Enterprise, Millville, and South Battle Creek (DWR 2003a, 2004a, 2004b, 2004c, 2004d, 2004e, 2004f). The Anderson subbasin is one of the main groundwater units in the Redding Basin. Groundwater levels in the unconfined and confined portions of the aquifer system fluctuate annually by 2 to 4 feet during normal precipitation years and up to 10 to 16 feet during drought years (DWR 2003b). Between spring 2010 and spring 2014 in the Redding Groundwater Basin, recent information indicates that groundwater levels declined at multiple wells by up to 10 feet. The groundwater levels in some areas declined up to 10 feet between Fall 2013 and Fall 2014 (DWR 2014c, 2014d).

Tehama County overlies three subbasins within the Redding Groundwater Basin and seven subbasins in the Sacramento Valley Groundwater Basin. The Rosewood, South Battle Creek, and Bowman subbasins in the Redding Groundwater Basin are located in Tehama County. The Red Bluff, Corning, Bend, Antelope, Dye Creek, Los Molinos, and Vina subbasins in the Sacramento Valley Groundwater Basin are located in Tehama County (DWR 2004b, 2004c, 2004f, 2004g, 2004h, 2004i, 2004j, 2004k, 2004l, 2006a). The Corning subbasin extends into northern Glenn County near Orland. The Vina subbasin extends into northern Butte County near Chico. Groundwater levels in these subbasins show a significant seasonal variation due to high groundwater use for irrigation during the summer months. Groundwater levels showed significant declines in some wells associated with the 1976 to 1977 and 1987 to 1992 drought periods. Groundwater levels appeared to recover quickly during subsequent wet years. Groundwater levels in the Corning area of Tehama County showed a general decline before 1965 due to increased groundwater pumping for agricultural uses. Following construction by the CVP of the Tehama-Colusa Canal and the Corning Canal, surface water was delivered to these areas and there was a subsequent upward trend in groundwater levels following initial operations (Tehama County Flood Control and Water Conservation District 1996). Between spring 2010 and spring 2014 in the Upper portion of the Sacramento Valley Groundwater Basin, recent information indicates that groundwater levels declined at multiple wells approximately 2.5 feet to 10 feet (DWR 2014c, 2014d). The groundwater levels in some areas declined up to 10 feet between fall 2013 and fall 2014, and in some areas more than 10 feet.

Groundwater quality in the Redding Groundwater Basin is generally good to excellent for most uses. Some areas of poor quality due to high salinity from marine sedimentary rock exist at the margins of the basin. Portions of the basin are characterized by high boron, iron, manganese, and nitrates in localized areas (DWR 2004a, 2004b, 2004c, 2004d, 2004e, 2004f). In general, groundwater in the Sacramento Valley Groundwater Basin within Tehama County is of excellent quality, with some localized areas with groundwater quality concerns related to boron, calcium, chloride, magnesium, nitrate, phosphorous, and TDS (DWR 2004g, 2004h, 2004i, 2004j, 2004k, 2004l, 2006a). In the vicinity of Antelope, east of Red Bluff, historical high nitrates in groundwater occur. Higher boron levels have been detected in wells located in the eastern portion of Tehama County. High salinity occurs near Salt Creek, which most likely originates from the Tuscan Springs, which is a source of high boron and sulfates.

The Vina subbasin was designated by the CASGEM program as high priority. The Anderson, Enterprise, Bowman, Red Bluff, Corning, Antelope, Dye Creek, and Los Molinos subbasins were designated medium priority. The Rosewood, Millville, South Battle Creek, and Bend subbasins were designated very low priority in the June 2014 CASGEM designation.

Groundwater Use and Management

Tehama County uses groundwater to meet approximately 65 percent of its total water needs (Tehama County Flood Control and Water Conservation District 2008). Groundwater in the county provides water supply for agricultural, domestic, environmental, and industrial uses.

One of the main users of groundwater in this area is the Anderson-Cottonwood Irrigation District. Approximately 5 percent of the irrigated acres rely upon groundwater (DWR 2003b). Groundwater also is the primary water supply for residences and small scale agricultural operations.

7.3.3.1.3 Lower Sacramento Valley (West of Sacramento River)

The Lower Sacramento Valley area west of the Sacramento River includes three main groundwater subbasins: Colusa, Yolo, and Solano (DWR 2003a, 2004m, 2004n, 2006b).

Hydrogeology and Groundwater Conditions

Colusa Subbasin

The Colusa subbasin is bordered by the Coast Ranges to the west, Stony Creek to the north, Sacramento River to the east, and Cache Creek to the south. The Colusa subbasin extends primarily in western Glenn and Colusa counties. This subbasin is composed of continental deposits of late Tertiary age, including the Tehama and the Tuscan Formations, to Quaternary age, including alluvial and floodplain deposits as well as Modesto and Riverbank Formations. The Tehama Formation represents the main water bearing formation for the Colusa subbasin (DWR 2003b, 2006b). Groundwater levels are fairly stable in this subbasin, except during droughts, such as in 1976 and 1977 and 1987 to 1992 (DWR 2013a). Groundwater levels in the Colusa subbasin declined in the 2008 drought, and increased during the wetter periods of 2010 and 2011 to the pre-drought 2008 levels (DWR 2014c, 2014d). Historically, groundwater levels fluctuate by approximately 5 feet seasonally during normal and dry years (DWR 2006b, 2013a). Recent information indicates that groundwater levels declined at multiple wells in the Colusa subbasin approximately 10 to 20 feet between spring 2010 and spring 2014 in southwestern Colusa subbasin (DWR 2014c, 2014d). The groundwater levels in some areas declined up to 10 feet between fall 2013 and fall 2014, and in some areas more than 10 feet.

Groundwater quality for the Colusa subbasin is characterized by moderate to high TDS; with localized areas of high nitrate and manganese concentrations near the town of Colusa (DWR 2013a, 2006b). High TDS and boron concentrations have been observed near Knights Landing. High nitrate levels have been observed near Arbuckle, Knights Landing, and Willows.

The Colusa subbasin was designated by the CASGEM program as medium priority.

Yolo Subbasin

The Yolo subbasin lies to the south of the Colusa subbasin primarily within Yolo County. The primary water bearing formations for the Yolo subbasin are the same as those for the Colusa subbasin. Younger alluvium from flood basin deposits and stream channel deposits lie above the saturated zone and tend to provide significant well yields. In general, groundwater levels are stable in this subbasin, except during periods of drought, and in certain localized pumping depressions in the vicinity of Davis, Woodland, and Dunnigan and Zamora areas (DWR 2004m, 2013a). However, between spring 2010 and spring 2014 in the Yolo subbasin, recent information indicates that groundwater levels declined at multiple wells at least 10 feet and in some areas up to 20 feet (DWR 2014c, 2014d). The groundwater levels in some areas declined up to 10 feet between fall 2013 and fall 2014, and in some areas more than 10 feet.

Groundwater quality is generally good for beneficial uses except for localized impairments including elevated concentrations of boron in groundwater along Cache Creek and in the Cache Creek Settling Basin area, elevated levels of selenium present in the groundwater supplies for the City of Davis, and localized areas of nitrate contamination (DWR 2004m, 2013a). The cities of Davis and Woodland, which heavily rely on groundwater supply, lost nine municipal wells since 2011 due to high nitrate concentrations (YCFCWCD 2012). Sources of high nitrate concentrations near these cities have been determined to be primarily from agricultural and wastewater operations. High salinity levels have also been reported in some areas that may be related to groundwater use for irrigation which tends to increase salt concentrations in groundwater.

In Yolo County, as much as 4 feet of groundwater withdrawal-related subsidence has occurred since the 1950s. Groundwater withdrawal-related subsidence has damaged or reduced the integrity of highways, levees, irrigation canals, and wells in Yolo County, particularly in the vicinities of Zamora, Knights Landing, and Woodland (Water Resources Association of Yolo County 2007).

The Yolo subbasin was designated by the CASGEM program as high priority.

Solano Subbasin

The Solano subbasin includes most of Solano County, southeastern Yolo County, and southwestern Sacramento County. In the Solano subbasin, general groundwater flow directions are from the northwest to the southeast (DWR 2004n, 2013a). Increasing agricultural and urban development in the 1940s in the Solano subbasin has caused significant groundwater level declines. Today, groundwater levels are relatively stable but show significant declines during drought cycles. Groundwater level data also suggest that these declines tend to recover quickly during subsequent wet years. Between spring 2010 and spring 2014 in the Solano subbasin, recent information indicates that groundwater levels declined at multiple wells by at least 10 feet (DWR 2014c, 2014d).

Groundwater quality in the Solano subbasin is generally good and is deemed appropriate for domestic and agricultural use (DWR 2004n, 2013a). However, TDS concentrations are moderately high in the central and southern areas of the basin with localized areas of high calcium and magnesium.

The Solano subbasin was designated by the CASGEM program as medium priority.

Groundwater Use and Management

Many irrigators on the west side of the Sacramento Valley relied primarily on groundwater prior to completion of the CVP Tehama-Colusa Canal facilities which conveyed surface water to portions of Colusa County.

In the Colusa subbasin, although surface water is the primary source of water to meet water supply needs, groundwater is also used to assist in meeting agricultural, domestic, municipal, and industrial water needs, primarily in areas outside of established water districts. The Tehama Colusa Canal Authority service area is also an area of groundwater use in the Colusa subbasin. Although the Tehama-Colusa Canal Authority delivers surface water to agricultural users when the CVP water supplies are restricted due to hydrologic conditions, water users rely upon groundwater to supplement limited surface water supplies.

Groundwater is the source of water for municipal and domestic uses in Yolo County except for the City of West Sacramento, as described in Chapter 5, Surface Water Resources and Water Supplies. Recently, in normal years, approximately 40 percent of the irrigation users in Yolo County rely on groundwater (Yolo County 2009). For the East Yolo South area of the County (eastern Yolo subbasin), a 2006 study estimated that groundwater supplies about 80 to 85 percent of the total annual water demand in the county (YCFCWCD 2012).

Within Yolo and Sacramento counties portions of the Solano subbasin, groundwater is primarily used for domestic and irrigation uses. Within Solano County, groundwater is used exclusively by most rural residential landowners and the cities of Rio Vista and Dixon (Solano County 2008). The City of Vacaville uses groundwater to provide approximately 30 percent of the water supply. Other communities rely upon surface water, as described in Chapter 5, Surface Water Resources and Water Supplies. Irrigation users within the Solano Irrigation District rely upon surface water. All other irrigation users rely upon groundwater.

7.3.3.1.4 Lower Sacramento Valley (East of Sacramento River)

The Lower Sacramento Valley area is located to the east of the Sacramento River, and includes seven groundwater subbasins: West Butte, East Butte, North Yuba, South Yuba, Sutter, North American, and South American (DWR 2003a, 2004o, 2004p, 2004q, 2006c, 2006d, 2006e, 2006f).

Hydrogeology and Groundwater Conditions

The aquifer system throughout the Lower Sacramento Valley east of the Sacramento River is composed of Tertiary to late Quaternary age deposits. The confined portion of the aquifer system includes the Tertiary-age Tuscan and Laguna formations. The Tuscan formation consists of volcanic mudflows, tuff breccia, tuffaceous sandstone, and volcanic ash deposits. The Laguna formation consists of moderately consolidated and poorly to well cemented interbedded alluvial sand, gravel, and silt with a low permeability, overall. The Quaternary portion of the aquifer system, typically unconfined, is largely composed of unconsolidated gravel, sand, silt, and clay stream channel and alluvial fan deposits. South and east of the Sutter Buttes, the deposits contain Pleistocene alluvium, which is composed of loosely compacted silts, sands, and gravels that are moderately permeable; however, nearly impermeable hardpans and claypans also exist in this deposit, which restrict the vertical movement of groundwater (DWR 2003a, 2004o, 2004p, 2004q, 2006c, 2006d, 2006e, 2006f).

West and East Butte Subbasins

The West Butte subbasin is located within Butte, Glenn, and Sutter counties. In the West Butte subbasin, groundwater levels declined during the 1976 to 1977 and 1987 to 1992 droughts, followed by a recovery in groundwater levels to pre-drought conditions of the early 1980s and 1990s (DWR 2004o, 2013a). A comparison of spring-to-spring groundwater levels from the 1950s and 1960s, to levels in the early 2000s, indicates about a 10-foot decline in groundwater levels in portions of this subbasin. Several groundwater depressions exist in the Chico area, due to year-round groundwater extraction for municipal uses. Between spring 2010 and spring 2014 in the West Butte subbasin, recent information indicates that groundwater levels declined at multiple wells at least 10 feet and in some areas up to 20 feet near Chico (DWR 2014c, 2014d). The groundwater levels in some areas declined up to 10 feet between fall 2013 and fall 2014.

The East Butte subbasin is located with Butte and Sutter counties. In the northern portion of the East Butte subbasin, annual groundwater fluctuations in the confined and semi-confined aquifer system ranges from 15 to 30 feet during normal years (DWR 2004p, 2013a). In the southern part of Butte County, groundwater fluctuations for wells constructed in the confined and semi-confined aquifer system average 4 feet during normal years and up to 5 feet during drought years. Between spring 2010 and spring 2014 in the East Butte subbasin, recent information indicates that groundwater levels either increased or declined at multiple wells by approximately 2 to 3 feet near Oroville (DWR 2014c, 2014d).

High nitrates occur near the Chico area in the West Butte subbasin. There are localized areas in the subbasin with high boron, calcium, electrical conductivity (EC), and TDS concentrations (DWR 2004 o, 2013a). There are several groundwater areas near Chico that historically had high perchloroethylene concentrations from industrial sites. Following implementation of groundwater treatment, the chemicals have not been detected (Butte County 2010).

There are localized high concentrations of calcium, salinity, iron, manganese, magnesium, and TDS throughout the East Butte subbasin (DWR 2004p, 2013a).

The West Butte subbasin was designated by the CASGEM program as high priority. The East Butte subbasin was designated as medium priority.

North and South Yuba Subbasins

The North Yuba subbasin is located within Butte and Yuba counties. The South Yuba subbasin is located within Yuba County. In the North Yuba and South Yuba subbasins areas along the Feather River, the groundwater levels have been generally stable since at least 1960, with some seasonal fluctuations between spring and summer conditions. Groundwater levels in the central parts of the two subbasins declined until about 1980, when surface water deliveries were extended to these areas and groundwater levels started to rise. Hydrographs in the central portions of the North and South Yuba subbasins also show the effect of groundwater substitution transfers (during 1991, 1994, 2001, 2002, 2008, and 2009), in the form of reduced groundwater levels followed by recovery to pre-transfer levels (YCWA 2010). Between spring 2010 and spring 2014 in the North Yuba and South Yuba subbasins, recent information indicates that groundwater levels declined at multiple wells by 10 to 20 feet, especially near Yuba City (DWR 2014c, 2014d). The groundwater levels in some areas declined up to 10 feet between fall 2013 and fall 2014.

Historical water quality data show that in most areas of the North and South Yuba subbasins, trends of increasing concentrations of calcium, bicarbonate, chloride, alkalinity, and TDS occur. In general, groundwater salinity increases with distance from the Yuba River. No groundwater quality impairments were documented at the DWR monitoring wells in the North Yuba subbasin (DWR 2006c). High salinity occurred in the Wheatland area of the South Yuba subbasin within the South Yuba Water District and Brophy Irrigation District (DWR 2006d; YCWA 2010).

The North Yuba and South Yuba subbasins were designated by the CASGEM program as medium priority.

Sutter Subbasin

The Sutter subbasin is located in Sutter County. In the Sutter subbasin, groundwater levels have remained relatively constant. The water table is very shallow and most groundwater levels in the subbasin tend to be within about 10 feet of ground surface (DWR 2006e, 2013a). Between the spring 2010 and spring 2014 in the Sutter subbasin, recent information indicates that groundwater levels declined at multiple wells by up to 10 feet (DWR 2014c, 2014d). The groundwater levels in some areas declined up to 10 feet between fall 2013 and fall 2014, and in some areas more than 10 feet.

Groundwater quality in the western portion of the Sutter subbasin includes areas with high concentrations of arsenic, boron, calcium magnesium bicarbonate, chloride, fluoride, iron, manganese, sodium, and TDS. In the southern portion of the subbasin, groundwater in the upper aquifer system tends to be high in salinity (DWR 2003b, 2006e).

The Sutter subbasin was designated by the CASGEM program as medium priority.

North American Subbasin

The North American subbasin underlies portions of Sutter, Placer, and Sacramento Counties, including several dense urban areas. Since at least the 1950s, concentrated groundwater extraction occurred east of downtown Sacramento, which resulted in a regionally extensive cone of depression. Drawdown in the wells in this areas have been in excess of 70 feet over the past 60 years (SGA 2008). Water purveyors have constructed facilities to import surface water to allow groundwater levels to recover from the historic levels of drawdown. In general, since around the mid-1990s to the late 2000s, water levels remained stable in the southern portion of the subbasin and in some cases groundwater levels are continuing to increase slightly in response to increases in conjunctive use and reductions in pumping near McClellan Air Force Base (SGA 2014). Groundwater levels in Sutter and northern Placer Counties generally have remained stable, although some wells in southern Sutter County have experienced declines (DWR 2006f, 2013a). Overall, groundwater levels are higher along the eastern portion of the North American subbasin and decline towards the western portion (Roseville et al. 2007). There is a groundwater depression in the southern Placer-Sutter counties area near the border with Sacramento County. Between the spring 2010 and spring 2014 in the North American subbasin, recent information indicates that groundwater levels declined at multiple wells by up 10 feet (DWR 2014c, 2014d). The groundwater levels were relatively constant between fall 2013 and fall 2014.

The area along the Sacramento River extending from Sacramento International Airport northward to the Bear River contains high levels of arsenic, bicarbonate, chloride, manganese, sodium, and TDS (DWR 2006f, 2013a). In an area between Reclamation District 1001 and the Sutter Bypass, high TDS concentrations occur. There have been three sites within the subbasin with significant groundwater contamination issues: the former McClellan Air Force Base, the Union Pacific Railroad Rail Yard in Roseville, and the Aerojet Superfund Site. Mitigation operations have been initiated for all of these sites. In the deeper portions of the aquifer, the groundwater geochemistry indicates the occurrence of connate water from the marine sediments underlying the freshwater aquifer, which mixes with the fresh water. Water quality concerns due to this type of geology include elevated levels of arsenic, bicarbonate, boron, chloride, fluoride, iron, manganese, nitrate, sodium, and TDS (DWR 2003b).

The North American subbasin was designated by the CASGEM program as high priority.

South American Subbasin

The South American subbasin is located within Sacramento County. Groundwater levels in the South American subbasin have fluctuated over the past 40 years, with the lowest levels occurring during periods of drought. From 1987 to 1995, water levels declined by about 10 to 15 feet and then recovered to levels close to the mid-80s by 2000. Over the past 60 years, a general lowering of groundwater levels was caused by intensive use of groundwater in the region. Areas affected by municipal pumping show a lower groundwater level recovery than other areas (DWR 2004q, 2013a). A large cone of depression is centered in the southwestern portion of the subbasin. Between the spring 2010 and spring 2014 in the South American subbasin, recent information indicates that groundwater levels declined at multiple wells by up 10 feet (DWR 2014c, 2014d). The groundwater levels were relatively constant between fall 2013 and fall 2014.

The groundwater quality is characterized by low to moderate TDS concentrations (DWR 2004q, 2013a). Seven sites historically had significant groundwater contamination, including three Superfund sites near the Sacramento metropolitan area. These sites are in various stages of cleanup.

The South American subbasin was designated by the CASGEM program as high priority.

Groundwater Use and Management

In this area, groundwater is used for agricultural, domestic, municipal, and industrial purposes. Most of the groundwater extraction occurs via privately owned domestic and agricultural wells.

West and East Butte Subbasins

The primary water source in Butte County is surface water (approximately 70 percent, by volume), and groundwater use accounts for about 30 percent of total county water use. In Butte County, most of the irrigation users rely upon surface water and approximately 75 percent of the residential water users rely upon groundwater (Butte County 2004, 2010).

The cities of Chico and Hamilton City are served by groundwater provided by California Water Service Company (California Water Service Company 2011g).

North and South Yuba Subbasins

The Yuba County Water Agency actively manages surface water and groundwater conjunctively to prevent groundwater overdraft in the North and South Yuba subbasins. The majority of water demand in these subbasins is crop water use from irrigated agriculture (YCWA 2010).

Sutter Subbasin

Agricultural water use in Sutter County is composed, on average, of approximately 60 percent surface water, 20 percent groundwater, and 20 percent of land irrigated by both surface water and groundwater. Permanent crops are predominantly irrigated with groundwater. Groundwater is also used for small communities and rural domestic uses (Sutter County 2011).

North American Subbasin

Several agencies manage water resources in the North American subbasin: South Sutter Water District, Placer County Water Agency, Natomas Central Mutual Water Company, and several urban water purveyors which are part of the Sacramento Groundwater Authority (SGA), a joint powers authority (SGA 2014). The northern portion of this subbasin is rural and agricultural, while the southern portion is urbanized, including the Sacramento Metropolitan area. Many of the urban agencies in Placer County rely upon surface water for normal operations, and have developed or are planning on developing groundwater for emergency situations (Roseville et al. 2007). In the urban area encompassed by SGA, some agencies rely entirely on groundwater for their water supply (SGA 2014).

Local planning efforts have been implemented in a local groundwater planning area known as the American River Basin region. This area encompasses Sacramento County and the lower watershed portions of Placer and El Dorado counties, and overlies the productive North American and South American subbasins. Groundwater is a regionally significant source of water supply, and is used as a primary source for many agencies in the region. However, in recent years, regional conjunctive use programs have allowed for the optimization of water supplies and a decrease in groundwater use has been observed in the past 5 years (RWA 2013).

Since 2000, groundwater extraction decreased in the northeastern portion of the North American subbasin as additional surface water supplies were made available under conjunctive use operations implemented following the Water Forum Agreement in 2000. In 2007, groundwater extraction increased because additional surface water was not available due to dry surface water supply conditions (SGA 2008, 2011).

South American Subbasin

The South American subbasin lies entirely within Sacramento County and is overlain by a majority of urban and densely populated areas. Many of the water users in this subbasin use surface water.

The main water purveyors that use South American subbasin groundwater include the Elk Grove Water District, California-American Water Company, Golden State Water Company, and the Sacramento County Water Agency. The entities serve the communities of Antelope, Arden, Lincoln Oaks, Parkway, Rosemont, and portions of the City of Rancho Cordova (California-American Water Company 2011; EGWD 2011; Golden State Water Company 20111; Sacramento County Water Agency 2011).The majority of groundwater pumping is for agricultural uses (SCGA 2010). The South American subbasin also includes portions of the area known as the American River Basin, as described above under the North American subbasin section.

7.3.3.2 Delta

The Delta overlies the western portion of the area where the Sacramento River and San Joaquin River groundwater basins converge, as shown in Figure 7.5. The Delta includes the Solano subbasin and the South American subbasin in the Sacramento Valley Groundwater Basin (as described above); the Tracy subbasin, the Eastern San Joaquin subbasin, and the Cosumnes subbasin in the San Joaquin Valley Groundwater Basin (as described in subsequent sections of this chapter for the San Joaquin); and the Suisun-Fairfield Valley Basin (as described in subsequent sections of this chapter for the San Francisco Bay Area Region).

7.3.3.2.1 Hydrogeology and Groundwater Conditions

In some areas of the western and central Delta floodplain, floodplain deposits contain organic material (peat) that range in thickness from 0 to 150 feet. Below the surficial floodplain deposits, unconsolidated non-marine sediments occur, at depths of a few hundred feet near the Coast Range to nearly 3,000 feet near the eastern margin of the Sacramento Valley Groundwater Basin. These non-marine sediments form the major water-bearing formations in the Delta.

In general, shallow groundwater conditions and extensive groundwater-surface water interaction characterize the Delta. Spring runoff generated by melting snow in the Sierra Nevada increases flows in the Sacramento and San Joaquin rivers and their tributaries and cause groundwater levels near the rivers to rise. Because the Delta is a large floodplain and the shallow groundwater is hydraulically connected to the surface water, changes in river stages affect groundwater levels and vice versa. Groundwater levels in the central Delta are very shallow, and land subsidence on several islands has resulted in groundwater levels close to the ground surface. Maintaining groundwater levels below crop rooting zones is critical for successful agriculture, especially for islands that lie below sea level. Many farmers rely on an intricate network of drainage ditches and pumps to maintain groundwater levels of about 3 to 6 feet below ground surface. The accumulated agricultural drainage is discharged into adjoining surface water bodies (USGS 2000a). Without this drainage system, many of the islands would be subject to extremely high groundwater, bogs, or localized flooding.

Groundwater generally flows from the Sierra Nevada in the east toward the low-lying lands of the Delta to the west. However, a number of pumping depressions have reversed this trend, and groundwater inflow from the Delta toward these pumping areas has been observed, primarily in the Stockton area.

Subsidence in the Delta is well-documented and a major source of concern for farming operations. The oxidation of peat soils is the primary mechanism of subsidence in the Delta, and some areas are located below sea level. Another mechanism for subsidence is wind erosion. There is a possibility that certain areas in the Delta could continue to subside 2 to 4 more feet over the next 35 years (DWR 2013i).

7.3.3.2.2 Groundwater Use and Management

Groundwater is used throughout the Delta for domestic and irrigation water supplies. Irrigation supplies are provided by wells and plant uptake in the root zone. An accurate accounting of groundwater used in the region is not available because wells are not metered and there is no method to measure root-zone irrigation.

Groundwater is used for potable water supplies by the Delta communities of Clarksburg, Courtland, Freeport, Hood, Isleton, Rio Vista, Ryde, and Walnut Grove. In the rural portions of the Delta, private groundwater wells provide residential and agricultural water supplies (Sacramento County 2010; Yolo County 2009; SCWA et al. 2005; Solano County 2008; San Joaquin County 2009;

Contra Costa County 2005). In some portions of the Delta, groundwater use is limited because of low well yields and poor water quality. Shallow groundwater in the western Delta may be saline due to hydraulic connection with western Delta waterways that are influenced by sea water intrusion. Shallow groundwater levels can be detrimental if the groundwater encroaches into the crop root zones. Therefore, groundwater pumping frequently is used to drain shallow groundwater and surface water from agricultural fields.

7.3.3.3 Suisun Marsh

To the west, the Suisun Marsh overlies the Suisun–Fairfield Valley subbasin. The Suisun-Fairfield Groundwater Basin is adjacent to, but hydrogeologically distinct from, the Sacramento River Groundwater Basin, and is adjacent to Suisun Bay. This basin is bounded by the Coast Ranges to the north and west and the Sacramento River Groundwater Basin in the east, as shown in Figure 7.5. It is separated from the Sacramento River Groundwater Basin by the English Hills.

7.3.3.3.1 Hydrogeology and Groundwater Conditions

In the Suisun-Fairfield Valley Groundwater Basin, freshwater occurs within the alluvial deposits that overlie the Sonoma volcanics (Travis AFB 1997; USGS 1960).

The overall direction of groundwater flow in the Suisun-Fairfield Valley Groundwater Basin is from the uplands toward Suisun Marsh (USGS 1960; Reclamation et al. 2011). Depth to groundwater varies seasonally, with higher groundwater levels occurring during the rainy season (Solano County 2008). Prior to implementation of the Solano Project that conveys water into Solano County from Lake Berryessa as part of the Solano Project and the SWP North Bay Aqueduct, groundwater depressions were occurring near Fairfield. Following importation of surface water from the Solano Project and the North Bay Aqueduct, surface water was used more extensively to reduce the groundwater overdraft (Solano County 2008; Travis AFB 1997). Few groundwater monitoring sites exist in the basin, and most are near ongoing groundwater investigations. Data from these groundwater investigations suggest that groundwater levels in the basin are generally stable.

Groundwater quality issues within the Suisun-Fairfield Valley Groundwater Basin include high boron, TDS, and volatile organic compound concentrations near Travis Air Force Base (USGS 1960, 2008). Volatile organic compound plumes at Travis Air Force Base are largely contained on base, but volatile organic compound constituents have migrated up to 0.5-mile off base at three sites. Containment and remediation is occurring at each of these sites (Travis AFB 2005).

The Suisun-Fairfield Valley Groundwater Basin was designated by the CASGEM program as very low priority.

7.3.3.3.2 Groundwater Use and Management

Information on groundwater supplies in the Suisun-Fairfield Valley Groundwater Basin is limited. Groundwater was the primary water source for the Suisun–Fairfield Valley Groundwater Basin, including the cities of Fairfield and Suisun City, through the 1950s. This groundwater production resulted in local areas of depressed groundwater levels. As surface water became available, groundwater use declined. Studies have shown that the basin provides low well yields and therefore is probably not used as a major water supply (Reclamation et al. 2011). Many private well owners in the Suisun-Fairfield Valley Groundwater Basin use groundwater for irrigation. However, due to the brackish quality of the groundwater, surface water is used for potable water supplies (Reclamation et al. 2011).

7.3.3.4 San Joaquin Valley

The San Joaquin Valley Groundwater Basin extends from the Sacramento-San Joaquin Delta in the north to the Tehachapi Mountains in the South. Groundwater is estimated to provide over 47 percent of the overall water supply in the San Joaquin Valley, including 70 percent of municipal uses and 43 percent of irrigation supplies from 2005 through 2010 (DWR 2013i). The San Joaquin Valley has an average annual precipitation between 5 to 18 inches. Due to the low amounts of average annual precipitation, limited surface water supply and extensive agricultural water use, there are areas of significant overdraft that exist in the San Joaquin Valley Groundwater Basin. Eight subbasins in the San Joaquin Valley Groundwater Basin were identified in a state of critical overdraft: Chowchilla, Eastern San Joaquin, Madera, Kings, Kaweah, Tule, Tulare Lake, and Kern (DWR 1980). Three of these subbasins are on the eastern side of the San Joaquin River: Eastern San Joaquin, Chowchilla, and Madera. Recent studies have indicated that overdraft continues to exist in these subbasins (DWR 2013i). By 1970, over 5,200 square miles of irrigable land had subsided by a minimum of 1 foot. The maximum subsidence occurred near Mendota at almost 30 feet (9 meters) (Reclamation 2013a). Due to the drought that started in 2011, surface water supplies have declined and new wells have been constructed. Between January and October 2014, over 100 wells were drilled in both Kern and Kings counties, almost 200 in Stanislaus County, almost 250 in Merced County, and over 350 in both Fresno and Tulare counties (DWR 2014d).

The elevation of the base of freshwater in the western and central San Joaquin Valley ranges from 600 to 800 feet below mean sea level (WWD 2013). This area has experienced subsidence of up to 28 feet between 1926 and 1970 (USGS 2009). The water quality of the semi-perched aquifer on the western side of the San Joaquin Valley is impaired with high salinity, selenium, and boron concentrations. These constituents are from both naturally occurring deposits in the Coast Ranges to the west and agricultural activities. The chemicals become trapped in the soil matrix due to the low permeability clay layers close to the surface. There are also localized areas with high concentrations of naturally occurring arsenic or selenium.

Portions of the San Joaquin Valley Groundwater Basin in the Cosumnes, Tracy, and Eastern San Joaquin subbasins were designated by the State Water Resources Control Board in 2000 as Hydrogeologically Vulnerable Areas and Groundwater Protection Areas based on hydrogeologic permeability. These areas could be more vulnerable to groundwater quality impairment if applied surface water, including recycled water, contained high concentrations of constituents of concern to the beneficial users of the groundwater (CVRWQCB 2014b).

7.3.3.4.1 Northern Portions of the San Joaquin Valley Groundwater Basin

Extending south into the Central Valley from the Delta to the southern extent marked by the San Joaquin River, DWR has delineated nine subbasins within the northern portion of the San Joaquin Valley Groundwater Basin based on groundwater divides, barriers, surface water features, and political boundaries (DWR 2003a), as shown in Figure 7.6. The Cosumnes, Eastern San Joaquin, and Tracy subbasins partially underlie the Delta. The Delta-Mendota, Modesto, Turlock, Merced, Chowchilla, and Madera subbasins are located between the Delta and the San Joaquin River.

The northern portion of the San Joaquin Valley Groundwater Basin is marked by laterally extensive deposits of thick fine-grained materials deposited in lacustrine and marsh depositional systems. These units, which can be tens to hundreds of feet thick, create vertically differentiated aquifer systems within the subbasins. The Corcoran Clay (or E-Clay), occurs in the Tulare Formation and separates the alluvial water-bearing formations into confined and unconfined aquifers. The direction of groundwater flow generally coincides with the primary direction of surface water flows in the area, which is to the northwest toward the Delta (DWR 2003a, 2004r, 2004s, 2004t, 2004u, 2006g, 2006h, 2006k). Groundwater levels fluctuate seasonally and a strong correlation exists between depressed groundwater levels and periods of drought, when more groundwater is pumped in the area to support agricultural operations.

Water users in the northern portion of the San Joaquin Valley Groundwater Basin rely upon groundwater, which is used conjunctively with surface water for agricultural, industrial, and municipal supplies (DWR 2003a). Groundwater is estimated to account for about 38 percent of the overall water supply in the northern portion of the San Joaquin Valley Groundwater Basin (DWR 2013i). Annual groundwater pumping in the northern portion of the San Joaquin Valley Groundwater Basin accounts for about 19 percent of all groundwater pumped in the state of California. Groundwater use in the northern portion of the San Joaquin Valley Groundwater Basin is estimated to average 3.2 million acre-feet per year between 2005 and 2010.

According to the Draft California Water Plan 2013 Update (DWR 2013i), three planning areas within the northern portion of the San Joaquin Valley Groundwater Basin rely heavily on groundwater pumping: the Eastern Valley Floor Planning Area, the Lower Valley Eastside Planning Area, and the Valley West Side Planning Area. Each of these areas has limited local surface water supplies and uses extensive groundwater pumping for their agricultural water supply (DWR 2013i).

The northern portion of the San Joaquin Valley Groundwater Basin discussion is divided into two sub-regions: West of the San Joaquin River, and East of the San Joaquin River, as described below.

West of the San Joaquin River

The Tracy and the Delta-Mendota subbasins are located on the west side of the San Joaquin River.

Hydrogeology and Groundwater Conditions

Along the western portion of the San Joaquin Valley, the Tulare formation comprises the primary freshwater aquifer. The Tulare Formation originated as reworked sediments from the Coast Ranges re-deposited in the San Joaquin Valley as alluvial fan, flood basin, deltaic (pertaining to a delta) or lacustrine, and marsh deposits (USGS 1986).

Tracy Subbasin

The Tracy subbasin underlies eastern Contra Costa County and western San Joaquin County. A large portion of the subbasin is located within the Delta. In the Tracy subbasin, groundwater generally flows from south to north and discharges into the San Joaquin River. According to DWR and the San Joaquin County Flood Control and Water Conservation District, groundwater levels in the Tracy subbasin have been relatively stable over the past 10 years, apart from seasonal variations resulting from recharge and pumping (DWR 2006g, 2013b). Recent information indicates that between the spring 2010 and spring 2014, groundwater levels declined at some wells in the Tracy subbasin by up to 10 feet (DWR 2014c, 2014d). The groundwater levels in some areas declined up to 10 feet between fall 2013 and fall 2014, and in some areas more than 10 feet.

In the Tracy subbasin, areas of poor water quality exist throughout the area. Elevated chloride concentrations are found along the western side of the subbasin near the City of Tracy and along the San Joaquin River. Overall, Delta groundwater wells in the Tracy subbasin are characterized by high levels of chloride, TDS, arsenic, and boron (DWR 2006g, 2013b; USGS 2006). The Central Valley Regional Water Quality Board recently adopted general waste discharge requirements to protect groundwater, as well as surface water, within the San Joaquin County and Delta areas, including the Tracy subbasin (CVRWQCB 2014b). Supporting information recognizes the potential for groundwater impairment due to the water quality of applied water to crops if the applied water quality contains high concentrations of constituents of concern.

The Tracy subbasin was designated by the CASGEM program as medium priority.

Delta-Mendota Subbasin

The Delta-Mendota subbasin underlies portions of Stanislaus, Merced, Madera, and Fresno counties. The geologic units present in the Delta-Mendota subbasin consist of the Tulare Formation, terrace deposits, alluvium, and flood-basin deposits. Groundwater occurs in three water-bearing zones: the lower zone contains confined fresh water in the lower section of the Tulare Formation; the upper zone contains confined, semi-confined, and unconfined water in the upper section of the Tulare formation; and a shallow zone that contains unconfined water (DWR 2006h, 2013b). The groundwater is characterized by moderate to extremely high salinity with localized areas of high iron, fluoride, nitrate, and boron (DWR 2006h, 2013b).

In the Delta-Mendota subbasin, groundwater levels have generally declined by as much as 20 feet in the northern portion of the basin near Patterson between 1958 and 2006. Surface water imports in the early 1970s resulted in decreased pumping, and a steady recovery of groundwater levels. However, the lack of imported surface water availability during the drought periods of 1976 to 77, 1986 to 1992, and 2007 to 2009 resulted in increases in groundwater pumping, and associated declines in groundwater levels to near-historic lows (USGS 2012). Recent information indicates that between the spring 2010 and spring 2014, groundwater levels declined at some wells in the Delta-Mendota subbasin by up to 20 feet (DWR 2014c, 2014d).

In areas adjacent to the Delta-Mendota Canal in this subbasin, extensive groundwater withdrawal has caused land subsidence of up to 10 feet in some areas. Land subsidence can cause structural damage to the Delta-Mendota Canal which has caused operational issues for CVP water delivery. Historical wide-spread soil compaction and land subsidence between 1926 and 1970 has caused reduced freeboard and flow capacity of the Delta-Mendota Canal, the California Aqueduct, other canals, and roadways in the area. To better understand subsidence issues near the Delta-Mendota Canal and improve groundwater management in the area, the U.S. Geological Survey (USGS) provided and evaluated information on groundwater conditions and the potential for additional land subsidence in the San Joaquin Valley (USGS 2013a). Results show that at least 1.8 feet of subsidence occurred near the San Joaquin River and the Eastside Bypass from 2008 to 2010 period, affecting the southern part of the Delta-Mendota Canal by about 0.8 inches of subsidence during the same period. It was estimated that subsidence rates doubled in 2008 in some areas. The subsidence measured was primarily inelastic (or permanent, not reversible, due to the compaction of fine-grained material). The area of maximum active subsidence is shown to be located southwest of Mendota and extends into the Merced subbasin to the south of El Nido. Land subsidence in this area is expected to continue to occur due to uncertainties and limitations (especially climate-related changes) in surface water supplies to meet irrigation demand and the continuous need to supplement water supply with groundwater pumping.

Groundwater Use and Management

In this area, groundwater is used for agricultural, domestic, municipal, and industrial purposes.

Tracy Subbasin

The primary water source in Contra Costa County is surface water. Groundwater is used by individual homes and businesses and the communities of Brentwood, Bethel Island, Knightsen, Byron and Discovery Bay (Contra Costa County 2005).

The Diablo Water District groundwater blending facility provides water to users in the City of Oakley by blending groundwater and treated water from Contra Costa Water District (DWD 2011).

Contra Costa Water District has an agreement with the East Contra Costa Irrigation District to purchase surplus irrigation water for municipal and industrial purposes in East Contra Costa Irrigation District's service area (CCWD 2011). The agreement includes an option to implement an exchange of surface water for groundwater that can be used in the Contra Costa Water District service area when the CVP allocations are less than full contract amounts. This groundwater exchange water was implemented during the 2007 to 2009 drought.

Groundwater and surface water are used within western San Joaquin County for agricultural operations and for the cities of Stockton, Lathrop, and Tracy (San Joaquin 2009). In the 1980s, about 30 percent of the water supplies in San Joaquin County were based on groundwater (including the Tracy, Cosumnes, and Eastern San Joaquin subbasins). By 2007, groundwater was used to supply over 60 percent of water demand in the county.

Delta-Mendota Subbasin

Groundwater is used for agricultural and domestic water supplies in the Delta-Mendota subbasin (Reclamation and DWR 2011). Groundwater is primarily used for domestic and industrial water supplies in Stanislaus County, including for the City of Patterson (Stanislaus County 2010; Patterson 2014). In the Delta-Mendota subbasin within Merced County, approximately 3 percent of groundwater withdrawals are used for municipal and industrial purposes (including uses in the city of Gustine, Los Banos, and Santa Nella), and 97 percent of the groundwater withdrawals are used for agricultural purposes (Merced County 2012). Most of the portions of Madera County within the Delta-Mendota subbasin use groundwater for domestic and agricultural uses (Madera County 2002, 2008). In portions of Western Fresno County within the Delta-Mendota subbasin, domestic water users rely upon groundwater (including the cities of Mendota and Firebaugh), and agricultural water users rely upon surface water and/or groundwater (Mendota 2009; Firebaugh 2015; Fresno County 2000).

East of the San Joaquin River

The east side of the San Joaquin River is underlain by seven groundwater subbasins: the Cosumnes, Eastern San Joaquin, Modesto, Turlock, Merced, Chowchilla, and Madera subbasins. Three of these subbasins are in a critical state of overdraft: the Chowchilla, Eastern San Joaquin, and Madera (DWR 2013i).

Hydrogeology and Groundwater Conditions

Several of the hydrogeologic units present in the southern Sacramento Valley extend south into the San Joaquin Valley. Along the eastern boundary of the Central Valley, the Ione, Mehrten, Riverbank, and Modesto formations are primarily composed of sediments originating from the Sierra Nevada.

Historically, surface water and groundwater were hydraulically connected in most areas of the San Joaquin River and its tributaries. This resulted in a significant quantity of groundwater actively discharging into streams in most of this watershed. However this condition changed as increased groundwater pumping in the area lowered groundwater levels and reversed the hydraulic gradient between the surface water and groundwater systems, resulting in surface water recharging the underlying aquifer system through streambed seepage. Long-term groundwater production throughout this basin has lowered groundwater levels faster than natural recharge rates. Areas where this overdraft has occurred include eastern San Joaquin County, Merced County, and western Madera County. This occurs along the San Joaquin River where the riverbed is highly permeable and river water readily seeps into the underlying aquifer. This condition reduces groundwater and surface water outflows to the Delta, lowers the water table, and may increase the potential for land subsidence (USFWS 2012).

Generally, the groundwater in the San Joaquin River subbasins east of the San Joaquin River is of suitable quality for most urban and agricultural uses with only local impairments. There are localized areas with high concentrations of boron, chloride, iron, nitrate, TDS, and organic compounds (DWR 2003a, 2004r, 2004s, 2004t, 2004u, 2006i, 2006j, 2006k). The use of groundwater for agricultural supply is impaired in western Stanislaus and Merced counties due to elevated boron concentrations. Groundwater use for drinking water supply is also impaired in the Tracy, Modesto-Turlock, Merced, and Madera areas due to elevated nitrate concentrations (USFWS 2012).

Dibromochloropropane (DBCP), a soil fumigant that was extensively used on grapes and cotton before it was banned, is prevalent in groundwater near Merced and Stockton and in the Merced, Modesto, Turlock, Cosumnes, and Eastern San Joaquin subbasins (CVRWQCB 2011; DWR 2004r; USFWS 2012). Many areas with high concentrations of DBCP have undergone groundwater remediation, and the DBCP concentrations are declining.

Declining groundwater levels in the subbasins east of the San Joaquin River have resulted in an area approximately 16-miles long with high salinity due to saltwater intrusion from the Delta (USFWS 2012).

Cosumnes Subbasin

The Cosumnes subbasin underlies western Amador County, northwestern Calaveras County, southeastern Sacramento County, and northeastern San Joaquin County. Groundwater levels in the Cosumnes subbasin have fluctuated significantly over the past 40 years, with the lowest levels occurring during periods of drought. From 1987 to 1995, water levels declined by about 10 to 15 feet and then recovered by that same amount through 2000. Areas affected by municipal pumping show a lower magnitude of groundwater level recovery during this period than in other areas of the subbasin (DWR 2006i, 2013b). Within the portion of Sacramento County in the Cosumnes subbasin, it is estimated that the recent average annual decline in groundwater levels has been approximately 1 foot, with a lower rate of decline in more recent years (South Area Water Council 2011). Recent information indicates that between the spring 2010 and spring 2014, groundwater levels declined at some wells in the Cosumnes subbasin by up to 10 feet (DWR 2014c, 2014d).

The Cosumnes subbasin contains groundwater of very good quality, with localized high concentrations of calcium bicarbonate and pesticides (DWR 2006i, 2013b).

The Cosumnes subbasin was designated by the CASGEM program as medium priority.

Eastern San Joaquin Subbasin

The Eastern San Joaquin subbasin underlies western Calaveras County, a large portion of San Joaquin County, and a portion of Stanislaus County. Groundwater levels in the Eastern San Joaquin subbasin have continuously declined in the past 40 years due to groundwater overdraft. Cones of depression are present near major pumping centers such as the City of Stockton and the City of Lodi (DWR 2006j, 2013b). Groundwater level declines of up to 100 feet have been observed in some wells. In the 1990s, groundwater levels were so low that many wells were inoperable and many groundwater users were obligated to construct new deeper wells (NSJCGBA 2004). Recent information indicates that between the spring 2010 and spring 2014, groundwater levels declined at some wells in the Eastern San Joaquin subbasin by up to 20 feet (DWR 2014c, 2014d).

In the Eastern San Joaquin subbasin, the groundwater is characterized with low to high salinity levels and localized areas of high calcium or magnesium bicarbonate, salinity, nitrates, pesticides, and organic constituents (DWR 2006j, 2013b). The high groundwater salinity is attributed to poor-quality groundwater intrusion from the Delta caused by the pumping-induced decline in groundwater levels, especially in the groundwater underlying the Stockton area since the 1970s (SJCFCWCD 2008). High chloride concentrations have also been observed in the Eastern San Joaquin subbasin. Ongoing studies are evaluating the sources of chloride in groundwater along a line extending from Manteca to north of Stockton. Initial concern was that long-term overdraft conditions in the eastern portion of the subbasin were enabling more saline water from the Delta to migrate inland. Other possible sources include upward movement of deeper saline formation water and agricultural practices (USGS 2006). In addition, large areas of groundwater with elevated nitrate concentrations have been observed in several portions of the subbasin, such as areas southeast of Lodi and south of Stockton and east of Manteca, and in areas extending towards the San Joaquin-Stanislaus County line (USFWS 2012).

The Eastern San Joaquin subbasin was designated by the CASGEM program as high priority.

Modesto Subbasin

The Modesto subbasin underlies northern Stanislaus County. In the Modesto subbasin, water levels have declined nearly 15 feet on average between 1970 and 2000 (DWR 2004r, 2013b), with the major declines occurring in the eastern portion of the subbasin. Recent information indicates that between the spring 2010 and spring 2014, groundwater levels declined at some wells in the Modesto subbasin by up to 20 feet (DWR 2014c, 2014d).

The groundwater is characterized by low to high TDS concentrations with localized areas of boron, chlorides, DBCP, iron, manganese, and nitrate concentrations (DWR 2004r, 2013b; Stanislaus County 2010).

The Modesto subbasin was designated by the CASGEM program as high priority.

Turlock Subbasin

The Turlock subbasin underlies portions of Stanislaus and Merced counties. In the Turlock subbasin, water levels declined nearly 7 feet on average from 1970 through 2000 (DWR 2006k, 2013b). Comparison of groundwater contours from 1958 and 2006 shows that historically, groundwater flows occurred from east to west, toward the San Joaquin River. Groundwater pumping centers to the east of the City of Turlock have drawn the groundwater toward these cones of depression, allowing less water to flow toward the San Joaquin River, and diminishing the discharge of groundwater to the river. Recent information indicates that between the spring 2010 and spring 2014, groundwater levels declined at some wells in the Turlock subbasin by up to 20 feet (DWR 2014c, 2014d). The storage capacity of the Turlock subbasin is estimated at about 15,800,000 acre-feet (DWR 2006k, 2013b).

The groundwater quality is characterized with low to high concentrations of TDS and localized high concentrations of boron, chlorides, DBCP, nitrates, and TDS (DWR 2013b).

The Turlock subbasin was designated by the CASGEM program as high priority.

Merced Subbasin

The Merced subbasin underlies most of Merced County. In the Merced subbasin, water levels have declined nearly 30 feet on average from 1970 through 2000. Water level declines have been more severe in the eastern portion of the subbasin (DWR 2004s, 2013b). The estimated specific yield of the groundwater subbasin is 9 percent. Recent information indicates that between the spring 2010 and spring 2014, groundwater levels declined at some wells in the Merced subbasin by up to 20 feet (DWR 2014c, 2014d).

The groundwater quality is characterized by low to high TDS concentrations and localized areas with high concentrations of chloride, DBCP, iron, and nitrate (DWR 2004s, 2013b; USFWS 2012).

The Merced subbasin was designated by the CASGEM program as high priority.

Chowchilla Subbasin

The Chowchilla subbasin underlies southwestern Merced County and northwestern Madera County. In the Chowchilla subbasin, water levels declined nearly 40 feet on average from 1970 to 2000. Water level declines were more severe in the eastern portion of the subbasin from 1980 to present, but the western portion of the subbasin showed the strongest declines before 1980 (DWR 2004t, 2013b). Groundwater recharge in this subbasin is primarily from irrigation water percolation. Recent information indicates that between the spring 2010 and spring 2014, groundwater levels declined at some wells in the western Chowchilla subbasin by up to 10 feet (DWR 2014c, 2014d).

There are localized areas with high concentrations of chloride, iron, nitrate, and hardness (DWR 2004t, 2013b). Organic chemicals were detected in some wells in the Chowchilla subbasin between 1983 and 2003 (CVRWQCB 2011).

The Chowchilla subbasin was designated by the CASGEM program as high priority.

Madera Subbasin

The Madera subbasin underlies most of Madera County. In the Madera subbasin, water levels have declined nearly 40 feet on average from 1970 through 2000. Water level declines have been more severe in the eastern portion of the subbasin from 1980 to the present, but the western subbasin showed the strongest declines before this period (DWR 2004u, 2013b). Recent information indicates that between the spring 2010 and spring 2014, groundwater levels declined at some wells in the western Chowchilla subbasin by up to 10 feet (DWR 2014c, 2014d).

Groundwater in the Madera subbasin is characterized by low to high TDS and localized areas with high concentrations of chlorides, iron, nitrates, and hardness (DWR 2004u, 2013b). Occurrences of organic chemicals have been observed including DBCP and pesticides (CVRWQCB 2011; DWR 2004u, 2013b).

The Madera subbasin was designated by the CASGEM program as high priority.

Groundwater Use and Management

In this area, groundwater is used for agricultural, domestic, municipal, and industrial purposes.

Cosumnes Subbasin

Currently, urban and agricultural water users on the valley floor are reliant on groundwater for water supply. Water demands in the Cosumnes Subbasin area are supported by nearly 95 percent groundwater (South Area Water Council 2011). Groundwater and surface water are used for agricultural and domestic water supplies in the Cosumnes subbasin (CVRWQCB 2011). Groundwater is used by many agricultural water users and the community of Galt (CVRWQCB 2011; South Area Water Council 2011).

The Central Valley Regional Water Quality Board recently adopted general waste discharge requirements to protect groundwater, as well as surface water, within the San Joaquin County and Delta areas, including the Cosumnes subbasin. The new requirements do not address protection of groundwater related to use of recycled water on crops because those operations would require separate discharge permits from the Central Valley Regional Water Quality Board and are not anticipated to be widely used in this area due to availability of recycled water near farms. However, the supporting information recognizes the potential for groundwater impairment due to the water quality of applied water to crops if the applied water quality contains high concentrations of constituents of concern (CVRWQCB 2014b).

Eastern San Joaquin Subbasin

Groundwater and surface water are used for agricultural and domestic water supplies in the Eastern San Joaquin subbasin (CVRWQCB 2011). Groundwater is the major source of water supply for agricultural areas in eastern San Joaquin County (NSJCGBA 2007). Groundwater is used by many agricultural water users and the communities of Escalon, Lodi, Manteca, Ripon, and Stockton (NSJCGBA 2004, 2007). The cities of Manteca and Stockton use both groundwater and surface water, while Lodi, Escalon, and Ripon primarily use groundwater for their municipal needs.

The City of Stockton uses both surface water and groundwater for its municipal and industrial water needs. Due to overdraft of the aquifer beneath Stockton, the city has limited annual groundwater extraction. All of these demands on the finite groundwater resources available in the basin historically have resulted in annual groundwater withdrawals in excess of the natural recharge volume in the East San Joaquin subbasin (DWR 2003a, 2006j). This extensive use of groundwater to meet local demand results in localized overdraft conditions within the subbasin.

The Northeastern San Joaquin County Groundwater Banking Authority is a joint-powers authority that develops local projects to strengthen water supply reliability in Eastern San Joaquin County. The Northeastern San Joaquin County Groundwater Banking Authority facilitated the development and adoption of the Eastern San Joaquin Groundwater Basin Groundwater Management Plan and completed an Integrated Regional Water Management Plan (IRWMP). This plan outlines the requirements for an integrated conjunctive use program that takes into account the various surface water and groundwater facilities in eastern San Joaquin County and promotes better groundwater management to meet future basin demands (NSJCGBA 2004). Conjunctive use refers to the use and management of the groundwater resource in coordination with surface water supplies by users overlying the basin. Potential projects that could be implemented to improve groundwater conditions in the area include urban and agricultural water use efficiency projects, recycled municipal water projects, groundwater banking operations, new surface water storage opportunities, improved conveyance facilities, and utilizing new sources of surface water (NSJCGBA 2007). Pursuant to the IRWMP, a program-level Environmental Impact Report identified potential changes to the environmental and mitigation measures to reduce identified significant adverse impacts (NSJCGBA 2011).

The Farmington Groundwater Recharge Program led by Stockton East Water District, in conjunction with the U.S. Army Corp of Engineers, and other local water agencies, was developed to utilize flood-season and excess irrigation water supplies in the Eastern San Joaquin groundwater subbasin to recharge the groundwater aquifer. This program supports replenishment of a critically overdrafted groundwater basin by recharging an average of 35,000 acre-feet of water annually into the Eastern San Joaquin subbasin. The program includes recharge of surface water on 800 to 1,200 acres of land using direct field-flooding. In addition, the program increases surface water deliveries in-lieu of groundwater pumping to reduce overdraft (Farmington Program 2012).

A joint conjunctive use and groundwater banking project was evaluated by the East San Joaquin Parties Water Authority and East Bay Municipal Utility District, named the Mokelumne Aquifer Recharge and Storage Project (NSJCGBA 2004). The goal of this project was to store surface water underground in wet years, and in dry years, East Bay Municipal Utility District would extract and export the recovered water supply (NSJCGBA 2004, 2009). Several studies have concluded that the test area is suitable for recharge and recovery of groundwater; however, more testing needs to be done to further evaluate the feasibility of this project.

The Central Valley Regional Water Quality Control Board recently adopted general waste discharge requirements to protect groundwater, as well as surface water, within the San Joaquin County and Delta areas. The new requirements do not address protection of groundwater related to use of recycled water on crops because those operations would require separate discharge permits from the Central Valley Regional Water Quality Board and are not anticipated to be widely used in this area due to availability of recycled water near farms. However, the supporting information recognizes the potential for groundwater impairment due to the water quality of applied water to crops if the applied water quality contains high concentrations of constituents of concern (CVRWQCB 2014b).

Modesto Subbasin

Groundwater is used for agricultural and domestic water supplies in the Modesto subbasin (Reclamation and DWR 2011). Groundwater is used by many agricultural water users and the community of Modesto (DWR 2004r; Stanislaus County 2010).

Turlock Subbasin

Groundwater is used for agricultural and domestic water supplies in the Turlock subbasin (Reclamation and DWR 2011). Groundwater is used by many agricultural water users and the community of Turlock in Stanislaus County and the communities of Delhi and Hilmar in Merced County (DWR 2006k; Stanislaus County 2010; Merced County 2012).

Merced Subbasin

Groundwater is used for agricultural and domestic water supplies in the Merced subbasin (Reclamation and DWR 2011). Groundwater is used by many agricultural water users and the communities of Atwater, El Nido, Le Grand, Livingston, Merced, Planada, and Winton (DWR 2004s; Merced County 2012).

Chowchilla Subbasin

Groundwater is used for agricultural and domestic water supplies in the Chowchilla subbasin (Reclamation and DWR 2011). Groundwater is used by many agricultural water users and the community of Chowchilla (DWR 2006k; Madera County 2002).

Madera Subbasin

Groundwater is used for agricultural and domestic water supplies in the Madera subbasin (Reclamation and DWR 2011). Groundwater is used by many agricultural water users and the community of Madera (DWR 2006k; Madera County 2002, 2008).

7.3.3.4.2 Tulare Lake Area of the San Joaquin Valley Groundwater Basin

The Tulare Lake Area overlies seven groundwater subbasins of the San Joaquin Valley Groundwater Basin, as defined by DWR (DWR 2003a): the Westside, Kings, Tulare Lake, Kaweah, Tule, Pleasant Valley, and Kern subbasins, as shown in Figure 7.7. The Kern and Pleasant Valley subbasins have distinct hydrogeology and groundwater management from the other subbasins, and therefore are described separately.

Northern Tulare Lake Area: Westside, Kings, Tulare Lake, Kaweah, Tule, Pleasant Valley, and Kern Subbasins

Hydrogeology and Groundwater Conditions

Hydrogeology

The aquifer system in the Tulare Lake Area consists of younger and older alluvium, flood-basin deposits, lacustrine and marsh deposits and unconsolidated continental deposits. These deposits are configured within most parts of the basin to form an unconfined to semi-confined upper aquifer and a confined lower aquifer. These aquifers are separated by the Corcoran Clay (E-Clay) member of the Tulare Formation, which occurs at depths between 200 and 850 feet within the central and western portions of the basin, specifically in the Westside and Tulare Lake subbasins and in the western Kings, Kaweah, and Tule subbasins. Fine-grained lacustrine deposits up to 3,600 feet thick also are present in the Tulare Lake region (DWR 2003a, 2004v, 2004w, 2006l, 2006m, 2006n, 2006o, 2006p).

Prior to extensive use of groundwater in the basin, groundwater generally flowed toward Tulare Lake. Due to depressed groundwater levels and interception of surface water, the Tulare Lake Area is dry except during extreme flood events; and recharge of the Tulare Lake Area is limited.

Groundwater withdrawals in the Tulare Lake Area account for approximately 38 percent of the total groundwater withdrawals in the state of California (DWR 2013i). The CVP and SWP surface water supplies are used by many agricultural water users and several communities in the Tulare Lake Area to reduce reliance on groundwater and allow for groundwater recharge. In drier years when the CVP and SWP water supplies are limited, extensive groundwater pumping occurs to meet the water demands. In drier years, water users in the

Westside, Kings, Tulare Lake, and Kaweah subbasins may use groundwater for up to 75 percent of their water supply (DWR 2013i).

Areal recharge from precipitation provides most of the groundwater recharge, and seepage from stream channels provides the remaining groundwater recharge. Most of the recharge occurs as mountain-front recharge in the coarse-grained upper alluvial fans where streams enter the basin (USGS 2009). Prior to development of the Tulare Lake Area, surface water and groundwater exchange occurred throughout the basin in response to hydrologic conditions. When rapid agricultural growth and groundwater development occurred, the primary interaction of surface water with groundwater occurred as stream flow loss to underlying aquifers. In areas of severe overdraft in the Tulare Lake Area of the San Joaquin Valley Groundwater Basin, complete disconnection between groundwater and overlying surface water systems has occurred. In some areas with disconnected hydrology where streambeds are used as conveyance elements for irrigation purposes and to recharge groundwater, the streams become losing streams. Recent information indicates that between the spring 2010 and spring 2014, groundwater levels declined at some wells in this area by up to 10 feet (DWR 2014c, 2014d). The groundwater levels in some areas declined up to 10 feet between fall 2013 and fall 2014, and in some areas more than 10 feet.

Groundwater Quality

In the northern Tulare Lake Area (including the Westside, Tulare Lake, Kings, Kaweah, and Tule subbasins), groundwater in the upper unconfined/semi-confined aquifer is characterized by high calcium and magnesium sulfate as well as high TDS (DWR 2006l, 2006m, 2006n, 2013c). The lower confined aquifer is approximately 300 feet below the ground surface and above the Corcoran Clay, and is characterized by high sodium sulfates and less dissolved solids than the upper aquifer.

Groundwater quality in the northern Tulare Lake Area is poor in portions of the upper aquifer, due to agricultural drainage issues and naturally occurring high salinity soils. Groundwater in the Westside subbasin is of poor quality due to historical agricultural drainage. The high clay content of the soils that comprise the upper aquifer restricts the movement of groundwater in the aquifer, further contributing to water quality impacts from root zone drainage. Studies have shown that the quality of the upper 20 to 200 feet of the saturated groundwater zone have been affected by crop irrigation and drainage issues (Reclamation 2006). The eastward movement of saline groundwater from the Westside subbasin also adversely affects the groundwater quality in adjacent subbasins, such as in the vicinity of the City of Mendota and Fresno Slough (Reclamation 2006).

The Westside and Kings subbasins also have localized areas with high boron concentrations (CVRWQCB 2011). The Kings and Tulare Lake subbasins have localized areas with high arsenic and hydrogen sulfide. In the Kaweah subbasin and the northern portion of the Tule subbasin, groundwater is of the calcium bicarbonate type with high TDS and localized areas with high nitrate concentrations (DWR 2004v, 2004w, 2013c). In the Kaweah subbasin, groundwater is characterized by moderate to high TDS concentrations (DWR 2004v, 2013c). In the Tule subbasin, low to moderate TDS concentrations occur in the most of the subbasin with high concentrations in areas with poor drainage (DWR 2004w, 2013c). On the western side of the subbasin there is shallow saline water. The eastern side of the subbasin has areas of high nitrates (DWR 2013c, 2004b). The Westside and Kings subbasins also have localized areas with high boron concentrations (CVRWQCB 2011). The Kings and Tulare Lake subbasins have localized areas with high arsenic and hydrogen sulfide. In the Kaweah subbasin and the northern portion of the Tule subbasin, groundwater is of the calcium bicarbonate type with high TDS and localized areas with high nitrate concentrations (DWR 2004v, 2004w, 2013c). Portions of the Kings subbasin are characterized by high nitrate concentrations due to historical agricultural practices (CVRWQCB 2011; DWR 2006n, 2013c). High DBCP and other pesticides concentrations occur in localized areas within the Westside, Kings, Tulare Lake, Kaweah, and Tule subbasins (CVRWQCB 2011).

A recent study evaluated high nitrate concentrations in groundwater and related public health issues in four community water systems with recorded violations related to nitrates in drinking water (Pacific Institute 2011). The communities served by the water systems were evaluated to assess the quality of groundwater provided by their water distribution systems and potential costs to the communities. Overall, this significant degradation of groundwater quality throughout the area has implications on public health and economic sustainability of the region. The findings of the report indicated that improved notification procedures, new funding mechanisms, and improved regulations and incentives are needed to provide safe drinking water, as described in Chapter 18, Public Health. The four water systems included Beverly Grand Mutual Water Company (Tule subbasin), Lemon Cove Water Company (east of Tule subbasin), El Monte Village Mobile Home Park (Kings subbasin), and Soults Mutual Water Company (Kings subbasin) in Tulare County.

High groundwater salinity occurs in many locations in the Tulare Lake Area. Salts are imported into the Tulare Lake Area through irrigation with Delta water and salts added through application of fertilizers, and other salt containing materials. Except in very wet years, the Tulare Lake Area has no natural drainage, so imported salts accumulate in the groundwater unless captured and sequestered. This salt accumulation causes groundwater quality degradation for potable and agricultural uses.

To the high nitrate and salinity problems, the Central Valley Salinity Alternatives for Long-Term Sustainability (CV-Salts) was formed as a strategic initiative to address accumulation of salts and nitrates throughout the region in a comprehensive, consistent and sustainable manner (CVRWQCB 2015; SWRCB 2015). The Central Valley Regional Water Quality Control Board and the State Water Resources Control Board in cooperation with stakeholders and the Central Valley Salinity Coalition collaborate to review and update the Water Quality Control Plans for the Sacramento Valley and San Joaquin Valley groundwater basins and the Delta Plan for salinity management, as described in Chapter 6, Surface Water Quality. The goals of this program are to address groundwater nitrate legacy conditions and current loadings, direct impacts of high nitrates on drinking water supplies from diverse sources, and economic costs for water treatment or alternate supplies. A final Salinity and Nitrate Management Plan is scheduled to be completed in May 2016.

Overall Groundwater Conditions

The Westside, Kings, Tulare Lake, Kaweah, Tule, and Kern subbasins were designated by the CASGEM program as high priority. The Pleasant Valley subbasin was designated as low priority.

Groundwater Use and Management

The northern Tulare Lake Area uses groundwater for its many water needs. Groundwater is used conjunctively with surface water, where possible, when surface water supplies are not sufficient to meet the region's demand for agricultural, industrial, and municipal uses (DWR 2003a). For example, the cities of Fresno and Visalia are almost entirely dependent on groundwater for their water supplies. Most groundwater subbasins in the Tulare Lake Area are in a state of overdraft as a consequence of groundwater pumping that exceeds the basin's safe yield (the amount of natural and induced recharge available to replenish the basin). As a result, the aquifers in these groundwater basins contain a significant amount of potential storage space that can be filled with additional recharged water. However, cities in the northern Tulare Lake Area are considering other water sources and/or groundwater banking programs.

Westside Subbasin

The Westside subbasin is located within western Fresno County and northwestern Kings County. The majority of lands within the Westside subbasin are within the Westlands Water District which uses CVP surface water, water transferred from other agencies, and groundwater. Groundwater levels in the Westside subbasin have fluctuated over the past 46 years in response to the availability of surface water deliveries from the CVP (WWD 2013). The lowest recorded average groundwater level below the Corcoran Clay between 1950 and 1968 (prior to delivery of CVP water to the subbasin) was 156 feet below mean sea level, which occurred in 1967. Groundwater elevations increased after 1968 to 89 feet above mean sea level in 1987.

Groundwater levels are closely related to the availability of surface water. In the 1977 drought when CVP water supplies were substantially reduced, groundwater withdrawals decreased the groundwater elevation by 97 feet in 1 year (WWD 2013). In 1991 and 1992 (during the 1987 to 1992 drought), the groundwater elevation declined to 62 feet below mean sea level. In 1996, the Westlands Water District adopted a groundwater management plan to preserve and enhance reliable groundwater resources; provide long-term availability of high quality groundwater; maintain local control of groundwater in the district; and minimize the cost and impact of groundwater use (WWD 2013a). The groundwater levels recovered following the drought that ended in 1992. However, in 2010, the CVP allocation was 45 percent of the contract amount, and the average groundwater elevation was 9 feet above mean sea level (WWD 2011). In 2012, the CVP allocation was 40 percent of the contract amount, and the average groundwater elevation decreased to 1 foot above mean sea level (WWD 2013). Recent information indicates that between the spring 2013 and spring 2014, groundwater levels have declined at some wells in the Westside subbasin by up to 40 feet within the 1-year period (DWR 2014c, 2014d).

Subsidence has occurred in the Westside subbasin as a result of the high rate of historic groundwater pumping resulting in reduced groundwater levels and the compaction of fine grained soils. In some areas, the land surface elevation has decreased substantially. It is estimated that extensive groundwater pumping prior to delivery of CVP water resulted in compaction of water bearing sediments and land subsidence of 1 to 24 feet between 1926 and 1972 (WWD 2013). The Westland Water District has referenced that the Department of Water Resources estimated the amount of subsidence since 1983 to be almost 2 feet in some areas of the District with most of that subsidence occurring since 1989 (WWD 2013). The USGS monitoring between 2003 and 2010 indicated no subsidence in the Westside subbasin area during the same time period while at least 1.8 feet of subsidence occurred in the Delta-Mendota subbasin area near the southern part of the Delta-Mendota Canal (USGS 2013a).

Kings Subbasin

The Kings subbasin includes most of central and eastern Fresno County, and northern Kings and Tulare County (DWR 2006n, 2013c). Two major groundwater depressions occur near the Fresno-Clovis urban area and approximately 20 miles southwest of Fresno in the Raisin City Water District (DWR 2013c). On average, the majority of this subbasin has experienced generalized declines in groundwater levels of approximately 20 feet between 2003 and 2011 (KRCD 2012a). The Kings subbasin is in overdraft condition and overdraft continues to be a major long-term problem due to increasing water demand and reduced surface water supply reliability. Recent information indicates that between the spring 2010 and spring 2014, groundwater levels declined at some wells in the Kings subbasin by up to 20 feet (DWR 2014c, 2014d).

Groundwater is used for a portion of agricultural water demands and for most of the domestic and industrial water demands in Fresno County, including for water users in the communities of Fresno, Clovis, Sanger, Fowler, Selma, Kingsburg, Reedley, Dinuba, Orange Cove, Raisin City, and Riverdale (CVRWQCB 2011; Fresno County 2000; KRCD 2012a).

The City of Fresno, which previously used groundwater for the municipal water supplies, has developed a surface water supply program. The groundwater is recharged through direct recharge and from applied agricultural water, and groundwater inflows from the adjacent foothills (City of Fresno 2015).

Several water agencies are coordinating efforts in the Kings subbasin to mitigate the extensive historical declines in groundwater levels resulting from pumping withdrawals. Current Kings subbasin groundwater recharge efforts include a total of 4,000 acres of dedicated recharge ponds (CGRA 2012). One of the biggest groundwater recharge efforts in the Kings subbasin area is the McMullin On-farm Flood Capture and Recharge Project near Raisin City (KRCD 2013).

Tulare Lake Subbasin

The Tulare Lake subbasin includes most of Kings County (DWR 2006m, 2013c). In the Tulare Lake subbasin, water levels have declined nearly 17 feet on average from 1970 through 2000. Fluctuations in water levels have been most exaggerated in the Tulare Lakebed area of the subbasin, which has experienced both the steepest declines and the steepest rises over time. Groundwater overdraft conditions also prevail in this subbasin, similar to the Kings subbasin. Recent information indicates that between the spring 2010 and spring 2014, groundwater levels declined at some wells in the Tulare Lake subbasin by up to 20 feet (DWR 2014c, 2014d).

Groundwater is used for a portion of agricultural water demands and for most of the domestic and industrial water demands in Kings County, including the communities of Corcoran, Hanford, Lemoore, and Kettleman Hills (CVRWQCB 2011; KRCD 2012a).

Kaweah Subbasin

The Kaweah subbasin includes a portion of eastern Kings County and northwestern Tulare County. Water levels in this subbasin declined about 12 feet on average from 1970 through 2000 (DWR 2004v, 2013c). The basin is subject to large fluctuations in water levels since the 1970s to as low as 35 feet lower than the 1970 water level in 1995 to 25 feet higher in 1988. These fluctuations correspond to successive dry years (declines) and wet years (rebounds), respectively. Recent information indicates that between the spring 2010 and spring 2014, groundwater levels declined at some wells in the Kaweah subbasin by up to 20 feet (DWR 2014c, 2014d). The Kaweah Delta Water Conservation District operates recharge facilities to supplement groundwater recharge that occurs along the natural stream channels (KDWCD 2006). Water is released from the Terminus Reservoir on the Kaweah River to flow into over 40 recharge basins throughout the basin. Use of CVP water from the Friant-Kern Canal by Tulare Irrigation District and Ivanhoe Irrigation District reduces the need for groundwater withdrawals when the CVP water is available.

Groundwater is used for a portion of agricultural water demands and for most of the domestic and industrial water demands in the subbasin, including for water users in the communities of Visalia, Tulare, and Lindsay (CVRWQCB 2011; Tulare County 2010).

Tule Subbasin

The Tule subbasin includes southwestern Tulare County. Water levels in this subbasin increased by about 4 feet on average from 1970 through 2000 (DWR 2004w, 2013c). Water levels have fluctuated during dry and wet years between 16 feet below the 1970 water level in 1995 to 20 feet above the 1970 water level in 1988. Recent information indicates that between the spring 2010 and spring 2014, groundwater levels declined at some wells in the Tule subbasin by up to 20 feet (DWR 2014c, 2014d). The Deer Creek and Tule River Authority implemented a groundwater management plan in 2006 in the Tule Subbasin (DCTRA 2012). The plan participants include Lower Tule River Irrigation District, Pixley Irrigation District, Porterville Irrigation District, Terra Bella Irrigation District, Saucelito Irrigation District, Tea Pot Dome Irrigation District, Vandalia Irrigation District, Tipton Community Services District, Poplar Community Services District (primarily the City of Porterville), and Woodville Public Utility District. Many of these agencies have CVP water service contracts and some of these agencies have surface water rights. Groundwater recharge occurs in more than 25 groundwater recharge basins and along the Tule River and Deer Creek channels.

Southern Tulare Lake Area: Kern County Subbasin

The Kern County subbasin is located between the Tule and Tulare Lake groundwater subbasins on the north, the Sierra Nevada and Tehachapi Mountains granitic rock on the east, and the marine sediments of the Coast Ranges on the west. The major water suppliers within the Kern County subbasin include Kern County Water Agency and the City of Bakersfield.

Hydrogeology and Groundwater Conditions

The unconfined aquifer in the Kern County Groundwater subbasin is composed primarily of sediments that were deposited during the tertiary and quaternary age. The Tulare Formation, located in the western portion of the subbasin, includes the Corcoran Clay unit which occurs at depths of 300 to 650 feet and overlies the confined aquifer (DWR 2006o, 2013c).

Net groundwater level changes in the Kern County subbasin varied in different portions of the subbasin between 1970 and 2000 (DWR 2006o, 2013c). Since the late 1970s, the groundwater levels have ranged from an increase of over 30 feet in the southeastern portion of the subbasin to a decrease of up to 25 feet near Bakersfield and 50 feet near McFarland/Shafter. Recent information indicates that between the spring 2013 and spring 2014, groundwater levels declined at some wells in the Kern County subbasin by up to 40 feet (DWR 2014c, 2014d). The groundwater levels in some areas declined up to 10 feet between fall 2013 and fall 2014, and in some areas more than 10 feet.

Complete hydraulic disconnection between the groundwater and overlying surface water systems has occurred in the Kern County area. Kern River, a losing stream, is used as a conveyance element for irrigation purposes and to recharge groundwater.

Groundwater quality in the region is generally characterized by calcium bicarbonate in the shallow aquifers, and the groundwater quality is generally suitable for most uses. Lower aquifers have higher sodium concentrations (DWR 2006o, 2013c). Salinity is a significant groundwater quality issue in the region. Salt from imported CVP and SWP water accumulates annually in groundwater because the Tulare Lake is a closed system without any natural outlets (KCWA 2011).

Shallow groundwater with high salinity occurs in the western and southern portions of the Kern County subbasin and is related to drainage problems for irrigated agriculture (DWR 2006o, 2013c). An agricultural drainage study showed that shallow groundwater occurs between 0 and 30 feet below the ground surface in the southern portion of the Kern County subbasin (DWR 2013j). The shallow groundwater is characterized by high TDS, sodium chloride, selenium, and sulfates (DWR 2013j). Areas with high nitrate and pesticide concentrations occur in localized areas due to historic agricultural practices including irrigation and dairy wastes (CVRWQCB 2011; DWR 2006o). Elevated arsenic concentrations tend to occur in isolated areas associated with lakebed deposits. Selenium and chromium also naturally occur in portions of the subbasin (KCWA 2011).

Groundwater Use and Management

The Kern County subbasin is located in western Kern County. The majority of the lands within the Kern County subbasin are within Kern County Water Agency or the City of Bakersfield. Water supplies in the subbasin include local surface water, CVP and SWP water supplies, and groundwater. The subbasin includes a portion of the land evaluated in the Tulare Lake Basin Portion of the Kern Region IRWMP. It is estimated that over the long-term, approximately 39 percent of water supplies in this area are met by groundwater (KCWA 2011). Groundwater can provide up to 60 percent of the total water supply in drier years.

Much of the groundwater is withdrawn by individuals or farmers who do not maintain groundwater extraction records. Historically, groundwater extractions were estimated based upon electricity use, changes in groundwater storage, or changes in crop patterns and/or water requirements (DWR 2004o, 2013c; KCWA 2011).

Most of the groundwater is used by agriculture and the communities of Bakersfield, Rosedale, Shafter, Delano, Taft, and Wasco (KCWA 2011). The City of Bakersfield and surrounding unincorporated areas use surface water and groundwater. The groundwater supplies in 2010 include water provided by California Water Service Company; East Niles Community Services District;, Kern County Water Agency Improvement District No. 4 and North of the River Municipal Water District; and Vaughn Water Company (California Water Service Company 2011a; ENCSD 2011; KCWA 2011; KCWA and NORMWD 2011; Vaughn Water Company, Inc. 2011). The water entities along with adjacent water agencies manage the groundwater basin levels through ongoing recharge projects and conjunctive use projects.

Conjunctive Use and Groundwater Banking

Conjunctive use is an important component of water management in the Kern County subbasin. Many groundwater banking facilities supplement water supplies delivered to customers in dry years, when insufficient surface water supplies are available to meet demands.

More than 30,000 acres of groundwater recharge ponds are estimated to exist in the Kern County subbasin area (KCWA 2011). Infrastructure used for groundwater banking includes recharge basins, recharge canals, recovery wells, and conveyance pipelines. In addition, connections to regional conveyance infrastructure conveys water from the local water supplies, including the Kern River; Friant-Kern Canal; the Cross Valley Canal; and California Aqueduct to the recharge areas. Groundwater banking programs have developed various interties to the regional conveyance systems, such as the Semitropic Water Storage District Intake Canal and the Kern Water Bank Canal (KCWA 2011).

The major groundwater banking programs in Kern County include the Kern Water Bank operated by the Kern Water Bank Authority; the Semitropic Groundwater Bank, operated by the Semitropic Water Storage District; a groundwater bank operated by the North Kern Water Storage District; a groundwater bank operated by the City of Bakersfield; and a groundwater bank operated by Rosedale-Rio Bravo Water Storage District.

The Kern Water Bank Authority is located west of Bakersfield and covers nearly 30 square miles of the Kern County subbasin. The Kern Water Bank includes recharge ponds where water from local surface streams and the SWP infiltrates into the aquifer (KCWA n.d.; KWBA 2011). Eighty-four recovery wells are used to pump groundwater out of the aquifer in dry years when additional water is needed for irrigation since the program began operations in 1995 (KCWA 2011).

The Semitropic Water Storage District is located west of Wasco and covers more than 220,000 acres (SWSD 2011a). The Semitropic Water Storage District Stored Water Recovery Unit (a subunit of the overall Semitropic Water Storage District Water Bank) partnered with the Antelope Valley Water Bank, located close to Rosamond in the Kern County portion of the Antelope Valley, to form the Semitropic-Rosamond Water Bank Authority (SWSD 2011b). The major banking partners of Semitropic Water Storage District include (SWSD 2014):

- Metropolitan Water District of Southern California
- Santa Clara Valley Water District
- Alameda County Water District
- Zone 7 Water Agency
- Poso Creek Water Company
- Newhall Land & Farming Company
- San Diego County Water Authority
- Homer, LLC
- City of Tracy
- Harris Farms

Other banking programs include (KCWA and NORMWD 2011; KCWA 2011, n.d.):

- Arvin-Edison Water Storage District Banking

- Buena Vista Water Storage District Banking
- Cawelo Water District Banking
- City of Bakersfield 2800 Acres Recharge Facility
- Kern County Water Agency Improvement District No. 4 Pioneer Project and Allen Road Complex Well Field
- Kern Delta Water District Banking
- Kern Tulare and Rag Gulch Water Districts Banking
- Rosedale-Rio Bravo Water Storage District Banking (developed with Kern County Water Agency Improvement District No. 4)

Western Tulare Lake Area: Pleasant Valley Subbasin

The Pleasant Valley subbasin is located within the western portions of Fresno and Kings Counties.

Hydrogeology and Groundwater Conditions

Tertiary continental and marine sediments of the Coast Ranges and Kettleman Hills form the western boundary of the Pleasant Valley subbasin (DWR 2006p, 2013c). Alluvium of the San Joaquin Valley extends into the subbasin from the north, east, and south. Ephemeral streams from the Coast Ranges and Kettleman Hills flow into the subbasin. Groundwater recharge occurs primarily along these and other streams within the subbasin.

In the Pleasant Valley subbasin, groundwater levels are generally continuing a historical trend of decline. DWR measurements indicated a decline of 5 to 25 feet during the 1990s (DWR 2006p, 2013c).

Water quality in the Pleasant Valley subbasin is characterized by high TDS (CVRWQCB 2011; DWR 2006p, 2013c). Localized areas of high concentrations of boron, calcium, chlorides, magnesium, pesticides, sodium, bicarbonates, and sulfates occur in the groundwater.

The Pleasant Valley subbasin was designated by the CASGEM program as low priority.

Groundwater Use and Management

Groundwater is used to meet agricultural and municipal water demands in the Pleasant Valley subbasin (DWR 2006p, 2013c). Due to limited recharge capabilities in the subbasin, surface water is used either completely or conjunctively in western Fresno and Kings Counties. The communities of Avenal and Coalinga use CVP surface water due to groundwater quality, as described in Chapter 5, Surface Water Resources and Water Supplies (Reclamation 2012).

7.3.4 San Francisco Bay Area Region

The San Francisco Bay Area Region includes portions of Contra Costa, Alameda, Santa Clara, and San Benito counties that are within the CVP and SWP service areas. The SWP water users in Napa County do not use groundwater. Therefore, groundwater resources for Napa County are not described in this EIS.

There are several groundwater basins in the San Francisco Bay Area Region; however, only some of the basins are within the CVP and SWP service areas evaluated in this EIS. The portions of the San Francisco Bay Area Region within the CVP and/or SWP service areas include the Pittsburg Plain, Clayton Valley, Ygnacio Valley, Arroyo Del Hambre Valley, San Ramon Valley, Livermore Valley, Castro Valley, and Santa Clara Valley groundwater basins within the San Francisco Bay Hydrologic Region; and Gilroy-Hollister Valley Groundwater Basin within the Central Coast Hydrologic Region.

Groundwater represents approximately 15 percent of the agricultural, municipal, and industrial water supplies in the San Francisco Bay Area (DWR 2013i). Conjunctive use programs have been implemented by several agencies to optimize the use of groundwater and surface water sources.

Groundwater quality in the San Francisco Bay Area is generally suitable for most agricultural and municipal uses, but concerns exist about groundwater contamination from industrial and agricultural chemical spills, leaky underground and above ground storage tanks, landfill leachate, and poorer-quality surface water bodies. There were over 800 groundwater cleanup projects in the area with the majority resulting from leaky fuel tanks (DWR 2013i). Portions of the San Francisco Bay Area Region along the shorelines include aquifers that are susceptible to seawater intrusion.

In the southern San Francisco Bay Area Region, groundwater and surface water are connected through in-stream and off-stream artificial recharge projects, in which surface water is delivered to water bodies that permit the infiltration of water to recharge underlying aquifers. Surface waters recharge aquifers in other regions of the San Francisco Bay Area Region along streambeds, especially in areas with depressed groundwater levels that have resulted from extensive groundwater pumping.

This section describes groundwater in subbasins within CVP and/or SWP water service areas, including Pittsburg Plain, Clayton Valley, Arroyo Del Hambre Valley, Ygnacio Valley, and San Ramon Valley subbasins in Contra Costa County; East Bay Plain and Livermore Valley subbasins in Contra Costa and Alameda counties; Castro Valley subbasin in Alameda County; Santa Clara and Llagas Area subbasins in Santa Clara County; and Bolsa, Hollister, and San Juan Bautista Area subbasins in San Benito County, as shown in Figure 7.8.

7.3.4.1 San Francisco Bay Hydrologic Region

7.3.4.1.1 Hydrogeology and Groundwater Conditions

Each of these groundwater basins in the San Francisco Bay Hydrologic Region contains unique hydrogeologic characteristics. However, generally the water bearing materials consist of alluvial, unconsolidated sand, sand and gravel, and clay (DWR 2004x, 2004y, 2004z, 2004aa, 2004ab, 2004ac, 2004ad, 2004ae, 2006q, 2006r, 2013d). Aquifers in these basins are hydrologically connected to surface water bodies, such as the San Joaquin River, Suisun Bay, local streams, and San Francisco Bay.

The movement of groundwater is locally influenced by features such as faults and structural depressions and operating production wells; however, groundwater generally flows toward the nearby bays. Groundwater levels in the area exhibit seasonal variation and have been historically depressed from significant groundwater use. However, as groundwater use decreased over the last few decades following implementation of surface water projects, groundwater levels have risen significantly. Over the entire period of record, groundwater levels have shown only a slight decline and are stable in more recent years.

Pittsburg Plain, Clayton Valley, Ygnacio Valley, and Arroyo Del Hambre Valley Groundwater Basins

The Pittsburg Plain, Clayton Valley, Ygnacio Valley, and Arroyo Del Hambre Valley groundwater basins represent the majority of groundwater storage in northern Contra Costa County. Except for portions of the Pittsburg Plain, most of these groundwater basins are not located within the Delta.

These basins extend inland from Suisun Bay towards Mt. Diablo. The Pittsburg Plain Groundwater Basin is composed of Pleistocene deposits of consolidated and unconsolidated clay sediments; overlain by alluvial soft water-saturated muds, peat, and loose sands (DWR 2004x, 2013d). The Clayton Valley and Ygnacio Valley groundwater basins are composed of unconsolidated alluvium and semi-consolidated alluvium interbedded with clay, sand, and gravel lenses. Along Suisun Bay, the water bearing formations are composed of alluvial soft water-saturated muds, peat, and loose sands (DWR 2004y, 2004z, 2004aa, 2013d).

Groundwater levels are relatively stable because the groundwater is recharged from streams (DWR 2004x, 2004y, 2004z, 2004aa, 2013d). The streams include Kirker and Willow creeks in the Pittsburg Plain Groundwater Basin; Marsh Creek in the Clayton Valley Groundwater Basin; Walnut and Grayson creeks in the Ygnacio Valley Groundwater Basin; and Alhambra Creek in the Arroyo Del Hambre Valley Groundwater Basin. There are no recent data for these basins related to groundwater levels or storage capacities.

The groundwater in this area is characterized by moderate to high TDS (DWR 2004x, 2004y, 2004z, 2004aa, 2013d). High nitrate concentrations occur in some rural areas of these basins (Contra Costa County 2005).

The Pittsburg Plain, Clayton Valley, Ygnacio Valley, and Arroyo Del Hambre Valley groundwater basins were designated by the CASGEM program as very low priority.

San Ramon Valley Groundwater Basin

The San Ramon Valley Groundwater Basin is located in southern Contra Costa County and extends from the Alamo area southward under the Town of Danville and City of San Ramon to the county boundary.

The basin is a closed basin characterized by alluvial fan deposits of sand, gravel, silt, and clay sediments (DWR 2004ab, 2013d). Multiple faults within the basin affect groundwater movement.

There are no recent data for this basin related to groundwater levels, storage capacities, or quality (DWR 2004ab, 2013d).

The San Ramon Valley Groundwater Basin was designated by the CASGEM program as very low priority.

Livermore Valley Groundwater Basin

The Livermore Valley Groundwater Basin extends under northeastern Alameda County and southern Contra Costa County. The Livermore Valley Groundwater Basin contains groundwater-bearing materials originating from continental deposits from alluvial fans, outwash plains, and lakes (DWR 2006q, 2013d).

The Main Basin is the aquifer that includes the highest yielding aquifers and highest quality groundwater (Zone 7 2012). The Main Basin generally is divided into the Upper Aquifer Zone and Lower Aquifer Zone which are separated by a relatively continuous silty clay lens. Water from the Upper Aquifer Zone moves into the Lower Aquifer Zone when groundwater levels in the upper zone are high.

Well yields are mostly adequate and in some areas can produce large quantities of groundwater for all types of wells (DWR 2006q, 2013d). The movement of groundwater is locally impeded by structural features such as faults that act as barriers to groundwater flow, resulting in varying water levels in the basin. Groundwater follows a westerly flow pattern, similar to the surface water streams, along the structural central axis of the valley toward municipal pumping centers (Zone 7 2005).

Groundwater levels in the main portion of the Livermore Valley Groundwater Basin started declining in the early 1900s when groundwater pumping removed large quantities of groundwater (Zone 7 2005, 2010, 2013). This trend continued until the late 1960s when Zone 7 Water Agency began importing SWP water. Subsequently, Zone 7 Water Agency developed surface water projects to capture local runoff. Local runoff and SWP water is stored in Lake Del Valle and used to recharge groundwater within the Livermore Valley. The importation of additional surface water alleviated the pressure on the aquifer, and groundwater levels started to rise in the 1970s. However, historical lows were reached during periods of drought. During the recent dry period, groundwater levels declined 7 to 17 feet throughout the aquifers used by Zone 7 Water Agency between 2011 and 2012.

The Livermore Valley Groundwater Basin is characterized by localized areas of high boron, nitrate, and TDS (DWR 2006q, 2013; Zone 7 2012). High boron levels can be attributed to marine sediments adjacent to the basin.

Nitrate concentrations generally are within potable water criteria; however, high nitrate concentrations occur in some locations of the upper aquifer (Zone 7 2012). The source of nitrates appears to be related to agricultural activities, wastewater disposal, and natural sources from decaying vegetation.

Salinity of the aquifer depends upon the quality of the water used for recharge operations. Salinity has increased over the past 30 years (Zone 7 2012) especially in the western portion of the Main Basin. Aquifers in the central and eastern portions of the Livermore Valley Groundwater Basin are generally recharged through streambeds and are characterized by lower salinity due to the high recharge rate.

The Livermore Valley Groundwater Basin was designated by the CASGEM program as medium priority.

Castro Valley Groundwater Basin

The Castro Valley Groundwater Basin is located in the Castro Valley area of Alameda County between San Lorenzo Creek on the east and the Hayward Fault on the west (Castro Valley 2012).

The basin is composed of alluvial deposits of sand, gravel, silt, and clay sediments (DWR 2004ac, 2013d). Previous studies indicated that the maximum yield was about 140,000 gallons per day (Castro Valley 2012).

The groundwater is characterized by bicarbonates with calcium and sodium. Localized contamination has occurred in this shallow aquifer related to agricultural activities and underground storage tanks (Castro Valley 2012).

The Castro Valley Groundwater Basin was designated by the CASGEM program as very low priority.

Santa Clara Valley Groundwater Basin

The Santa Clara Valley Groundwater Basin includes three subbasins in areas that are within the CVP and/or SWP service areas. The three subbasins include the East Bay Plain subbasin in Contra Costa and Alameda counties, Niles Cone subbasin in Alameda County, and Santa Clara subbasin in Santa Clara County.

East Bay Plain Subbasin

The East Bay Plain subbasin is an alluvial plain that extends from San Pablo Bay southward to the Niles Cone subbasin, and extends under San Francisco Bay (DWR 2004ad, 2013d; EBMUD 2013). The alluvium consists of unconsolidated sediments of mud, silts, sands, and clays. Multiple faults within the subbasin affect groundwater movement. Groundwater levels declined to approximately 250 feet below the ground surface until the mid-1960s when groundwater levels began to increase. By 2000, groundwater levels were close to the ground surface. The groundwater quality is characterized as calcium and sodium bicarbonate with moderate to high TDS. Higher TDS concentrations occur near San Francisco Bay where localized sea water intrusion has occurred. High nitrate concentrations occur in localized areas due to historic agricultural activities.

The East Bay Plain subbasin was designated by the CASGEM program as medium priority.

Niles Cone Subbasin

The Niles Cone subbasin is mainly comprised of the alluvial fan along Alameda Creek. The Hayward Fault crosses the Niles Cone subbasin and further separates the subbasin into the Below Hayward Fault (west of the Hayward Fault) and Above Hayward Fault (east of the Hayward Fault) subbasins (ACWD 2012; DWR 2006r, 2013d).

The Niles Cone subbasin was in overdraft condition through the early 1960s. After 1962, groundwater levels increased as SWP water was delivered to the area and used to recharge the groundwater subbasin (DWR 2006r, 2013d).

The main groundwater quality impairment in the Niles Cone subbasin is saltwater intrusion caused by groundwater pumping (ACWD 2012; DWR 2006r, 2013d). In the 1950s the migration of saline water extended into the Above Hayward Fault subbasin, and migrated into deeper aquifers. Alameda County Water District has developed aquifer reclamation programs to help control the movement of saline water and restore the quality of groundwater in the affected aquifers, as described below.

Niles Cone subbasin was designated by the CASGEM program as medium priority.

Santa Clara Subbasin

The Santa Clara subbasin is located within Santa Clara County along a structural trough that parallels the Coast Ranges and extends from the Diablo Range and Santa Cruz Mountains. The water bearing formations of the Santa Clara subbasin include unconsolidated to semi-consolidated gravel, sand, silt and clay (DWR 2004ac, 2013d). The upper alluvial fan in the northern portion of the subbasin is characterized by coarse-grained sediments (SCVWD 2010). Towards the central portion of the subbasin, thick silty clay lenses are inter-bedded with thin sand and gravel lenses. The northern and central portions of the subbasin are locally referred to as the Santa Clara Plain (SCVWD 2011). The southern portion of the subbasin consists of extensive alluvial deposits of unconsolidated and semi-consolidated sediments and is referred to as the Coyote Valley (SCVWD 2010). The central portions and areas along the edges of the Santa Clara Plain subbasin consist of unconfined aquifers that provide recharge to the basin (SCVWD 2010, 2011). The Shallow Aquifer consists of water-bearing sediments that are less than 150 feet deep. The Principal Aquifer provides most of the groundwater supply for the Santa Clara Valley and is separated from the Shallow Aquifer by a confining lens in some areas of the Santa Clara Plain. The groundwater recharge primarily occurs due to percolation of water on the soil from precipitation or artificial recharge operations (as described below), seepage from stream beds, and subsurface inflow from surrounding hills.

In the Coyote subbasin, the groundwater aquifer is primarily unconfined with areas of perched groundwater above discontinuous clay deposits (SCVWD 2010, 2011). Groundwater recharge occurs along the streambeds. When the groundwater levels are high in the Coyote subbasin, groundwater seeps into the streams.

The movement of groundwater in the Santa Clara subbasin is locally influenced by groundwater recharge activities, proximity to streams, and operating production wells (SCVWD 2010). Regionally, groundwater in the Santa Clara Subbasin generally flows northwest toward the San Francisco Bay.

The Santa Clara subbasin has historically experienced decreasing groundwater level trends. Between 1900 and 1960, water level declines of more than 200 feet from groundwater pumping have induced unrecoverable land subsidence of nearly 13 feet (SCVWD 2011). Importation of surface water using CVP, SWP, and San Francisco Public Utilities District water supplies; and the development of an artificial recharge program have resulted in rising groundwater levels since the late 1960s. The groundwater levels in some portions of this subbasin declined up to 10 feet between fall 2013 and fall 2014, and in some areas more than 10 feet.

The groundwater quality in the Santa Clara subbasin is good to excellent and suitable for most beneficial uses. The groundwater meets all drinking water standards and can be used without additional treatment (SCVWD 2001, 2010). Some areas affected by historical saltwater intrusion exist in the northern portion of the Santa Clara subbasin in the Shallow Aquifer. Recent groundwater monitoring has indicated that seawater intrusion appears to be stabilizing (SCVWD 2012a). High nitrate concentrations occur in the Coyote Valley.

Santa Clara subbasin was designated by the CASGEM program as medium priority.

7.3.4.1.2 Groundwater Use and Management

Use of groundwater in the San Francisco Bay Hydrologic Region varies extensively. In the basins within Contra Costa County (Pittsburg Plain, Clayton Valley, Ygnacio Valley, Arroyo Del Hambre Valley, and San Ramon Valley), local wells are used for small agricultural activities and landscape irrigation by individual land owners. In the Livermore Valley Groundwater Basin, groundwater is used for a major portion of the water supply.

Pittsburg Plain, Clayton Valley, Ygnacio Valley, and Arroyo Del Hambre Valley Groundwater Basins

Groundwater use is limited within northern Contra Costa County within the Pittsburg Plain, Clayton Valley, Ygnacio Valley, and Arroyo Del Hambre Valley groundwater basins. This area is located within the Contra Costa Water District or East Bay Municipal Utilities District service areas. These districts provide surface water to most water users in this area.

Within the Contra Costa Water District service area, groundwater use is limited (CCWD 2011). The use of existing Contra Costa Water District wells at the Mallard Well Fields is limited because of the threat of contamination from adjacent industrial areas.

The City of Pittsburg operates two municipal wells from the Pittsburg Plain Groundwater Basin (Pittsburg 2011).

The City of Martinez operates up to two wells in the Arroyo Del Hambre Valley Groundwater Basin to provide irrigation water to a municipal park (Martinez 2011).

San Ramon Valley Groundwater Basin

Groundwater use is limited within the San Ramon Valley Groundwater Basin located in southern Contra Costa County. Local wells are used for small agricultural activities and landscape irrigation by individual land owners. This area is located within the East Bay Municipal Utilities District service area. The district provides surface water to most water users in this area.

Livermore Valley Groundwater Basin

In the Livermore Valley Groundwater Basin, Zone 7 Water Agency administers oversight of the groundwater basins used for water supply and provides water to California Water Service Company, Dublin San Ramon Services District, City of Livermore, and City of Pleasanton. Zone 7 Water Agency only withdraws groundwater that has been recharged using surface water supplies (Zone 7 2010). The California Water Service Company, Dublin San Ramon Services District, and City of Pleasanton also withdraw groundwater (California Water Service Company 2011h; DSRSD 2011; City of Livermore 2011; City of Pleasanton 2011).

Zone 7 Water Agency manages the groundwater levels and quality in the Livermore Valley Groundwater Basin to maintain groundwater levels that would avoid subsidence and provide emergency reserves for the worst credible drought (DWR 2006q, 2013d).

Zone 7 Water Agency artificially recharges the Livermore Valley Groundwater Basin with local surface water supplies and SWP water by releasing the surface waters into the Arroyo Mocho and Arroyo Valle (Zone 7 2005, 2010). The infiltrated water is then pumped from the groundwater basin for various uses, mostly during the summer and during drought periods when local surface water supplies are diminished and the available SWP water supplies are less than the entitlement value Zone 7 Water Agency, City of Livermore, City of Pleasanton, Dublin San Ramon Services District, and California Water Service Company are permitted to withdraw groundwater from this subbasin.

In 2009, the Zone 7 Water Agency began operation of the Mocho Groundwater Demineralization Plant (Zone 7 2010). This plant is a wellhead treatment plant that produces potable water using reverse osmosis to remove TDS and hardness from the Main Basin.

Castro Valley Groundwater Basin

Groundwater use is limited within the Castro Valley Groundwater Basin. Local wells are used for small agricultural activities and landscape irrigation by individual land owners (Castro Valley 2012). This area is located within the East Bay Municipal Utilities District service area. The district provides surface water to most water users in this area.

Santa Clara Valley Groundwater Basin

The Santa Clara Valley Groundwater Basin includes the East Bay Plain, Niles Cone, and Santa Clara subbasins.

East Bay Plain Subbasin

Groundwater use is limited within the East Bay Plains subbasin. Local wells are used for small agricultural activities and landscape irrigation by individual land owners (DWR 2004ad, 2013d; EBMUD 2013). Well fields that served the communities were initially constructed in the late 1800s and early 1900s, and were closed by 1930. This area is located within the East Bay Municipal Utilities District service area. The district provides surface water to most water users in this area. East Bay Municipal Utilities District initiated the Bayside Groundwater Project in 2009 to store surface water in wet years for use during droughts.

Niles Cone Subbasin

Alameda County Water District is the primary water agency that relies upon the Niles Cone subbasin. This Alameda County Water District uses fresh groundwater from the Niles Cone subbasin and desalinated brackish groundwater in addition to local and imported surface water supplies. The Niles Cone subbasin is primarily recharged in the Alameda Creek watershed by percolation of local runoff and SWP water (ACWD 2011, 2012). In wetter years, when local water supplies are abundant, Alameda County Water District diverts some of the SWP allocation to the Semitropic Water Storage District in Kern County through a water banking agreement (as described above for the Kern County subbasin). This agreement allows Alameda County Water District to subsequently recover this water during drier years through an exchange agreement with Semitropic Water Storage District (ACWD 2012).

Alameda County Water District provides retail water supplies to the cities of Fremont, Newark, and Union City. The district has implemented treatment of brackish groundwater to allow previously unused groundwater to be used as a potable water source (ACWD 2011, 2012). In 2003, the Alameda County Water District Newark Desalination Facility began to remove salts and other constituents from the Niles Cone subbasin groundwater that is subject to seawater intrusion using a reverse-osmosis process. The aquifer reclamation program also includes withdrawing water to prevent a plume of brackish water in the Centerville-Fremont Aquifer from further migrating toward the Alameda County Water District Mowry Wellfield. Future groundwater desalination facilities are being evaluated by the district.

Santa Clara Subbasin

Local water agencies and individual landowners use groundwater in the Santa Clara subbasin. The Santa Clara subbasin is primarily recharged from percolation of local runoff and water supplied by the CVP and/or SWP that is discharged to streambeds and recharge facilities (SCVWD 2011).

Treated water is provided by the Santa Clara Valley Water District to retail water agencies in order to promote conjunctive use of groundwater. The water entities in the Santa Clara subbasin that use treated surface water include the cities of Milpitas, Mountain View, Palo Alto, San Jose, Santa Clara, and Sunnyvale; California Water Service (Los Altos), Purissima Water District, and San Jose

Water Company. Several of these entities also use surface water from San Francisco Public Utilities Commission as part of their overall water supply.

In the Santa Clara subbasin, groundwater is withdrawn by local water suppliers and private well owners to meet municipal, domestic, agricultural, and industrial water needs (SCVWD 2011). Groundwater provides approximately 40 to 50 percent of total water supply in Santa Clara County in average water year conditions (SCVWD 2010). Within the Santa Clara subbasin, the users of the most groundwater include San Jose Water Company, City of Santa Clara, Great Oaks Water Company, California Water Service, and individual land owners primarily in the southern portion of the subbasin (SCVWD 2012a).

The Santa Clara Valley Water District is responsible for groundwater management in the Santa Clara subbasin, and operates a robust and flexible conjunctive use program that uses a variety of surface water sources: local supplies, imported SWP and CVP supplies, and imported transfer options. Surface water is also supplied to some water users by the San Francisco Public Utilities Commission (SCVWD 2001, 2010). The district operates an extensive system of in-stream and off-stream artificial recharge facilities to replenish the groundwater basin and provide more flexibility to manage water supplies. Eighteen major recharge systems allow local reservoir water and imported water to be released in over 30 local creeks and 71 percolation ponds that provide 393 acres for artificial recharge to the groundwater basin. Recharge in this subbasin occurs along streambeds and off-stream managed basins. Most of the recharge facilities are located in the Santa Clara subbasin. Two major recharge facilities, the Lower Llagas and Upper Llagas recharge systems, are located in the Llagas subbasin of the Gilroy-Hollister Groundwater Basin, as described below (SCVWD 2011, 2012a). The amount of water artificially recharged throughout the entire district depends upon the availability of local, CVP, and/or SWP surface water supplies.

7.3.4.2 Central Coast Hydrologic Region: Gilroy-Hollister Valley Groundwater Basin

Portions of the Gilroy-Hollister Valley Groundwater Basin within the CVP and/or SWP water service areas include the Llagas Area, Hollister Area, and San Juan Bautista Area subbasins.

7.3.4.2.1 Hydrogeology and Groundwater Conditions

Each of these groundwater basins in the Gilroy-Hollister Valley Groundwater Basin contains unique hydrogeologic characteristics. However, generally the water bearing materials consist of alluvial, unconsolidated sand, sand and gravel, and clay. Within four subbasins in the study area of this EIS, groundwater flows towards the Pajaro River which flows to Monterey Bay (DWR 2004af, 2004ag, 2004ah, 2004ai, 2013d).

Llagas Area Subbasin

The water bearing formations of the Llagas subbasin include continental deposits of unconsolidated to semi-consolidated gravel, sand, silt and clay (DWR 2004af, 2013d; SCVWD 2010, 2011). Alluvium along the edges and the center portions of the subbasin are underlain by dense clayey soils. Younger alluvium does not have a well-defined clay subsoil.

As described above for the Santa Clara subbasin in the Santa Clara Valley Groundwater Basin, Santa Clara Valley Water District manages groundwater in the Llagas Area subbasin. Groundwater withdrawals in the Llagas subbasin have been relatively stable in recent years; and groundwater elevation has been stable since the late 1990s (SCVWD 2012a).

The groundwater quality in the Llagas subbasin is of good to excellent mineral composition and suitable for most beneficial uses (SCVWD 2010, 2012a). High nitrate concentrations occur in localized areas throughout the subbasin due to historical agricultural practices and wastewater effluent disposal. Santa Clara Valley Water District implemented a Nitrate Management Program in 1997 and nitrate concentrations are beginning to decline.

Bolsa Area, Hollister Area, and San Juan Bautista Subbasins

The Bolsa Area, Hollister Area, and San Juan Bautista Area subbasins extend over northern San Benito County. The subbasins are comprised of a sedimentary sequence that contains the principal aquifers underlying the Hollister and San Juan Valleys. The water bearing formation includes clay, silt, sand, and gravel (DWR 2004ag, 2004ah, 2004ai, 2013e).

The main water bearing formation in this area is composed of alluvium in the Bolsa Area and Hollister Area subbasins (San Benito County Water District 2012). The water bearing formations in the northern San Juan Bautista Area consist of alluvium (San Benito County Water District 2012). Groundwater movement within the aquifers is affected by the numerous faults, including the San Andreas and Calaveras Faults. Groundwater aquifers in this area include both unconfined and confined aquifer conditions with surficial clay deposits in the northern portions of these subbasins.

Groundwater in these subbasins is characterized by artesian conditions when groundwater levels are high, such as in the early 1900s (San Benito County Water District 2012). After the mid-1940s, groundwater levels declined with increased withdrawals. One of the lowest levels occurred in the late 1970s when the groundwater elevation was approximately 150 feet lower than the high water level conditions. In 2012, groundwater elevations ranged from 80 feet above mean sea level in the Bolsa Area subbasin to 700 feet above mean sea level in the San Juan Bautista Area subbasin.

The Bolsa Area, Hollister Area, and San Juan Bautista Area subbasins have localized areas with high concentrations of boron, chloride, hardness, metals, nitrate, sulfate, potassium, and TDS (San Benito County Water District 2012). The most substantial constituents include high TDS concentrations in the southeastern Bolsa Area subbasin, Hollister Area subbasin, and northern San Juan Bautista Area subbasin. High nitrate concentrations occur in the northern San Juan Bautista Area subbasin.

Overall Groundwater Conditions

The Llagas Area subbasin was designated by the CASGEM program as high priority. The Hollister Area and San Juan Bautista Area subbasins were designated as medium priority.

7.3.4.2.2 Groundwater Use and Management

Llagas Area Subbasin

As described in Chapter 5, Surface Water Resources and Water Supplies, groundwater is the primary water supply for local water agencies and individual landowners in the Llagas Area subbasin. The subbasin is primarily recharged from percolation of local runoff and water supplied by the CVP that is discharged to recharge facilities managed by Santa Clara Valley Water District, as described above for the Santa Clara subbasin in the Santa Clara Valley Groundwater Basin (SCVWD 2011). The two major recharge facilities in the Llagas Area subbasin include the Lower Llagas and Upper Llagas recharge systems (SCVWD 2010).

The primary municipal water suppliers are the cities of Gilroy and Morgan Hill. Groundwater is used by these local water suppliers and private well owners to meet municipal, domestic, agricultural, and industrial water needs (SCVWD 2011).

Bolsa Area, Hollister Area, and San Juan Bautista Subbasins

Local water agencies and individual landowners use groundwater in the Bolsa Area, Hollister Area, and San Juan Bautista subbasins. The subbasins are primarily recharged from percolation of local runoff in streambeds, including water from Hernandez and Paicines Reservoirs that is released to Tres Pinos Creek (San Benito County Water District 2012).

San Benito County Water District provides CVP water to the cities of Hollister and San Juan Bautista, Sunnyslope County Water District, residential areas surrounding Hollister and Tres Pinos, and agricultural areas in northern San Benito County to reduce groundwater use by these areas (San Benito County Water District 2012). Most other water users in the subbasins rely upon groundwater and/or local surface water stored in Hernandez and Paicines Reservoirs.

In 2011, groundwater supplies provided 49 percent of the water used for agriculture, municipal, domestic, and industrial supply in the areas of the subbasin supplied by CVP water (San Benito County Water District 2012).

7.3.5 Central Coast Region

The Central Coast Region includes portions of San Luis Obispo and Santa Barbara counties served by the SWP. The Central Coast Region encompasses the southern planning area of the Central Coast Hydrologic Region (DWR 2009a).

The SWP water is provided to the Central Coast Region by the Central Coast Water Authority (CCWA 2013a). The facilities divert water from the SWP California Aqueduct at Devil's Den and convey the water to the 43 million gallon per day water treatment plant at Polonto Pass. The treated water is conveyed to municipal water users in San Luis Obispo and Santa Barbara counties to reduce groundwater overdraft in these areas.

Portions of the Central Coast Region that use SWP water are included in the Central Coast Hydrologic Region which includes 50 delineated groundwater basins, as defined by DWR (DWR 2003a). The basins vary from large extensive alluvial aquifers to small inland valleys and coastal terraces. Groundwater in the large alluvial aquifers exists in thick unconfined and confined basins.

Groundwater is generally used for urban and agricultural use in the Central Coast Region.

7.3.5.1 Hydrogeology and Groundwater Conditions

The areas within the SWP service area in the Central Coast Region include the Morro Valley and Chorro Valley groundwater basins in San Luis Obispo County; Santa Maria River Valley Groundwater Basin in San Luis Obispo and Santa Barbara counties; and San Antonio Creek Valley, Santa Ynez River Valley, Goleta, Foothill, Santa Barbara, Montecito, and Carpinteria groundwater basins in Santa Barbara County, as shown in Figure 7.9.

7.3.5.1.1 Morro Valley and Chorro Valley Groundwater Basins

In the portions of San Luis Obispo County within the SWP service area near Morro Bay, groundwater is provided by Morro Valley and Chorro Valley groundwater basins. The water bearing formations are alluvium that consists of clays, silts, sands, and gravel that extend into the Pacific Ocean (DWR 2004aj, 2004ak, 2013e). The alluvium is recharged by seepage from streambeds and precipitation and irrigation water applied to the soils.

The groundwater has moderate TDS (DWR 2004aj, 2004ak, 2013e). Localized areas have high nitrate concentrations (Morro Bay 2011). Localized areas with organic contamination are also present; however, actions have been implemented to reduce the concentrations. Seawater intrusion occurs in localized areas near the Pacific Ocean.

The Morro Valley and Chorro Valley groundwater basins were designated by the CASGEM program as high priority.

7.3.5.1.2 Santa Maria River Valley Groundwater Basin

The Santa Maria River Valley Groundwater Basin is located in San Luis Obispo and Santa Barbara counties. The water bearing formation is primarily unconfined alluvium with localized confined areas near the coast (DWR 2004 al, 2013e; SMVMA 2012). Recharge occurs along the streambeds. Groundwater levels in the Basin have fluctuated over the past 100 years with declining groundwater levels until the mid-1970s, recovery through the mid-1980s, and declining levels through the mid-1990s. Following importation of SWP water, groundwater levels increased to historic high levels. However, in the last decade, groundwater levels have gradually declined which could be partially due to reductions in Twitchell Reservoir releases for groundwater recharge since 2000. Groundwater levels have been maintained at levels above 15 feet above mean sea level in shallow and deep aquifers near the coast to avoid seawater intrusion. Groundwater recharge occurs along streambeds. Water released from Twitchell and Lopez reservoirs increase groundwater recharge rates (SMVMA 2012).

Groundwater quality issues in the Santa Maria Valley Groundwater Basin include hardness, nitrates, salinity, sulfate and volatile organic compounds (DWR 2004al, 2013e; San Luis Obispo County 2011; SMVMA 2012). TDS concentrations are moderate to high. There are localized areas in the basin with high sulfate concentrations. Volatile organic compound contamination was a major issue for two wells used by the City of San Luis Obispo in the late 1980s. High nitrate concentrations occur in the shallow aquifer due to historic agricultural practices. Higher salinity levels occur in the shallow aquifer near the coast than within the inland areas or in the deep aquifer.

The Santa Maria River Valley Groundwater Basin was designated by the CASGEM program as high priority.

7.3.5.1.3 San Antonio Creek Valley Groundwater Basins

San Antonio Creek Valley Groundwater Basin is located along the Pacific Ocean within San Luis Obispo and Santa Barbara counties. The water bearing formations are characterized by unconsolidated alluvial and terrace deposits of sand, clay, silt, and gravel (DWR 2004dq, 2013e). Groundwater flows towards the Pacific Ocean. A groundwater barrier to the east of the Pacific Ocean creates the Barka Slough. Groundwater has declined in some areas of the basin over the past 60 years. Groundwater quality issues include areas with high salinity near the Pacific Ocean.

The San Antonio Creek Valley Groundwater Basin was designated by the CASGEM program as medium priority.

7.3.5.1.4 Santa Ynez River Valley Groundwater Basins

Several groundwater basins in Santa Barbara County are in a state of overdraft, including the Santa Ynez River Valley Groundwater Basin. The Santa Ynez Groundwater Basin is located along the Pacific Ocean in southwestern Santa Barbara County. The water bearing formations are characterized by unconsolidated alluvial and terrace deposits of gravel, sand, silt, and clay (DWR 2004an, 2013e). Groundwater flows towards the Santa Ynez River, and then towards the Pacific Ocean. Groundwater recharge occurs along the stream beds.

Groundwater quality is generally good for municipal and agricultural uses. There are localized areas with high TDS near the Pacific Ocean due to seawater intrusion (DWR 2004an, 2013e).

The Santa Ynez River Valley Groundwater Basin was designated by the CASGEM program as medium priority.

7.3.5.1.5 Goleta, Foothill, Santa Barbara, Montecito, and Carpinteria Groundwater Basins

The Goleta, Foothill, Santa Barbara, Montecito, and Carpinteria groundwater basins are located in southwestern Santa Barbara County along the Pacific Ocean and near the boundary with Ventura County. The water bearing formations in the Goleta, Foothill, Santa Barbara, and Montecito groundwater basins are unconsolidated alluvium of clay, silt, sand, and/or gravel that overlays the generally confined Santa Barbara Formation of marine sand, silt, and clay (DWR 2004an, 2004ao, 2004ap, 2004aq, 2013e).

In the Carpinteria Groundwater Basin, the alluvium extends under the agricultural plain (DWR 2004ar, 2013e). A confined aquifer occurs under a thick clay bed in the lower part of the alluvium. This basin includes the Santa Barbara Formation; as well as the Carpinteria Formation, of unconsolidated to poorly consolidated sand with gravel and cobble; and the Casitas Formation, of poorly to moderately consolidated clay, silt, sand, and gravel.

Several faults restrict groundwater flow throughout these basins. Recharge occurs along streambeds and from subsurface inflow into the basin from upland areas. Water released from Lake Cachuma increases groundwater recharge rates.

The groundwater levels in portions of these groundwater basins declined up to 10 feet between fall 2013 and fall 2014, and in some areas more than 10 feet (DWR 2014d).

Groundwater quality is generally good for municipal and agricultural uses. There are localized areas with high TDS near the Pacific Ocean due to seawater intrusion (DWR 2004an, 2004ao, 2004ap, 2004aq, 2004ar, 2013e; GWD and LCMWC 2010). High concentrations of nitrate, iron, and manganese occur in localized areas in the Goleta Groundwater Basin. Localized areas of high nitrate and sulfate concentrations occur within the Foothill Groundwater Basin. High concentrations of calcium, magnesium, bicarbonate, and sulfate occur in localized areas of the Santa Barbara Groundwater Basin. High concentrations of iron and manganese occur in localized areas of the Montecito Groundwater Basin. Localized areas with high nitrates occur within the Carpinteria Groundwater Basin. Other basins are in equilibrium due to management of the basin through conjunctive use by local water districts (Santa Barbara County 2007). The Goleta Groundwater Basin generally is near or above historical groundwater conditions (Goleta Groundwater Basin and La Cumbre Mutual Water Company 2010), with the northern and western portions of the basin having groundwater levels near the ground surface. High groundwater levels may result in degradation to building foundations and agricultural crops (water levels within the crop root zone).

The Goleta Groundwater Basin was designated by the CASGEM program as medium priority. Goleta, Foothill, Santa Barbara, Montecito, and Carpinteria groundwater basins were designated as very low priority.

7.3.5.2 Groundwater Use and Management

Groundwater is an important source of water supply for the population of the Central Coast; it is the region's primary water source.

7.3.5.2.1 Morro Valley and Chorro Valley Groundwater Basins

As described in Chapter 5, Surface Water Resources and Water Supplies, the City of Morro Bay uses groundwater from Morro Valley and Chorro Valley groundwater basins. These basins have been designated by the State Water Resources Control Board as riparian underflow basins. The City of Morro Bay and other users of these basins have received water rights permits which limits the rate and volume of groundwater withdrawals (Morro Bay 2011).

7.3.5.2.2 Santa Maria River Valley Groundwater Basin

The Santa Maria River Valley Groundwater Basin is the primary water supply for irrigation in southwestern San Luis Obispo County and northwestern Santa Barbara County. Groundwater also is a major portion of the water supplies for the communities of Pismo Beach, Grover Beach, Arroyo Grande, Oceano, Nipomo, and several smaller communities in San Luis Obispo County; and Guadalupe, Santa Maria, and Orcutt in Santa Barbara County (City of Grover Beach 2011). In many cases, groundwater is the total water supply for these communities including Nipomo Community Services District (NCSD 2011).

The groundwater basin was adjudicated as defined by a settlement agreement, or stipulation, in 2005 that was filed in 2008. The stipulation defined the safe yield of the basin and measures to protect groundwater supplies (Pismo Beach 2011, Arroyo Grande 2012, NCSD 2011, Santa Maria 2011). The stipulation provided for the Northern Cities Management Area, Nipomo Mesa Management Area, and Santa Maria Valley Management Area. The groundwater adjudication considers groundwater recharge from precipitation and applied irrigation water; and water released from Reclamation's Twitchell Reservoir and San Luis Obispo Flood Control and Water Conservation District's Lopez Reservoir that recharge the basin from the downstream stream beds.

The cities of Pismo Beach, Grover Beach, Arroyo Grande; Oceano Community Services District; San Luis Obispo County; and San Luis Obispo Flood Control and Water Conservation District have formed the Northern Cities Management Area to manage and protect groundwater supplies in accordance with the adjudication stipulation (Pismo Beach 2011, Arroyo Grande 2012, NCSD 2011). Historical monitoring reporting indicates that the groundwater levels have varied from 20 feet above to 20 feet below mean sea level. When groundwater levels are below mean sea level, there is a potential for sea water intrusion. In 2008, groundwater levels in this area were approximately 10 feet below mean sea level. In 2010, groundwater levels had recovered and ranged from 0 to 20 feet above mean sea level. Overdraft conditions occurred more frequently prior to the groundwater adjudication and completion of the Central Coast Water Authority project that provides SWP water supplies to the area. There is a deep aquifer under the City of Arroyo Grande (Pismo Formation) that provides groundwater not addressed in the adjudicated Santa Maria Groundwater Basin.

Agricultural water users and the communities of Guadalupe, Orcutt, and Santa Maria use groundwater in the Santa Maria Valley Management Area of the Santa Maria Groundwater Basin (SMVMA 2012). Historically, groundwater was used to provide almost 50 percent of the water supply to the City of Santa Maria. Recently, groundwater supplies have become 10 to 20 percent of the total water supply to the city (Santa Maria 2011). Groundwater provides most of the water supplies in Orcutt (Golden State Water Company 2011a).

7.3.5.2.3 San Antonio Creek Valley Groundwater Basin

Groundwater is used for agricultural and domestic water supplies in the San Antonio Creek Valley Groundwater Basin, including the Los Alamos area (DWR 2004dq, 2013e).

7.3.5.2.4 Santa Ynez River Valley Groundwater Basin

Groundwater is used for agricultural and domestic water supplies in the Santa Ynez River Valley Groundwater Basin. As described in Chapter 5, Surface Water Resources and Water Supplies, groundwater is used by all agricultural water users and the communities of Buellton, Lompoc, Solvang, Mission Hills, Vandenberg Village, and Santa Ynez (DWR 2004am, 2013e; Santa Barbara County 2007).

7.3.5.2.5 Goleta, Foothill, Santa Barbara, Montecito, and Carpinteria Groundwater Basins

Groundwater is used agricultural and domestic water supplies in the Goleta, Foothill, Santa Barbara, Montecito, and Carpinteria groundwater basins within Santa Barbara County. Goleta Water District and La Cumbre Mutual Water Company are the major communities that use groundwater in the Goleta Groundwater Basin (DWR 2004an; GWD 2011; GWD and LCMWC 2010). This basin is operated under an adjudication settlement in 1989 and a voter-passed groundwater management plan. Historically, Goleta Water District provided up to 14 percent of the water supply by groundwater. As described in Chapter 5, Surface Water Resources and Water Supplies, Goleta Water District has increased use of surface water from Lake Cachuma and the SWP; and decreased long-term average use of groundwater to about 5 percent of the total water supply.

Portions of the La Cumbre Mutual Water Company and City of Santa Barbara use groundwater from the Foothill Groundwater Basin. The City of Santa Barbara also relies upon groundwater from the Santa Barbara Groundwater Basin. The City of Santa Barbara manages groundwater in accordance with the Pueblo Water Rights (Santa Barbara 2011).

Montecito Water District uses groundwater from the Montecito Groundwater Basin. Carpinteria Valley Water District uses groundwater from the Carpinteria Groundwater Basin (Carpinteria Valley WD 2011). Total groundwater pumping averages approximately 3,700 acre-feet per year.

7.3.6 Southern California Region

The Southern California Region includes portions of Ventura, Los Angeles, Orange, San Diego, Riverside, and San Bernardino counties served by the SWP. The Southern California Region groundwater basins are as varied as the geology that occurs in different geographic portions of the region. Therefore, the following discussions are organized in the following subregions.

- Ventura County and northwestern Los Angeles County
- Central and southern Los Angeles County and Orange County
- Western San Diego County
- Western and central Riverside County and southern San Bernardino County
- Antelope Valley and Mojave Valley

7.3.6.1 Western Ventura County and Northwestern Los Angeles County

The areas within the SWP service area in Ventura County and northwestern Los Angeles County in the Southern California Region include the Acton Valley Groundwater Basin in Los Angeles County; Santa Clara River Valley, Thousand Oaks Area, and Russell Valley groundwater basins in Ventura and Los Angeles counties; and Simi Valley, Las Posas Valley, Pleasant Valley, Arroyo Santa Rosa Valley, Tierre Rejada, and Conejo Valley groundwater basins in Ventura County, as shown in Figure 7.10.

7.3.6.1.1 Hydrogeology and Groundwater Conditions

Acton Valley Groundwater Basin

The Acton Valley Groundwater Basin is located upgradient of the Santa Clara River Valley Groundwater Basin and drains towards the Santa Clara River. Water bearing formations include unconsolidated alluvium of sand, gravel, silt, and clay with cobbles and boulders; and poorly consolidated terraced deposits (DWR 2004as; 2013f). Recharge occurs along the streambed, water applied to the soils, and subsurface inflow. Groundwater is characterized by calcium, magnesium, and sulfate bicarbonate with localized areas of high concentrations of TDS, sulfate, nitrate, and chlorides.

Acton Valley Groundwater Basin was designated by the CASGEM program as very low priority.

Santa Clara River Valley Groundwater Basin

The Santa Clara River Valley Groundwater Basin is the source of local groundwater along the Santa Clara River watershed from the Santa Clarita Valley in northwestern Los Angeles County to the Pacific Ocean near the City of Oxnard in Ventura County. The Santa Clara River Valley Groundwater Basin includes the Piru, Fillmore, Santa Paula, Mound, and Oxnard subbasins in Ventura county; and Santa Clara River Valley East Subbasin in Los Angeles County. Groundwater movement is effected by the occurrence of several fault zones (DWR 2004at, 2004au, 2006s, 2006t, 2006u, 2013f). Groundwater recharge occurs along the Santa Clara River and its tributaries, and by percolation of precipitation and applied irrigation water.

The Santa Clara River Valley East Subbasin is characterized by unconsolidated alluvium of sand, gravel, silt, and clay; poorly consolidated terrace deposits of gravel, sand, and silt; and the Saugus Formation of poorly consolidated sandstone, siltstone, and conglomerate (DWR 2006s, 2013f).

The Piru, Fillmore, Santa Paula, Mound, and Oxnard subbasins are characterized by alluvium of silts and clays interbedded with sand and gravel lenses; and the San Pedro Formation of fine sands and gravels over the alluvium (DWR 2004at, 2004au, 2006t, 2006u, 2006v, 2013f).

Groundwater quality in the Santa Clara River Valley Groundwater Basin is suitable for a variety of beneficial uses. However, some areas have been impaired by elevated TDS, nitrate, and boron concentrations (DWR 2004at, 2004au, 2006t, 2006u, 2006v, 2013f; CLWA et al. 2012). Groundwater quality is characterized by fluctuating salinity that increases during dry periods. Localized areas of high nitrates and organic compounds occur due to historic agricultural activities and wastewater disposal.

The Piru, Oxnard, and Santa Clara River Valley East subbasins were designated by the CASGEM program as high priority. The Fillmore, Santa Paula, and Mound subbasins were designated as medium priority.

Simi Valley Groundwater Basin

The Simi Valley Groundwater Basin is located in Ventura County (DWR 2004av, 2013f). Water bearing formations in this basin are characterized by generally unconfined alluvium of gravel, clays, and sands; with local clay lenses that provide confined aquifers. The Simi Fault confines the basin on the northern boundary. Groundwater recharge occurs along stream beds. Groundwater quality is characterized as calcium sulfate with localized areas of high TDS and organic contaminants.

Simi Valley Groundwater Basin was designated by the CASGEM program as low priority.

Las Posas Valley and Pleasant Valley Groundwater Basins

The Las Posas Valley and Pleasant Valley groundwater basins are located in western Ventura County. Groundwater is found within these basins in thick alluvium that is dominated by sand and gravel in the eastern part of the Las Posas Valley Groundwater Basin; and by silts and clays with lenses of sands and gravels in the western part of the Las Posas Valley Groundwater Basin and the Pleasant Valley Groundwater Basin (DWR 2006w, 2006x, 2013f). Underlying the alluvium are the San Pedro and Santa Barbara formations of gravels, sands, silts and clays with a discontinuous aquitard located within the Santa Barbara Formation. The movement of groundwater is locally influenced by features such as faults, structural depressions and constrictions and operating production wells; however, groundwater generally flows west-southwest toward the Oxnard Subbasin. Hydrographs from the Las Posas Valley and Pleasant Valley

Groundwater Basins have exhibited a variety of groundwater-level histories over the past couple decades. Most hydrographs in the eastern part of the Las Posas Valley Groundwater Basin indicate relatively unchanged groundwater levels or a slight rise since 1994. Most hydrographs in the western Las Posas Valley and Pleasant Valley groundwater basins indicate that groundwater levels have risen to and been maintained at moderate levels since 1992.

Groundwater quality in the Las Posas Valley and Pleasant Valley groundwater basins is suitable for a variety of beneficial uses. Moderate to high TDS concentrations occur in the Las Posas Valley Groundwater Basin and the Pleasant Valley Groundwater Basin (DWR 2006w, 2006x, 2013f).

The Las Posas Valley and Pleasant Valley groundwater basins were designated by the CASGEM program as high priority.

Arroyo Santa Rosa Valley Groundwater Basin

The Arroyo Santa Rosa Valley Groundwater Basin is located within Ventura County. The water bearing formations include alluvium of gravel, sand, and clay; and the alluvial San Pedro Formation of sand and gravel (DWR 2006y, 2013f). Groundwater recharge occurs along the Santa Clara River and the tributaries, and by percolation of precipitation and applied irrigation water. Fault zones affect groundwater movement within the basin. Groundwater quality is adequate for community and agricultural water uses. Localized areas of high sulfate and nitrate concentrations occur within the basin.

Arroyo Santa Rosa Valley Groundwater Basin was designated by the CASGEM program as medium priority.

Tierra Rejada Valley, Conejo Valley, and Thousand Oaks Area Groundwater Basins

The Tierra Rejada Valley, Conejo Valley, and Thousand Oaks groundwater basins in southern Ventura County are characterized by shallow alluvium that overlays marine sandstone and shale of the Modelo and Topanga formations (DWR 2004aw, 2004ax, 2004ay, 2013f). In some portions of the basin, the Topanga Formation of volcanic tuff, debris flow, and basaltic flow occurs. Groundwater recharge occurs along the streambeds and by percolation of precipitation and applied irrigation water. Fault zones affect groundwater movement within the basins. Groundwater quality is adequate for community and agricultural water uses. Localized areas of high alkalinity and nitrate concentrations occur within the basins. High iron and TDS occur in the Thousand Oaks Area Groundwater Basin (Thousand Oaks 2011).

Conejo Valley Groundwater Basin was designated by the CASGEM program as low priority. The Tierra Rejada Valley and Thousand Oaks Area groundwater basin were designated as very low priority.

Russell Valley Groundwater Basin

The Russell Valley Groundwater Basin is located along the boundaries of Ventura and Los Angeles counties (DWR 2004az, 2013f). This small groundwater basin is characterized by unconsolidated, poorly bedded, sand, gravel, silt, and clay with cobbles and boulders. The groundwater is recharged by precipitation within the basin. Groundwater quality is characterized by sodium bicarbonate and calcium bicarbonate with high sulfates and TDS in some localized areas.

Russell Valley Groundwater Basin was designated by the CASGEM program as very low priority.

7.3.6.1.2 Groundwater Use and Management

Groundwater is an important water supply throughout the Southern California Region. Many of the basins have been adjudicated and groundwater management agencies have been established to manage, preserve, and regulate groundwater withdrawals and recharge actions. In Ventura County, the Fox Canyon Groundwater Management Agency was established in 1982 to implement a groundwater plan that identifies withdrawal allocations and groundwater elevation and quality criteria (MWDSC 2007).

Acton Valley Groundwater Basin

As described in Chapter 5, Surface Water Resources and Water Supplies, the Acton community primarily uses groundwater supplemented by SWP water treated at the Antelope Valley East Kern Acton Water Treatment Plant (Los Angeles County 2014b).

Santa Clara River Valley Groundwater Basin

Communities and agricultural water users in the Santa Clara River Valley Groundwater Basin use a combination of surface water and groundwater to meet water demands. Agricultural use of groundwater is greater than community use of groundwater in this basin (UCWD 2012).

Four retail water purveyors provide water service to most residents of the Santa Clara River Valley East Subbasin. These water purveyors include the Castaic Lake Water Agency; Santa Clarita Water Division, Los Angeles County Waterworks District Number 36; Newhall County Water District; and Valencia Water Company. Groundwater is used by the communities of Santa Clarita, Saugus, Canyon Country, Newhall, Val Verde, Hasley Canyon, Valencia, Castaic, Stevenson Ranch (CLWA et al. 2012).

Water purveyors in the Piru, Fillmore, Santa Paula, Mound, and Oxnard subbasins include United Water Conservation District and Ventura County. United Water Conservation District operates surface water facilities to encourage groundwater protection through conjunctive use (UWCD 2012). Groundwater issues within the United Water Conservation District service area (which includes all of the basin) include overdraft conditions, sea water intrusion, and high nitrate concentrations.

Simi Valley Groundwater Basin

The Simi Valley area primarily relies upon surface water supplies, including SWP water supplies. Groundwater is used to supplement these supplies and by users that cannot be easily served with surface water. Groundwater is provided by Golden State Water Company service area and Ventura County Waterworks

District No. 8. The Golden State Water Company provides less 10 percent of the total water supply to the area (Golden State Water Company 2011b). Ventura County Waterworks District No. 8 provides groundwater to a golf course, nursery, and industrial user in the Simi Valley area (VCWD8 2011).

Las Posas Valley and Pleasant Valley Groundwater Basins

Communities and agricultural water users in the Las Posas Valley and Pleasant Valley groundwater basins use a combination of surface water and groundwater to meet water demands. Agricultural use of groundwater is greater than community use of groundwater in this basin (UCWD 2012). United Water Conservation District and Ventura County manage water service to many residents of the Las Posas Valley and Pleasant Valley groundwater basins.

As described above, United Water Conservation District operates surface water facilities to encourage groundwater protection through conjunctive use (UWCD 2012). Groundwater is used within the United Water Conservation District service area, which includes western Las Posas Valley and Pleasant Valley groundwater basins. The Oxnard Subbasin of the Santa Clara River Valley Groundwater Basin and Las Posas Valley and Pleasant Valley groundwater basins are within the groundwater management plan established by the Fox Canyon Groundwater Management Agency (Fox Canyon GMA 2013). The groundwater management agency manages and monitors groundwater in areas with groundwater overdraft and seawater intrusion which includes the communities of Port Hueneme, Oxnard, Camarillo, and Moorpark. The long-term average groundwater use within Fox Canyon Groundwater Management Agency includes a portion of the withdrawals reported by United Water Conservation District.

The Calleguas Municipal Water District, in partnership with Metropolitan Water District of Southern California (Metropolitan), operates the Las Posas Basin Aquifer Recharge and Recovery project. Calleguas Municipal Water District stores SWP surplus water in the Las Posas Valley Groundwater Basin, near the City of Moorpark. The current Aquifer Recharge and Recovery system includes 18 wells (Calleguas MWD 2011).

Arroyo Santa Rosa Valley Groundwater Basin

Communities and agricultural water users in the Arroyo Santa Rosa Valley Groundwater Basin use a combination of surface water and groundwater to meet water demands. Camarosa Water District and Fox Canyon Groundwater Management Agency manage groundwater supplies within the basin (Camarosa WD 2013).

Tierra Rejada Valley, Conejo Valley, and Thousand Oaks Area Groundwater Basins

Groundwater in the Tierra Rejada Valley, Conejo Valley, and Thousand Oaks Area groundwater basins is primarily used by agricultural and individual residential water users. Portions of the Tierra Rejada Valley Groundwater Basin is within the Camarosa Water District; however, this area is primarily open space and agricultural land uses with individual wells (Camarosa WD 2013). The City of Thousand Oaks does operate two wells; however, the city primarily relies upon SWP water supplies because of the high iron concentrations and salinity in the groundwater (Thousand Oaks 2011).

Russell Valley Groundwater Basin

Most groundwater users in the Russell Valley Groundwater Basin are agricultural and individual residential water users. Portions of the basin are located within the Calleguas Municipal Water District. However, the district does not use water from this basin (Calleguas MWD 2011). The Las Virgenes Municipal Water District withdraws groundwater from the Russell Basin to augment recycled water supplies (GLCIRWMR 2014).

7.3.6.2 Western Los Angeles County and Orange County

The areas within the SWP service area in Central and Southern Los Angeles County and Orange County in the Southern California Region include the San Fernando Valley, Raymond, San Gabriel Valley, Coastal Plain of Los Angeles, and Malibu Valley groundwater basins in Los Angeles County; Coastal Plain of Orange County and San Juan Valley groundwater basins in Orange County, as shown in Figure 7.10.

7.3.6.2.1 Hydrogeology and Groundwater Conditions

San Fernando Valley Groundwater Basin

The San Fernando Valley Groundwater Basin extends under the Los Angeles River watershed. Groundwater flows toward the middle of the basin, beneath the Los Angeles River Narrows, to the Central Subbasin of the Coastal Plain of Los Angeles Basin. The water bearing formation is mainly unconfined gravel and sand with clay lenses that provide some confinement in the western part of the basin (DWR 2004ba).

Groundwater movement is affected by the occurrence of several fault zones (DWR 2004ba). Groundwater is recharged naturally from precipitation and stream flow and from imported water and reclaimed wastewater that percolates into the groundwater from stormwater spreading grounds.

In the San Fernando Valley Groundwater Basin, the groundwater is characterized by calcium, magnesium, radioactive material, and sulfate bicarbonate with localized areas of high TDS, volatile organic compounds, petroleum compounds, chloroform, pesticides, nitrate, and sulfate (DWR 2004ba, ULARAW 2013). There are several ongoing groundwater remediation programs within the groundwater basin to reduce volatile organic compounds and one program to reduce hexavalent chromium.

San Fernando Valley Groundwater Basin was designated by the CASGEM program as medium priority.

Raymond Groundwater Basin

The Raymond Groundwater Basin is located to the north of the San Gabriel Valley Groundwater Basin. Groundwater flow is affected by the occurrence of several fault zones; and causes the groundwater to flow into the San Gabriel

Valley Groundwater Basin. The water bearing formations are mainly unconsolidated gravel, sand, and silt with local areas of confinement (DWR 2004bb). Groundwater is recharged naturally from precipitation and stream flow and from water that percolates into the groundwater from spreading grounds and local dams.

In the Raymond Groundwater Basin, the groundwater is characterized by calcium, magnesium, and sulfate bicarbonate with localized areas of high volatile organic compounds, nitrate, radioactive material, and perchlorate (DWR 2004bb). There is an ongoing groundwater remediation program within the groundwater basin to reduce volatile organic compounds and perchlorate.

Raymond Groundwater Basin was designated by the CASGEM program as medium priority.

San Gabriel Valley Groundwater Basin

Groundwater in the San Gabriel Valley Groundwater Basin flows from the San Gabriel Mountains towards the west under the San Gabriel Valley to the Whittier Narrows where it discharges into the Coastal Plain of the Los Angeles Groundwater Basin (DWR 2004bc). Groundwater in the San Gabriel Valley Groundwater Basin also is interconnected to groundwater in the Chino subbasin of the Upper Santa Ana Valley Groundwater Basin in Riverside County. The northeastern portion of the San Gabriel Valley Groundwater Basin adjacent to the Chino subbasin includes six subbasins and is known as “Six Basins.” The water-bearing formations include unconsolidated to semi-consolidated alluvium deposits of gravel, sands, and silts.

Groundwater recharge occurs from direct percolation of precipitation and stream flow, including treated wastewater effluent conveyed in the San Gabriel River (DWR 2004bc). In the San Gabriel Valley Groundwater Basin, the groundwater is characterized by calcium bicarbonate with localized areas of high TDS, carbon tetrachloride nitrate, and volatile organic compounds (DWR 2004bc).

San Gabriel Valley Groundwater Basin was designated by the CASGEM program as high priority.

Coastal Plain of Los Angeles Groundwater Basin

The Coastal Plain of Los Angeles Groundwater Basin includes the Hollywood, Santa Monica, Central, and West Coast subbasins.

Hollywood Subbasin

The Hollywood subbasin is located to the north of the Central subbasin and upgradient of the Santa Monica subbasin. Groundwater flows towards the Pacific Ocean (DWR 2004bd). The water bearing formations are mainly alluvial gravel. Groundwater is recharged naturally from precipitation and stream flow.

The Hollywood subbasin was designated by the CASGEM program as very low priority.

Santa Monica Subbasin

The Santa Monica subbasin is located to the north of the West Coast subbasin and to the west of the Hollywood subbasin. Groundwater flows towards the west and the Hollywood subbasin (DWR 2004be). The water bearing formations are mainly alluvial gravel and sand with semi-perched areas over silt and clay deposits. Unconfined shallow aquifers occur in the northern and eastern portions of the subbasin. Confined deeper aquifers occur in the remaining portion of the subbasin. Groundwater is recharged naturally from precipitation and stream flow.

The Santa Monica subbasin was designated by the CASGEM program as high priority.

Central Subbasin

The Central subbasin is located to the east of the West Coast subbasin. The Central subbasin is characterized by shallow sediments and extends from the Los Angeles River Narrows with groundwater flows from the San Gabriel Valley (DWR 2004bf).

The non-pressurized, or forebay, portions of the subbasin are located in the northern portion of the subbasin in unconfined aquifers underlying the Los Angeles and San Gabriel rivers (DWR 2004bf). These areas provide the major recharge areas for the subbasin. The "pressure" areas are confined aquifers composed of permeable sands and gravel separated by less permeable sandy clay and clay, and constitute the main water-bearing formations. Several faults and uplifts create some restrictions to groundwater flow in the subbasin while others run parallel to the groundwater flow and do not restrict flow.

In the Central subbasin, the groundwater is characterized by localized areas of high inorganics and volatile organic compounds (DWR 2004bf).

The Central subbasin was designated by the CASGEM program as high priority.

West Coast Subbasin

The West Coast subbasin is located on the southern coast of Los Angeles County to the west of the Central subbasin. The water bearing formations are composed of unconfined and semi-confined aquifers composed of sands, silts, clays, and gravels (DWR 2004bg). Several fault zones paralleling the coast act as partial barriers to groundwater flow in certain areas. The general regional groundwater flow pattern is southward and westward toward the Pacific Ocean. Recharge occurs through groundwater flow from the Central subbasin, and from infiltration along the Los Angeles and San Gabriel rivers. Seawater intrusion occurs along the Pacific Ocean coast.

In the West Coast subbasin, the most critical issue is high TDS along the Pacific Ocean coast due to seawater intrusion. As described below, several agencies have implemented sea water barrier projects to protect the groundwater quality.

The West Coast subbasin was designated by the CASGEM program as high priority.

Malibu Valley Groundwater Basin

The Malibu Valley Groundwater Basin is an isolated alluvial basin in northern Los Angeles County along the Pacific Ocean Coast under the Malibu Creek watershed (DWR 2004bh). Groundwater flows towards the Pacific Ocean. The water bearing formations are mainly gravel, sand, clays, and silt (DWR 2004bb). Groundwater is recharged naturally from precipitation and stream flow.

In the Malibu Valley Groundwater Basin, the groundwater is characterized by localized areas of high TDS due to sea water intrusion along the Pacific Ocean coast (DWR 2004bh).

The Malibu Valley Groundwater Basin was designated by the CASGEM program as very low priority.

Coastal Plain of Orange County Groundwater Basin

The Coastal Plain of Orange County Groundwater Basin is located under a coastal alluvial plain in northern Orange County (DWR 2004 bi). Groundwater is recharged naturally from precipitation and injection wells to reduce seawater intrusion. The water bearing formations are mainly interbedded marine and continental sand, silt, and clay deposits (DWR 2004bi). The Newport-Inglewood fault zone parallels the coast and generally forms a barrier to groundwater flow. Groundwater recharge occurs along the Santa Ana River. Water levels are characterized by seasonal fluctuations (DWR 2013f; Orange County 2009). Groundwater flowed towards the Pacific Ocean prior to recent development. However, due to extensive groundwater withdrawals, there are groundwater depressions that result in potential sea water intrusion. Groundwater levels have increased since the 1990s following implementation of several recharge programs.

In the Coastal Plain of Orange County Groundwater Basin, the groundwater is characterized as sodium-calcium bicarbonate with localized areas of high TDS due to sea water intrusion along the Pacific Ocean coast, as well as nitrate, and volatile organic compounds (DWR 2004bi).

The Coastal Plain of Orange County Groundwater Basin was designated by the CASGEM program as medium priority.

San Juan Valley Groundwater Basin

The San Juan Valley Groundwater Basin is located in southern Orange County (DWR 2004bj). Groundwater flows towards the Pacific Ocean. The water bearing formations are mainly sand, clays, and silt. Groundwater is recharged naturally from precipitation and stream flows from San Juan and Oso creeks and Arroyo Trabuca.

In the San Juan Valley Groundwater Basin, the groundwater is characterized as calcium bicarbonate, bicarbonate-sulfate, calcium-sodium sulfate, and sulfate-chloride with localized areas of high TDS due to sea water intrusion along the Pacific Ocean coast and high fluoride near hot springs near Thermal Canyon (DWR 2004bj).

The San Juan Valley Groundwater Basin was designated by the CASGEM program as low priority.

7.3.6.2.2 Groundwater Use and Management

Groundwater is an important water supply throughout the Southern California Region. Many of the groundwater basins in Los Angeles and Orange counties have been adjudicated, as summarized in Table 7.1, and groundwater management agencies have been established to manage, preserve, and regulate groundwater withdrawals and recharge actions.

San Fernando Valley Groundwater Basin

The communities and agricultural users in the San Fernando Valley Groundwater Basin use a combination of surface water and groundwater to meet water demands (GLCIRWMR 2014; ULARAW 2013). The Metropolitan Water District of Southern California provides wholesale surface water supplies to several communities. The cities of Los Angeles, Glendale, Burbank, San Fernando, Crescenta Valley, Bell Canyon, and Hidden Hills provide retail water supplies, including groundwater, to the communities. The groundwater basin has been adjudicated and is managed by the Upper Los Angeles River Area Watermaster.

Groundwater is recharged in the San Fernando Valley Groundwater Basin through seepage of precipitation within the groundwater basin, including the recharge of stormwater at spreading grounds between 1968 and 2012; and storage of imported water (ULARAW 2013). The spreading basins for stormwater flows are operated by Los Angeles County and the cities of Los Angeles and Burbank. A portion of the extracted groundwater is exported to areas that overly other groundwater basins.

The operations of the San Fernando Valley Groundwater Basin are defined by the Upper Los Angeles River Area January 26, 1979 Final Judgment; the Sylmar Basin Stipulations of August 26, 1983; and subsequent agreements. These agreements, as managed by the Upper Los Angeles River Area Watermaster, provide for the right to extract a percent of surface water, including applied recycled water, that enters within specified subbasins of the San Fernando Valley Groundwater Basin with specific calculations to identify maximum withdrawals for the cities of Burbank, Glendale, Los Angeles, and San Fernando and Crescenta Valley Water District; the right to store and withdraw water within specified subbasins by the cities of Burbank, Glendale, Los Angeles, and San Fernando; and the acknowledgment that the City of Los Angeles has an exclusive Pueblo Water Right for the native safe yield of the San Fernando subbasin within the larger San Fernando Valley Groundwater Basin.

Raymond Groundwater Basin

The communities in the Raymond Groundwater Basin use a combination of surface water and groundwater to meet water demands (GLCIRWMR 2014). The Metropolitan Water District of Southern California and Foothills Municipal Water District provide wholesale surface water supplies to several communities. The cities of Alhambra, Arcadia, Pasadena, San Marino, and Sierra Madre; Upper San

Gabriel Municipal Water District; and Valley Water Company and several other private water companies, provide retail water supplies, including groundwater, to the communities to Altadena, Las Crescenta-Montrose, La Cañada Flintridge, Rubio Canyon, and South Pasadena. The City of Alhambra and San Gabriel Valley Municipal Water District; can withdraw groundwater from the Raymond Basin, but currently are not operating wells within this groundwater basin (City of Alhambra 2011).

The groundwater basin was the first adjudicated groundwater basin in California and is managed by the Raymond Basin Management Board as the Watermaster (RBMB 2014). The Raymond Basin Management Board limits the amount of groundwater withdrawals in different areas of the basin, and allows for short-term and long-term storage of water in the groundwater basin.

Groundwater is recharged in the Raymond Groundwater Basin through seepage of precipitation within the groundwater basin, injection wells, and spreading basins operated by Los Angeles County and the cities of Pasadena and Sierra Madre (MWDSC 2007). Water from Metropolitan Water District of Southern California, which is generally a combination of SWP water and Colorado River water, cannot be used for direct recharge if the TDS is greater than 450 milligrams/liter (RBMB 2014). A portion of the extracted groundwater is exported to areas that overly other groundwater basins.

San Gabriel Valley Groundwater Basin

The communities in the San Gabriel Valley Groundwater Basin use a combination of surface water and groundwater to meet water demands (GLCIRWMR 2014; MWDSC 2007). The Metropolitan Water District of Southern California, San Gabriel Valley Municipal Water District, Upper San Gabriel Municipal Water District; Three Valleys Municipal Water District, and Covina Irrigating Company provide wholesale surface water and/or groundwater supplies to several communities. The cities of Alhambra, Arcadia, Azusa, Covina, El Monte, Glendora, La Verne, Monrovia, Pomona, San Marino, and Upland; San Gabriel County Water District and Valley County Water District; Golden State Water Company, San Antonio Water Company, San Gabriel Valley Water Company, Suburban Water Systems, Valencia Heights Water Company, and several other private water companies, provide retail water supplies, including groundwater, to users within their communities and to the communities of Baldwin Park, Bradbury, Claremont, Duarte, Hacienda Heights, Irwindale, La Puente, Montebello, Monterey Park, Pico Rivera, Rosemead, San Dimas, San Gabriel, Santa Fe Springs, Sierra Madre, South El Monte, South San Gabriel, Temple City, Valinda, and Whittier (City of Alhambra 2011; City of Arcadia 2011; City of La Verne 2011; City of Pomona 2011; City of Upland 2011; Golden State Water Company 2011c; SGCWD 2011; SGVWC 2011; Suburban Water Systems 2011; SAWCO 2011; TVMWD 2011; USGVMWD 2011).

The San Gabriel Valley Groundwater Basin includes several adjudicated basins. A portion of the groundwater basin is managed by the San Gabriel River Watermaster and the Main San Gabriel Basin Watermaster (MWDSC 2007; SGVWC 2011). The Watermasters coordinate groundwater elevation and water quality monitoring, coordinate imported water supplies, coordinate recharge operations with imported water and recycled water, manage the amount of groundwater withdrawals in different areas of the basin by balancing the amount of groundwater recharge, and allow for short-term and long-term storage of water in the groundwater basin. Groundwater is recharged through seepage of precipitation within the groundwater basin, injection wells, and spreading basins operated by Los Angeles County and a private water company (MWDSC 2007). Water recharged into the spreading basins from Metropolitan Water District of Southern California and San Gabriel Valley Municipal Water District.

The Six Basins portion of the groundwater basin also is adjudicated and managed by the Six Basins Watermaster Board (MWDSC 2007). The Watermaster manages withdrawals and requires replenishment obligation of equal amounts for withdrawals over the operating safe yield of the basin. The Pomona Valley Protective Agency conveys flows from San Antonio Creek and SWP water to the San Antonio Spreading Grounds; and from local waters to the Thompson Creek Spreading Grounds. The City of Pomona conveys flows from local surface waters to the Pomona Spreading Grounds. Los Angeles County Department of Public Works conveys flows from local surface water and SWP water to the Live Oak Spreading Grounds.

The cities of Alhambra, Arcadia, La Verne, Monterey Park, San Gabriel Valley Water Company, and other water entities operate groundwater treatment facilities to remove dichloroethane, chloroform, other volatile organic compounds, and/or nitrates (City of Alhambra 2011; City of Arcadia 2011; City of Monterey Park 2012; MWDSC 2007; SGVWC 2011).

Coastal Plain of Los Angeles Groundwater Basin

The Coastal Plain of Los Angeles Groundwater Basin includes four subbasins: Hollywood, Santa Monica, Central and West Coast.

Hollywood Subbasin

The primary user of groundwater in the Hollywood subbasin is the City of Beverly Hills (MWDSC 2007). The basin is not adjudicated. The city manages the groundwater subbasin through limits on withdrawals and discharges to the groundwater. Groundwater is recharged through seepage of precipitation within the groundwater subbasin (City of Beverly Hills 2011). All groundwater withdrawn by the city is treated to reduce salinity.

Santa Monica Subbasin

The primary user of groundwater in the Santa Monica subbasin is the City of Santa Monica (MWDSC 2007). The basin is not adjudicated. Groundwater is recharged through seepage of precipitation within the groundwater subbasin (City of Santa Monica 2011; MWDSC 2007). Groundwater treatment is provided to a portion of the subbasin withdrawals to reduce volatile organic compounds, and methyl tertiary butyl ether.

Central Subbasin

The communities in the Central subbasin use a combination of surface water and groundwater to meet water demands (GLCIRWMR 2014; MWDSC 2007). The Metropolitan Water District of Southern California and Central Basin Municipal Water District provide wholesale surface water supplies to several communities. The cities of Bell, Bell Gardens, Cerritos, Compton, Cudahy, Downey, Huntington Park, Lakewood, Long Beach, Los Angeles, Lynwood, Monterey Park, Norwalk, Paramount, Pico Rivera, Santa Fe Springs, Signal Hill, South Gate, Vernon, and Whittier; Los Angeles County Water District, La Habra Heights County Water District, Orchard Dale Water District, and Paramount Water District; Golden State Water Company, Suburban Water Systems, Bellflower-Somerset Mutual Water Company, Montebello Land & Water Company; Park Water Company, Dominguez Water Corp, California Water Service Company, San Gabriel Valley Water Company, Walnut Park Mutual Water Company, and several other private water companies, provide retail water supplies, including groundwater, to users within their communities and to the communities of Artesia, Commerce, Dominguez, East La Mirada, East Los Angeles, East Rancho, Florence-Graham, Hawaiian Gardens, La Mirada, Los Nieto, Maywood, Montebello, South Whittier, Walnut Park, Westmount, West Whittier, and Willow Brook (CBMWD 2011; BSMWC 2011; City of Compton 2011; City of Downey 2012; City of Huntington Park 2011; City of Lakewood 2011; City of Long Beach 2011; City of Los Angeles 2011; City of Monterey Park 2012; City of Norwalk 2011; City of Paramount 2011; City of Pico Rivera 2011; City of Santa Fe Springs 2011; City of South Gate; City of Vernon 2011; City of Whittier 2011; LHHCWD 2012; Golden State Water Company 2011d, 2011e, 2011f, 2011g; Suburban Water Systems 2011).

The Central subbasin was adjudicated, and is managed by DWR. The adjudication specifies a total amount of allowed annual withdrawals (or Allowable Pumping Allocation) in the Central subbasin (MWDSC 2007; WRD 2013a). Approximately 25 percent of the water users of groundwater from the Central subbasin are not located on the land that overlies the subbasin (CBMWD 2011). Groundwater from the San Gabriel Valley Groundwater Basin also is used by water users that overlie the Central subbasin.

The Water Replenishment District of Southern California has the statutory authority to replenish the groundwater in the Central and West Coast subbasins of the Coastal Plain of Los Angeles Groundwater Basin. The Water Replenishment District of Southern California purchases water for water replenishment facilities operated by Los Angeles County Department of Public Works at the Montebello Forebay near the Rio Hondo and San Gabriel Rivers near the boundaries of the Central and West Coast subbasins (CBMWD 2011; Los Angeles County 2015; WRD 2013a). The Montebello Forebay includes the Rio Hondo Coastal Basin Spreading Grounds along the Rio Hondo Channel; the San Gabriel River Coastal Basin Spreading Grounds; and the unlined reach of the lower San Gabriel River from Whittier Narrows Dam to Florence Avenue (LACDPW 2014, WRD 2013a).

The replenishment water is purchased water from two different sources: recycled water from various regional treatment facilities, and imported water (WRD 2013a). The recycled water is used for groundwater recharge at the spreading grounds and at the seawater barrier wells. Water Replenishment District of Southern California must blend recycled water with other water sources to meet the groundwater recharge water quality and volumetric requirements established by the State Water Resources Control Board. This blended water is either imported water from the SWP and/or the Colorado River, or untreated surface water flows from the San Gabriel River, Rio Hondo River, and waterways in the San Gabriel Valley (CBMWD 2011). Up to 35 percent of the replenishment water can be provided from recycled water supplies. Several recent projects have been implemented to store stormwater flows for increased replenishment water volumes.

In the Central subbasin, the Water Replenishment District of Southern California also purchases imported and recycled water for injection by the Los Angeles County Department of Public Works into the portion of the Alamitos Barrier Project located in Los Angeles County to reduce seawater intrusion (MWDSC 2007; WRD 2007). Initially, imported SWP water was used to prevent seawater intrusion. However, over the past 20 years, recycled water has been used for a substantial amount of the groundwater injection program. The Water Replenishment District of Southern California is planning to fully use recycled water at the Alamitos Gap Barrier Project by 2014 (WRD 2013b).

The cities of Long Beach, Monterey Park, South Gate, and Whittier operate groundwater treatment facilities in the Central subbasin (City of Long Beach 2012; City of Monterey Park 2012; City of South Gate; City of Whittier 2011).

West Coast Subbasin

The communities in the Central subbasin use a combination of surface water and groundwater to meet water demands (GLCIRWMR 2014; MWDSC 2007). The Metropolitan Water District of Southern California and West Basin Municipal Water District provide wholesale surface water supplies to several communities. The cities of Inglewood, Lomita, Manhattan Beach, and Torrance; Golden State Water Company, California Water Service Company, and several other private water companies, provide retail water supplies, including groundwater, to users within their communities and to the communities of Athens, Carson, Compton, Del Aire, Gardena, Hawthorne, Hermosa Beach, Inglewood, Lawndale, Lennox, Redondo Beach, Torrance (WBMWD 2011a; City of Inglewood 2011; City of Lomita 2011; City of Manhattan Beach 2011; City of Torrance 2011; Golden State Water 2011h; California Water Service Company 2011b, 2011c, 2011d, 2011e). The communities of El Segundo, Long Beach, and Los Angeles overlie the West Coast subbasin; however, no groundwater from this subbasin is used in these communities due to water quality issues and facilities locations. Groundwater use is primarily for emergency uses, including firefighting, in the communities of Hawthorne, Lomita, and Torrance due to high concentrations of minerals (e.g., iron and manganese), sulfides, and/or volatile organic compounds.

The West Coast subbasin was adjudicated, and is managed by DWR. The adjudication specifies a total amount of allowed annual withdrawals (or Allowable Pumping Allocation) in the West Coast subbasin (MWDSC 2007; WBMWD 2011a; WRD 2013a). Groundwater from the Central subbasin is used by some water users that overlie the West Coast subbasin.

The Water Replenishment District of Southern California has the statutory authority to replenish the groundwater in the Central and West Coast subbasins of the Coastal Plain of Los Angeles Groundwater Basin. In the West Coast subbasin, the Water Replenishment District of Southern California purchases imported and recycled water for injection by the Los Angeles County Department of Public Works into the West Coast Barrier Project and the Dominguez Barrier Project (MWDSC 2007; WRD 2007; WRD 2013). Water is purchased by the Water Replenishment District of Southern California for injection at the barrier projects (WRD 2013). Initially, imported SWP water was used to prevent seawater intrusion. However, over the past 20 years, recycled water has been used for a substantial amount of the groundwater injection program. The Water Replenishment District of Southern California is planning to fully use recycled water at the West Coast Barrier Project and the Dominguez Barrier Project by 2014 and 2017, respectively (WRD 2013b).

California Water Service Company operates groundwater treatment facilities within the community of Hawthorne (California Water Service Company 2011b). The Water Replenishment District of Southern California operates the Robert W. Goldsworthy Desalter near Torrance to reduce salinity for up to 18,000 acre-feet/year of groundwater that is located inland of the West Coast Basin Barrier (WRD 2013a).

The West Basin Municipal Water District treats brackish groundwater at the C. Marvin Brewer Desalter Facility for two wells near Torrance that are affected by a saltwater plume in the West Coast subbasin (WBMWD 2011a).

Malibu Valley Groundwater Basin

No groundwater is used by the communities in this groundwater basin, including the Malibu area (Los Angeles County 2011; MWDSC 2007).

Coastal Plain of Orange County Groundwater Basin

The communities in the Coastal Plain of Orange County Groundwater Basin use a combination of surface water and groundwater to meet water demands (MWDSC 2007). The Municipal Water District of Orange County, Orange County Water District, and East Orange County Water District provide wholesale surface water supplies to several communities. The cities of Anaheim, Buena Park, Fountain Valley, Fullerton, Garden Grove, Huntington Beach, La Habra, La Palma, Newport Beach, Orange, Santa Ana, Seal Beach, Tustin, and Westminister; East Orange County Water District, Irvine Ranch Water District, Mesa Consolidated Water District, Rowland Water District, Serrano Water District, Walnut Valley Water District, and Yorba Linda Water District; Golden State Water Company, California Water Service Company, California Domestic Water Company, and several other private water companies, provide retail water supplies, including groundwater, to users within their communities and to the communities of Brea, Costa Mesa, Cypress, Diamond Bar, Garden Grove, Hacienda Heights, Industry, Irvine, La Palma, La Puente, Los Alamitos, Midway City, Newport Beach, Orange, Panorama Heights, Placentia, Pomona, Rowland Heights, Rossmoor, Seal Beach, Stanton, Villa Park, Walnut, West Covina, West Orange, and Yorba Linda (City of Anaheim 2011; City of Brea 2011; City of Buena Park 2011; City of Fountain Valley 2011; City of Fullerton 2011; City of Garden Grove 2011; City of Huntington Beach 2011; City of La Habra 2011; City of La Palma 2011; City of Newport Beach 2011; City of Orange 2011; City of Santa Ana 2011; City of Seal Beach 2011; City of Tustin 2011; City of Westminster 2011; IRWD 2011; MCWD 2011; RWD 2011; SWD 2011; WVWD 2011; YLWD 2011; Golden State Water Company 2011i, 2011j). Groundwater use is primarily for non-potable water uses in West Covina and for supplemental supplies for users of recycled water in Rowland Heights.

The Coastal Plain of Orange County Groundwater Basin is managed by Orange County Water District in accordance with special State legislation to increase supply and provide uniform costs for groundwater (MWDSC 2007). The basin is managed to maintain a water balance over several years using two step pricing levels to incentivize users to obtain alternative water supplies after withdrawing a basin production target. The groundwater basin is managed to provide approximately a three-year drought supply.

Orange County Water District manages an extensive groundwater recharge program in the Coastal Plain of Orange County Basin (Orange County Water District 2014). The Orange County Water District manages spreading basins along the Santa Ana River and Santiago Creek for groundwater recharge (MWDSC 2007). Water is supplied to these basins with flows diverted from the Santa Ana River into the recharge basins at inflatable rubber dams, SWP water, and recycled water from the Orange County Water District/Orange County Sanitation District Groundwater Replenishment System Advanced Water Purification Facility (OCWD n.d.).

The Orange County Water District also injects water into the Talbert Barrier and the portion of the Alamitos Barrier Project within Orange County. Water supplies for the seawater barriers include water from the Groundwater Replenishment System and SWP water (GWRS n.d.; MWDSC 2007).

The Irvine Desalter Project was initiated in 2007 by Orange County Water District, Irvine Ranch Water District, Metropolitan Water District of Orange County, Metropolitan Water District of Southern California, and the U.S. Navy to reduce TDS and salts (IRWD 2011; MWDSC 2007). Several other treatment facilities remove volatile organic compounds. The city of Tustin operates the Tustin Seventeenth Street Desalter to reduce TDS within the Tustin community (MWDSC 2007). The City of Garden Grove and Mesa County Water District operate treatment facilities to reduce nitrates and compounds that change the color of the water, respectively (City of Garden Grove 2011; MCWD 2011).

San Juan Valley Groundwater Basin

The communities in the San Juan Groundwater Basin use a combination of surface water and groundwater to meet water demands (MWDSC 2007). The Municipal Water District of Orange County provides wholesale surface water supplies to several communities. The City of San Juan Capistrano; Moulton Niguel Water District, Santa Margarita Water District, and South Coast Water District provide retail water supplies to users within their communities and to the communities of Coto de Caza, Dana Point, Laguna Forest, Laguna Woods, Las Flores, Ladera Ranch, Mission Viejo, Rancho Santa Margarita, South Laguna, Talega, (City of San Juan Capistrano 2011; MNWD 2011; SCWD 2011; SMWD 2011). Most of the groundwater use occurs within or near the City of San Juan Capistrano. Groundwater use is small or does not occur within the Santa Margarita Water District, South Coast Water District, and Moulton Niguel Water District service areas.

The San Juan Basin Authority manages water resources development in the San Juan Valley Groundwater Basin and in the surrounding San Juan watershed to protect water quality and water resources (MWDSC 2007; SJBA 2013). In addition to community uses, groundwater also is used for agricultural and industrial purposes and golf course irrigation. Overall, groundwater provides less than 10 percent of the total water supply within the groundwater basin.

The City of San Juan Capistrano Groundwater Recovery Plant reduces iron, manganese, and TDS concentrations. This city is modifying the treatment plant to reduce recently observed high concentrations of methyl tertiary butyl ether (MTBE) (City of San Juan Capistrano 2011; MWDSC 2007). The South Coast Water District operates the Capistrano Beach Groundwater Recovery Facility in Dana Point to reduce iron and manganese concentrations (SCWD 2011; MWDSC 2007).

7.3.6.3 Western San Diego County

The areas within the SWP service area in western San Diego County in the Southern California Region include the San Mateo Valley Groundwater Basin in Orange and San Diego counties; and the San Onofre Valley, Santa Margarita Valley, San Luis Rey Valley, Escondido Valley, San Marcos Area, Batiquitos Lagoon Valley, San Elijo Valley, San Dieguito Creek, Poway Valley, San Diego River Valley, El Cajon Valley, Mission Valley, Sweetwater Valley, Otay Valley, Tijuana Basin groundwater basins in San Diego County, as shown in Figure 7.11.

7.3.6.3.1 Hydrogeology and Groundwater Conditions

In San Diego County, several smaller groundwater basins exist, in the western portion of the county. The most productive groundwater basins are characterized by narrow river valleys filled with shallow sand and gravel deposits. Groundwater occurs farther inland in fractured bedrock and semi consolidated sedimentary deposits with limited yield and storage (SDCWA et al. 2013).

San Mateo Valley, San Onofre Valley, and Santa Margarita Valley Groundwater Basins

The San Mateo Valley Groundwater Basin is located in southern Orange County and northern San Diego County (DWR 2004bk). The San Onofre Valley and Santa Margarita Valley groundwater basins are located in northwestern San Diego County (DWR 2004bl, 2004bm). Groundwater flows towards the Pacific Ocean. The water bearing formations are mainly gravel, sand, clays, and silt. Groundwater is recharged naturally from precipitation and stream flows. In the San Mateo Valley and San Onofre Valley groundwater basins, treated wastewater effluent discharged from the Marine Corps Base Camp Pendleton wastewater treatment plants into local streams also recharges the groundwater. In the San Mateo Valley and Santa Margarita Valley groundwater basins, the groundwater is characterized as calcium-sulfate-chloride. In the San Onofre Valley Groundwater Basin, the groundwater is characterized as calcium-sodium bicarbonate-sulfate. Localized areas with high boron, chloride, magnesium, nitrate, sulfate, and TDS occur in the Santa Margarita Valley Groundwater Basin.

Santa Margarita Valley Groundwater Basin was designated by the CASGEM program as medium priority. San Mateo Valley and San Onofre Valley groundwater basins were designated as very low priority.

San Luis Rey Valley Groundwater Basin

The San Luis Rey Valley Groundwater Basin is located in northwestern San Diego County (DWR 2004bn). Groundwater flows towards the Pacific Ocean. The water bearing formations are mainly gravel and sand. Under some portions of the alluvial aquifer, partially consolidated marine terrace deposits of partly consolidated sandstone, mudstone, siltstone, and shale occur. Groundwater is recharged naturally from precipitation and stream flows, and from runoff that flows into the streams from lands irrigated with SWP water. The groundwater is characterized as calcium-sodium bicarbonate-sulfate with localized areas of high magnesium, nitrate, and TDS (MWDSC 2007).

San Luis Rey Valley Groundwater Basin was designated by the CASGEM program as medium priority.

San Marcos Valley, Escondido Valley, San Pasqual Valley, Pamo Valley, Santa Maria Valley, and Poway Valley Groundwater Basins

The San Marcos Valley, Escondido Valley, San Pasqual Valley, Pamo Valley, Santa Maria Valley, and Poway Valley groundwater basins are located in the foothills within central, western San Diego County. The water bearing formations are mainly alluvium of sand, gravel, clay, and silt; consolidated sandstone; or weathered crystalline basement rock (DWR 2004bo, 2004bp, 2004bq, 2004br, 2004bs, 2004bt). The basins area bounded by semi-permeable marine and non-marine deposits and impermeable granitic and metamorphic rocks. Groundwater is recharged naturally from precipitation and stream flows, and from runoff that flows into the streams from irrigated lands. The groundwater is characterized with moderate to high concentrations of salinity. There are localized areas with high sulfate and nitrate concentrations in the Santa Maria Valley Groundwater Basin.

San Pasqual Valley Groundwater Basin was designated by the CASGEM program as medium priority. San Marcos Valley, Escondido Valley, Pamo Valley, Santa Maria, and Poway Valley groundwater basins were designated as very low priority.

Batiquitos Lagoon Valley, San Elijo Valley, and San Dieguito Valley Groundwater Basins

The Batiquitos Lagoon Valley, San Elijo Valley, and San Dieguito Valley groundwater basins are located along the central San Diego County coast of the Pacific Ocean. The water bearing formations are mainly alluvium of sand, gravel, clay, and silt with areas of consolidated sandstone (DWR 2004bu, 2004bv, 2004bw). Some areas of the Batiquitos Lagoon Valley Groundwater Basin are bounded by impermeable crystalline rock. Groundwater is recharged naturally from precipitation and stream flows, and from runoff that flows into the streams from irrigated lands. The groundwater is characterized with moderate to high concentrations of salinity.

Batiquitos Valley, San Elijo Valley, and San Dieguito Valley groundwater basins were designated by the CASGEM program as very low priority.

San Diego River Valley, El Cajon, Mission Valley, Sweetwater Valley, Otay Valley, and Tijuana Groundwater Basins

The San Diego River Valley, El Cajon, Mission Valley, Sweetwater Valley, Otay Valley, and Tijuana groundwater basins are located in the southwestern portion of San Diego County. The water bearing formations are mainly alluvium of sand, gravel, cobble, clay, and silt; or siltstone and sandstone (DWR 2004bx, 2004by, 2004bz, 2004ca, 2004cb, 2004cc). Groundwater is recharged naturally from precipitation and stream flows, and from runoff that flows into the streams from irrigated lands. The groundwater is characterized with moderate to high levels of salinity. A recent study by USGS evaluated the sources and movement of saline groundwater in these groundwater basins (USGS 2013b). The chloride concentrations ranged from 57 to 39,400 mg/L. The sources of salinity were natural geologic sources and sea water intrusion. There are localized areas with high sulfate and magnesium concentrations.

San Diego River Valley Groundwater Basin was designated by the CASGEM program as medium priority. El Cajon, Mission Valley, Sweetwater Valley, Otay Valley, and Tijuana groundwater basins were designated as very low priority.

7.3.6.3.2 Groundwater Use and Management

Groundwater production and use in the San Diego region is currently limited due to a lack of aquifer storage capacity, available recharge, and degraded water quality due to high salinity. Groundwater currently represents about 3 percent of the water supply portfolio within the areas of San Diego County that could be served by SWP water (SDCWA et al. 2013).

San Mateo Valley, San Onofre Valley, and Santa Margarita Valley Groundwater Basins

The primary user of groundwater in the San Mateo Valley, San Onofre Valley, and Santa Margarita Valley groundwater basins is the Marine Corps Base Camp Pendleton (FPUD 2011; MWDSC 2007; SCWD 2011; SDCWA et al. 2013). The Marine Corps Base Camp Pendleton withdraws approximately 8,500 acre-feet/year from the three groundwater basins and operates spreading basins to recharge the groundwater in the Santa Margarita Valley Groundwater Basin. Portions of the South Coast Water District overlie the northern portions of the San Mateo Valley Groundwater Basin; however, the district does not withdraw water from that basin. Fallbrook Public Utility District overlies northern portions of the Santa Margarita Valley Groundwater Basin; however, the district currently uses a small amount of groundwater to meet their water demand (FPUD 2011).

The Santa Margarita Valley Groundwater Basin is within an adjudicated watershed (SMRW 2011). The Santa Margarita River Watermaster manages both surface water and groundwater that contributes direct or indirect flows into the Santa Margarita River in accordance with the Modified Final Judgment and Decrees of 1966 by the U.S. District Court in the *United States v. Fallbrook Public Utility et al*. The watershed includes the Santa Margarita Valley Groundwater Basin near the Pacific Ocean and the Temecula Valley groundwater basins in the upper Santa Margarita River Watershed within Riverside County, as discussed in the following subsection. Within San Diego County, the only groundwater user in the Santa Margarita Valley Groundwater Basin is the Marine Corps Base Camp Pendleton.

San Luis Rey Valley Groundwater Basin

The communities in the San Luis Rey Valley Groundwater Basin use a combination of surface water and groundwater to meet water demands (City of Oceanside 2011; MWDSC 2007; RMWD 2011; VCMWD 2011; YMWD 2014a, 2014b). The San Diego County Water Authority provides wholesale surface water supplies to several communities. The City of Oceanside; Rainbow Municipal Water District, Valley Center Municipal Water District, and Yuima Municipal Water District; and Rancho Pauma Mutual Water Company and several other private water companies provide retail water supplies to users within their communities. Groundwater use is small or does not occur within the Rainbow Municipal Water District or Valley Center Municipal Water District. Groundwater also is used on agricultural lands, especially for orchards in the Pauma area (San Diego County 2010). The Tribal lands also depend upon groundwater including lands within the La Jolla Reservation, Los Coyotes Reservation, Pala Reservation, Pauma & Yuima Reservation, Rincon Reservation, and Santa Ysabel Reservation (SDCWA et al. 2013).

There are three municipal water districts that overlie the San Luis Rey Valley Groundwater Basin that manage water rights protection efforts. Groundwater is the only water supply within the Pauma Municipal Water District and the primary water supplies within the Mootamai Municipal Water District and the San Luis Rey Municipal Water District (SDLAFCO 2011; SDCWA et al. 2013). The districts protect groundwater, surface water rights, and water storage; and to coordinate planning studies and legal activities within the San Luis Rey River watershed. Vista Irrigation District withdraws and stores groundwater in Lake Henshaw and withdraws groundwater in a subbasin located upgradient the San Luis Rey Valley Groundwater Basin.

San Marcos, Escondido Valley, San Pasqual Valley, Pamo Valley, Santa Maria Valley, and Poway Valley Groundwater Basins

The communities in the San Marcos, Escondido Valley, San Pasqual Valley, Pamo Valley, Santa Maria Valley, and Poway Valley groundwater basins use a combination of surface water and groundwater to meet water demands (City of Escondido 2011; City of Poway 2011; Ramona MWD 2011; RDDMWD 2011; VWD 2011). The San Diego County Water Authority provides wholesale surface water supplies to several communities. The cities of Escondido and Poway; Ramona Municipal Water District, Rincon del Diablo Municipal Water District, Vallecitos Water District, and Vista Irrigation District; and private water companies provide retail water supplies to users within their communities. Groundwater use is small or does not occur within the cities of Escondido and Poway, Ramona Municipal Water District, Rincon del Diablo Municipal Water District, and Vallecitos Water District. Ramona Municipal Water District used to use groundwater until high nitrate concentrations required the district to abandon the wells.

Batiquitos Lagoon Valley, San Elijo Valley, and San Dieguito Valley Groundwater Basins

The communities in the Batiquitos Lagoon Valley, San Elijo Valley, and San Dieguito Valley groundwater basins primarily use surface water to meet water demands (CMWD 2011; OMWD 2011; SDLAFCO 2011; SDWD 2011; SFID 2011). The San Diego County Water Authority provides wholesale surface water supplies to several communities. Groundwater use is limited to private wells within the Carlsbad Municipal Water District, including the City of Carlsbad; Olivenhain Municipal Water District, including the cities of Encinitas, Carlsbad, San Diego, Solano Beach, and San Marcos, and the communities of Olivenhain, Leucadia, Elfin Forest, Rancho Santa Fe, Fairbanks Ranch, Santa Fe Valley, and 4S Ranch; San Dieguito Water District, including the communities of Encinitas, Cardiff-by-the-Sea, New Encinitas, and Old Encinitas; and Santa Fe Irrigation District, including the City of Solana Beach and the communities of Rancho Santa Fe and Fairbanks Ranch. Groundwater was used within the Carlsbad Municipal Water District area until high salinity caused the area to abandon the wells. Questhaven Municipal Water District manages groundwater for a recreation community located to the west of Escondido.

San Diego River Valley, El Cajon, Mission Valley, Sweetwater Valley, Otay Valley, and Tijuana Groundwater Basins

The communities in the San Diego River Valley, El Cajon, Mission Valley, Sweetwater Valley, Otay Valley, and Tijuana groundwater basins use a combination of surface water and groundwater to meet water demands (California American Water Company 2012; City of San Diego 2011; HWD 2011; OWD

2011; PDMWD 2011; SDCWA et al. 2013; Sweetwater Authority 2011). The San Diego County Water Authority provides wholesale surface water supplies to several communities. The City of San Diego, Helix Water District, and Sweetwater Authority provide retail surface water and/or groundwater supplies to users within cities of La Mesa, Lemon Grove, National City, and San Diego; portions of Chula Vista and El Cajon; and all or portions of the communities of Bonita, Lakeside, and Spring Valley. The County of San Diego–Campo Water and Sewer Maintenance District, Cuyamaca Water District, Decanso Community Services District, Julian Community Services District, Majestic Pines Community Services District, Wynola Water District, Lake Morena Oak Shores Mutual Water Company, Pine Hills Mutual Water Company, and Pine Valley Mutual Water Company rely upon groundwater to meet their water demands. Groundwater is not used for water supplies within Padre Dam Municipal Water District which serves the City of Santee and portions of the City of El Cajon; Otay Water District which serves portions of the cities of Chula Vista, El Cajon, and La Mesa, and several unincorporated communities; and California American Water which serves the City of Imperial Beach and portions of the cities of Chula Vista, Coronado, and San Diego. Sweetwater Authority operates the Desalination Facility to treat brackish groundwater (San Diego County LAFCO 2011).

7.3.6.4 Western Riverside County and Southwestern San Bernardino County

The areas within the SWP service area in western and central Riverside County and southern San Bernardino County in the Southern California Region include the Upper Santa Ana Valley Groundwater Basin in Riverside and San Bernardino counties; the Elsinore, San Jacinto Groundwater Basin in Riverside County; and the Temecula Valley Groundwater Basin in Riverside and San Diego counties, as shown in Figure 7.12.

7.3.6.4.1 Hydrogeology and Groundwater Conditions

Upper Santa Ana Valley Groundwater Basin

The Upper Santa Ana Valley Groundwater Basin consists of the Cucamonga, Chino, Riverside-Arlington, Temescal, Rialto-Colton, Cajon, Bunker Hill, Yucaipa, and San Timoteo groundwater subbasins.

Cucamonga Subbasin

The Cucamonga subbasin is located within San Bernardino County in the upper Santa Ana River watershed (DWR 2004 cd; MWDSC 2007). Groundwater is contained within the basin by the Red Hill fault. The water bearing formations are mainly alluvium of gravel, sand, and silt with beds of compacted clay. Groundwater is recharged naturally from precipitation and stream flows, water discharged to spreading basins, and runoff that flows into the streams from irrigated lands, including lands irrigated with SWP water. The groundwater is characterized as calcium-sodium bicarbonate with moderate to high TDS and nitrates, and localized areas with high volatile organic compounds, perchlorate, and dibromochloropropane (DBCP) (MWDSC 2007).

The Cucamonga subbasin was designated by the CASGEM program as medium priority.

Chino Subbasin

The Chino subbasin is located in San Bernardino County. The Chino subbasin is composed of alluvial material. The Rialto-Colton, San Jose, and the Cucamonga faults act as groundwater flow barriers (DWR 2006z). Along the southern boundary of the subbasin, groundwater can rise to the elevation of the Santa Ana River and be discharged into the stream. Groundwater is recharged naturally from precipitation and stream flows along the Santa Ana River and its tributaries, water discharged to spreading basins, and runoff that flows into the streams from irrigated lands, including lands irrigated with SWP water.

The Chino subbasin is characterized with high TDS and nitrate concentrations and localized areas of high volatile organic compounds, and perchlorate (MWDSC 2007).

The Chino subbasin was designated by the CASGEM program as high priority.

Riverside-Arlington Subbasin

The Riverside-Arlington subbasin is located within the Santa Ana River Valley in southwestern San Bernardino County and northwestern Riverside County (DWR 2004ce). Water bearing formations include alluvial deposits of sand, gravel, silt, and clay. The Rialto-Colton Fault separates this subbasin from the Rialto-Colton subbasin. The Riverside and Arlington portions of the subbasin are also separated. Groundwater flows to the northwest and to the Arlington Gap in the southwest area of the subbasin; and continues into the Temescal subbasin. Groundwater is recharged naturally from precipitation and stream flows in the Santa Ana River, and flow from adjacent subbasins. The groundwater is characterized as calcium-sodium bicarbonate with moderate to high TDS and nitrates, and localized areas with high volatile organic compounds, perchlorate, and DBCP (MWDSC 2007).

The Riverside-Arlington subbasin was designated by the CASGEM program as high priority.

Temescal Subbasin

The Temescal subbasin is located within the Santa Ana River Valley in Riverside County. Water bearing formations consist of alluvium bounded by the Elsinore fault zone on the west and the Chino fault zone on the northwest (DWR 2006aa). Groundwater is recharged naturally from precipitation and stream flows in the tributaries of the Santa Ana River. The groundwater is characterized as calcium-sodium bicarbonate with moderate to high TDS and nitrates, and localized areas with high volatile organic compounds, perchlorate, iron, and manganese (MWDSC 2007).

The Temescal subbasin was designated by the CASGEM program as medium priority.

Cajon Subbasin

The Cajon subbasin is located within the upper Santa Ana River Valley in San Bernardino County. Water bearing formations consist of alluvium bounded by the San Andreas Fault zone on the south and impermeable rock formations on the east and west (DWR 2004cf). Groundwater is recharged naturally from precipitation, stream flows in the tributaries of the Santa Ana River, and runoff that flows into the streams from irrigated lands, including lands irrigated with SWP water. The groundwater quality is good for the beneficial uses.

The Cajon subbasin was designated by the CASGEM program as very low priority.

Rialto-Colton Subbasin

The Rialto-Colton subbasin is located within the upper Santa Ana River Valley in southwestern San Bernardino County and northwestern Riverside County. Water bearing formations consist of alluvium bounded by the Rialto-Colton and San Jacinto fault zones (DWR 2004cg). Groundwater is recharged naturally from precipitation and stream flows. The groundwater quality is good for the beneficial uses with localized areas of high volatile organic compounds.

The Rialto-Colton subbasin was designated by the CASGEM program as medium priority.

Bunker Hill Subbasin

The Bunker Hill subbasin is located in San Bernardino County. The water bearing formations include alluvium of sand, gravel, and boulders with deposits of silt and clay bounded by the Rialto-Colton and San Jacinto fault zones (DWR 2004ch). Groundwater is recharged naturally from precipitation, stream flows in the Santa Ana River and its tributaries, water discharged to spreading basins, and runoff that flows into the streams from irrigated lands, including lands irrigated with SWP water. The groundwater quality is good for the beneficial uses. The groundwater is characterized as calcium- bicarbonate with localized areas of high volatile organic compounds and perchlorate within several contamination plumes (*Lockheed Martin Corporation v. United States, Civil Action No. 2008-1160*).

The Bunker Hill subbasin was designated by the CASGEM program as high priority.

Yucaipa Subbasin

The Yucaipa subbasin is located within the upper Santa Ana River Valley in San Bernardino County. Water bearing formations include alluvial deposits of sand, gravel, boulders, silt, and clay (DWR 2004ci). Several fault zones restrict groundwater movement. The San Timoteo formation along the western boundary of the basin causes the water to rise to the elevation of the San Timoteo Wash, a tributary of the Santa Ana River. Groundwater is recharged naturally from precipitation and stream flows, and water discharged to recharge basins. The groundwater is characterized as calcium-sodium bicarbonate with moderate TDS and high nitrate concentrations, and localized areas with high volatile organic compounds.

The Yucaipa subbasin was designated by the CASGEM program as medium priority.

San Timoteo Subbasin

The San Timoteo subbasin is located within the upper Santa Ana River Valley in Riverside County. Water bearing formations include alluvial deposits of gravel, silt, and clay (DWR 2004cj). Several fault zones restrict groundwater movement. Groundwater is recharged naturally from precipitation and stream flows, and water discharged to recharge basins. The groundwater is characterized as calcium-sodium bicarbonate and good quality for the beneficial uses.

The San Timoteo subbasin was designated by the CASGEM program as medium priority.

San Jacinto Groundwater Basin

The San Jacinto Groundwater Basin is located in upper Santa Ana River Valley in Riverside County, and underlies the San Jacinto, Perris, Moreno and Menifee valleys and Lake Perris. The water bearing formations are alluvium over crystalline basement rock (DWR 2006ab). Several fault zones restrict groundwater movement. Groundwater is recharged naturally from precipitation and stream flows along the San Jacinto River and its tributaries, percolation from Lake Perris, and water discharged to recharge basins. The groundwater is characterized as calcium-sodium bicarbonate with high TDS and nitrate concentrations and localized areas with high iron, manganese, sulfides, volatile organic compounds, and perchlorate (DWR 2006ac; MWDSC 2007).

The San Jacinto Groundwater Basin was designated by the CASGEM program as high priority.

Elsinore Groundwater Basin

The Elsinore Groundwater Basin is located in upper Santa Ana River Valley in Riverside County. The water bearing formations are alluvial fan, floodplain, and lacustrine deposits underlain by alluvium of gravel, sand, silt, and clay (DWR 2006ac). Several fault zones restrict groundwater movement. Groundwater is recharged naturally from precipitation and stream flows along the San Jacinto River, and water discharged to recharge basins. The groundwater is characterized as calcium-sodium bicarbonate with moderate salinity and localized areas with high fluoride, arsenic, nitrate, iron, manganese, volatile organic compounds, and perchlorate (DWR 2006ac; MWDSC 2007).

The Elsinore Groundwater Basin was designated by the CASGEM program as high priority.

Temecula Valley Groundwater Basin

The Temecula Valley Groundwater Basin is located in the upper Santa Margarita River watershed within Riverside and San Diego counties. The water bearing formations are alluvium of sand, tuff, and silt underlain by fractured bedrock

(DWR 2004ck). Several fault zones restrict groundwater movement. Groundwater is recharged naturally from precipitation and stream flows. The groundwater is characterized as calcium-sodium bicarbonate with high TDS, fluoride, nitrate, volatile organic compounds, and perchlorate (DWR 2006ac; MWDSC 2007).

The Temecula Valley Groundwater Basin was designated by the CASGEM program as high priority.

7.3.6.4.2 Groundwater Use and Management

Upper Santa Ana Valley Groundwater Basin

The Upper Santa Ana Valley Groundwater Basin consists of the Cucamonga, Chino, Riverside-Arlington, Temescal, Rialto-Colton, Cajon, Bunker Hill, Yucaipa, and San Timoteo groundwater subbasins.

Cucamonga and Chino Subbasins

The communities in the Cucamonga and Chino subbasins use a combination of surface water and groundwater to meet water demands (City of Chino 2011; City of Ontario 2011; City of Pomona 2011; City of Upland 2011; Cucamonga Valley WD 2011; FWC 2011; JCSD 2011; MWDSC 2007; MVWD 2011; SAWC 2011; WMWD 2011). The cities of Chino, Ontario, Pomona, and Upland; Cucamonga Valley Water District, Jurupa Community Services District, Monte Vista Water District, and Western Municipal Water District; San Antonio Water Company, Fontana Water Company, Santa Ana River Water Company, and Marygold Mutual Water Company, and Golden State Water Company provide wholesale and/or retail water supplies, including groundwater, to users within their communities and to portions of the City of Rialto, Montclair, Rancho Cucamonga, and San Antonio Heights.

The Cucamonga subbasin was adjudicated in 1958 to allocate groundwater rights in the basin and surface water rights to Cucamonga Creek (City of Chino 2011; Cucamonga Valley WD 2011; MWDSC 2007). The water supplies are allocated to the Cucamonga Valley Water District, San Antonio Water Company, and the West End Consolidated Water Company. The City of Upland has agreements with San Antonio Water Company and the West End Consolidated Water Company to divert from the subbasin.

The Chino subbasin was adjudicated in 1978 through the Chino Basin Judgment which established the Chino Basin Watermaster to manage the subbasin and enforce the provisions of the judgment (City of Chino 2011; Cucamonga Valley WD 2011; MWDSC 2007). The judgment and subsequent agreements allocated the available safe yield to three categories, or pools: Overlying Agricultural Pool, including dairies, farms, and the State of California; Overlying Non-Agricultural Pool for industrial users; and the Appropriative Pool Committee, including local cities, public water agencies, and private water companies. The judgment and subsequent agreements included provisions for reallocation of water rights, groundwater replenishment if the subbasin is operated in a controlled overdraft condition, and development of a groundwater management plan. Through "Peace

Agreements" adopted in 2000 and amended in 2004, included provisions to allow: members of the Overlying Non-Agricultural Pool to transfer their water within their pool or to the Watermaster, appropriators to provide water service to overlying lands, and the Watermaster to allocate unallocated safe yield. The Peace Agreement also addressed use of local storage facilities, management of the subbasin under the Dry Year Yield program when imported water, including SWP water, is not fully available. Groundwater replenishment is allowed through spreading basins, percolation, groundwater injection, and in-lieu use of other water supplies, including SWP water. The Chino Basin Watermaster also was required to develop an Optimum Basin Management Plan, adopted in 1998, to address approaches that would enhance basin water supplies, protect and enhance water quality, enhance management of the basin, and equitably finance implementation of programs identified in the plan. The Peace II Agreement was adopted in 2007 addressed procedures related to basin reoperation under controlled overdraft conditions using the Chino Desalters to meet the replenishment obligation and to maintain hydraulic control in the subbasin, and transfers. The Groundwater Recharge Master Plan update was prepared by the Watermaster in 2010.

The Santa Ana Regional Water Quality Control Board adopted a Water Quality Control Plan in 2004 for the entire Santa Ana River Basin which included a Maximum Benefit Basin Plan, recommended by the Chino Basin Watermaster and the Inland Empire Utilities Agency. The plan established water quality objectives in groundwater quality objectives for TDS and Total Inorganic Nitrogen and wasteload allocations to allow use of recycled water for groundwater recharge. The Maximum Benefit Basin Plan includes commitments for surface water and groundwater monitoring programs; implementation of up to 40 million gallons/day of treated groundwater at desalters; implementation of recharge facilities, conjunctive use programs, and recycled water quality management programs; and groundwater management to provide hydraulic controls to protect the Santa Ana River water quality.

Operations of the Chino Basin portion of the upper Santa Ana River are also affected by surface water right judgments administered by the Santa Ana River Watermaster.

A large portion of the natural runoff in the upper Santa Ana River watershed is captured and used to recharge the groundwater aquifers. Flood control channels and percolation basins are operated by San Bernardino County Flood Control District to allow for flood control and groundwater recharge (MWDSC 2007). Groundwater recharge also occurs in spreading basins operated by the City of Upland, San Antonio Water Company, and San Antonio Water Company. The Chino Basin Water Conservation District operates percolation ponds and spreading basins to facilitate groundwater recharge (IEUA 2011).

The Inland Empire Utilities Agency manages production and treatment of recycled water supplies that are used in groundwater recharge operations and as part of conjunctive use programs in the cities of Chino, Chino Hills, Ontario, and Upland; and in the service areas of the Cucamonga Valley Water District, Monte

Vista Water District, Fontana Water Company, and San Antonio Water Company (IEUA 2011). The district is a member of the Chino Basin Watermaster Board of Directors. The Inland Empire Utilities Agency operates several recharge facilities in the Chino subbasin. Recharge water comes from three sources: recycled water, stormwater, and imported SWP water. The Inland Empire Utilities Agency operates the Chino Desalter Authority's Chino I and Chino II Desalters that treat water from 22 wells. The Chino Desalter Authority is a joint powers authority that includes the cities of Chino, Chino Hills, Norco, and Ontario; and the Jurupa Community Services District, Santa Ana River Water Company, Western Municipal Water District, and Inland Empire Utilities Agency. The treated water from the desalters is used for potable water supplies, groundwater recharge with water with reduced salts and nitrates, and improved water quality of the Santa Ana River.

Riverside-Arlington and Temescal Subbasins

The communities in the Riverside-Arlington and Temescal subbasins use a combination of surface water and groundwater to meet water demands (City of Corona 2011; City of Norco 2014; City of Rialto 2011; City of Riverside 2011; JCSD 2011; MWDSC 2007; RCWD 2011; SBVMWD 2011; WMWD 2011). The San Bernardino Valley Municipal Water District and Western Municipal Water District provide wholesale and retail water supplies, including groundwater, in the areas that overlay the Riverside-Arlington and Temescal subbasins. The cities of Colton, Corona, Norco, Rialto, and Riverside; Elsinore Valley Municipal Water District; Jurupa Community Services District, Lee Lake Water District; Rubidoux Community Services District, San Bernardino Valley Municipal Water District, Western Municipal Water District, and West Valley Water District; and Box Springs Mutual Water Company, Riverside Highland Mutual Water Company, and Terrace Water Company provide retail water supplies, including groundwater, to users within their communities. The Jurupa Community Services District uses wells within the Riverside-Arlington subbasin for non-potable uses (JCSD 2011).

The Riverside portion of the Riverside-Arlington subbasin was adjudicated in 1969 through the stipulated judgment for the *Western Municipal Water District of Riverside County et al. versus East San Bernardino County Water District, et al.* The judgment provided average annual extraction volumes and replenishment schedules for the separate sections of the subbasin as defined by the San Bernardino County and Riverside County boundary (Riverside North and Riverside South portions of the subbasin) (City of Riverside 2011; MWDSC 2007). Within the Riverside North portion, the judgment affects only withdrawals that are to be used in Riverside County because withdrawals for use of water in San Bernardino County are not limited. The Western-San Bernardino Watermaster manages the monitoring and reporting of groundwater conditions of the Riverside portion of the subbasin.

The northern portion of the Riverside portion of the subbasin also was part of the 1969 judgment in the *Orange County Water District v. City of Chino et al.* This judgment primarily includes the Bunker Hill subbasin and small portions of the northern Riverside, Rialto-Colton, and Yucaipa subbasins; and requires minimum downstream flows into the lower Santa Ana River (SBVMWD 2011). To meet the flow obligations, the San Bernardino Valley Municipal Water District is responsible to manage groundwater and surface waters within the San Bernardino Basin Area, as defined in the judgment. The district manages the groundwater by allocation of groundwater withdrawal amounts and requiring replenishment when additional groundwater is withdrawn.

The Arlington portion of the Riverside-Arlington subbasin and the Temescal subbasins are not adjudicated (City of Corona 2011; MWDSC 2007). In 2008, an agreement was adopted between Elsinore Valley Municipal Water District and the City of Corona for use of water from the southern portion of the Temescal subbasin.

The City of Riverside operates two water treatment plants as part of the North Riverside Water Project to remove volatile organic compounds. The City of Corona operates the Temescal Basin Desalter Treatment Plant/Facility and the Western Municipal Water District operates the Arlington Desalter (City of Corona 2011; WMWD 2011) to reduce TDS. The City of Norco operates a groundwater treatment plant to reduce iron, manganese, and hydrogen sulfide (City of Norco 2014).

Cajon, Rialto-Colton, Bunker Hill, Yucaipa, and San Timoteo Subbasins

The communities in the Cajon, Rialto-Colton, Bunker Hill, Yucaipa, and San Timoteo subbasins use a combination of surface water and groundwater to meet water demands (City of Rialto 2011; City of Riverside 2011; MWDSC 2007; SBVMWD 2011; YVWD 2011; WMWD 2011; West Valley WD 2014a). The San Bernardino Valley Municipal Water District and Western Municipal Water District provide wholesale and retail water supplies, including groundwater, in the areas that overlay the Cajon, Rialto-Colton, Bunker Hill, Yucaipa, and San Timoteo subbasins. The cities of Colton, Loma Linda, Redlands, Rialto, Riverside, and San Bernardino; Beaumont-Cherry Valley Water District, East Valley Water District, South Mesa Water District, West Valley Water District, Western Municipal Water District, West Valley Water District, and Yucaipa Valley Water District; and several private water companies provide retail water supplies, including groundwater, to users within their communities and to portions of the cities of Beaumont, Calimesa, and Yucaipa; the communities of Cherry Valley, Mission Grove, Orange Crest, and Woodcrest; and numerous private water companies.

Groundwater adjudication in these subbasins have occurred over the past 90 years. A portion of the Bunker Hill subbasin underlays the Lytle Creek watershed (City of Rialto 2011). The remaining portion of the Lytle Creek watershed overlays the Lytle Creek groundwater basin that is not included in the DWR Bulletin 118. The entire Lytle Creek groundwater basin, including the portion in the Bunker Hill subbasin, is a major groundwater recharge source to the Bunker Hill and Rialto-Colton subbasins; and was adjudicated in 1924. The stipulation of the judgment allocated groundwater withdrawal right to the City of Rialto, Citizens Land and Water Company, Lytle Creek Water and Improvement Company, Rancheria Water Company, and Mutual Water Company.

The Rialto-Colton subbasin was adjudicated in 1961 under the *Lytle Creek Water & Improvement Company vs. Fontana Ranchos Water Company et al* (City of Rialto 2011). The adjudication allocated groundwater withdrawals between the cities of Rialto and Colton, West Valley Water District, and Fontana Union Water Company based upon spring groundwater levels at three index wells between March and May of each water year. The groundwater subbasin is managed by the Rialto Basin Management Association. The stipulation of the judgment allocated groundwater withdrawal right to the City of Rialto, Citizens Land and Water Company, Lytle Creek Water and Improvement Company, and private well users. Use of this aquifer has been limited due to contamination with volatile organic compounds which are currently being treated. The City of Rialto also has agreements with San Bernardino Municipal Water District to store SWP water in the Rialto subbasin. The city can withdraw the stored water without affecting the water allowed to be withdrawn under the 1961 decree.

As described above under the Riverside-Arlington and Temescal Subbasins section, in 1969 the stipulated judgment for the *Western Municipal Water District of Riverside County et al. versus East San Bernardino County Water District, et al*. to preserve the safe yield of the San Bernardino Basin Area through entitlements to groundwater withdrawals to protect the safe yield and establishment of replenishment schedules when the safe yield is exceeded (City of Rialto 2011; SBVMWD 2011). The San Bernardino Basin Area includes the Bunker Hill subbasin and portions of the Rialto-Colton and Yucaipa subbasins; and portions of the Mill Creek, Lytle Creek, and upper Santa Ana River watersheds. The Western-San Bernardino Watermaster, which includes Western Municipal Water District and San Bernardino Municipal Water District, manages the monitoring and reporting of groundwater conditions. The primary users of the groundwater under this decree include the cities of Colton, Loma Linda, Redlands, and Rialto; East Valley Water District, San Bernardino Municipal Water District, West Valley Water District, and Yucaipa Valley Water District; Riverside-Highland Water Company and 13 private water companies.

In 2002, the City of Beaumont, Beaumont-Cherry Valley Water District, South Mesa Water Company, and Yucaipa Valley Water District formed the San Timoteo Watershed Management Authority to enhance water supplies and water quality, manage groundwater in the Beaumont Basin (part of the San Timoteo subbasin), protect riparian habitat in San Timoteo Creek, and allocate benefits and costs of these programs (Beaumont Basin Watermaster 2013; SBVMWD 2011). One of the issues that the authority initiated was negotiations related to groundwater withdrawals by the City of Banning. A Stipulated Agreement was adopted in 2004 in accordance with the judgment for the *San Timoteo Watershed Management Authority, vs. City of Banning et al.* The judgment established a Watermaster committee of the cities of Banning and Beaumont, Beaumont-Cherry Valley Water District, South Mesa Water Company, and Yucaipa Valley Water

District. The judgment allocated groundwater supplies in a manner that allows for storage of groundwater recharge from spreading basins or in-lieu programs.

The Seven Oaks Accord, a settlement agreement, was signed by the City of Redlands; East Valley Water District, San Bernardino Valley Municipal Water District, and Western Municipal Water District; and Bear Valley Mutual Water Company, Lugonia Water Company, North Fork Water Company, and Redlands Water Company to recognize prior rights of water users of a portion of the natural flow of the Santa Ana River (SBVMWD 2011). The Seven Oaks Accord requires that San Bernardino Valley Municipal Water District, and Western Municipal Water District develop a groundwater spreading program to recharge the groundwater in cooperation with other parties to the accord to maintain relatively constant groundwater levels.

In 2005, the San Bernardino Valley Municipal Water District entered into an agreement with the San Bernardino Valley Water Conservation District to work cooperatively to develop and implement a groundwater management plan which includes groundwater banking programs (SBVMWD 2011).

The City of Rialto, San Bernardino Valley Municipal Water District, West Valley Water District, and Riverside Highland Water District have jointly constructed the Baseline Feeder to convey groundwater from the Bunker Hill subbasin to the Rialto area and West Valley Water District to be used in an in-lieu program that would reduce reliance on SWP water supplies (City of Rialto 2011; West Valley WD 2014c, 2014d).

West Valley Water District implemented a bioremediation wellhead treatment system (West Valley Water District 2014b).

San Jacinto Groundwater Basin

The communities in the San Jacinto Groundwater Basin use a combination of surface water and groundwater to meet water demands (City of Hemet 2011; City of San Jacinto 2011; EMWD 2011; LHMWD 2011; MWDSC 2007; RCWD 2011). The Eastern Municipal Water District provides wholesale and retail water supplies, including groundwater, in the areas that overlay the San Jacinto Groundwater Basin. The cities of Hemet and San Jacinto; and Eastern Municipal Water District and Rancho California provide retail water supplies, including groundwater, to users within their communities and to portions of the cities of Menifee, Moreno Valley, Murrieta, and Temecula; Lake Hemet Municipal Water District; Nuevo Water Company and numerous private water companies; and the communities of Edgemont, Homeland, Juniper Flats, Lakeview, Mead Valley, North Perris Water System, Romoland, Sunnymead, Valle Vista, and Winchester. The City of Perris overlays a portion of the San Jacinto Groundwater Basin; however, the city does not use groundwater. A substantial portion of the groundwater supplies within the San Jacinto Groundwater Basin are used by agricultural water users.

The 1954 Fruitvale Judgment allows for Eastern Municipal Water District to withdraw water from the San Jacinto Groundwater Basin if the groundwater elevation is greater than a specified elevation (EMWD 2009, 2011, 2014). The judgment includes a maximum withdrawal volume for use outside of the groundwater basin. There are further restrictions within the Canyon Basin subbasin of the San Jacinto Groundwater Basin. DWR worked with the cities of Hemet and San Jacinto, Lake Hemet Municipal Water District, Eastern Municipal Water District, and private groundwater companies to file a stipulated judgment in 2007 to form a Watermaster to develop and implement the Hemet/San Jacinto Water Management Plan, including the Hemet/San Jacinto Integrated Recharge and Recovery Program, Recycled Water In-Lieu Project, and Hemet Filtration Plant. The stipulated judgment also limited groundwater withdrawals to protect the groundwater basin, provide for recharge programs, expand water production, and protect water quality. The program uses SWP water and San Jacinto River runoff to recharge the San Jacinto-Upper Pressure Groundwater Management Zone. In 2013, the judgment was filed with the court to adopt the Hemet/San Jacinto Water Management Plan and create the Watermaster Board.

The stipulated judgment also addressed methods to fulfil the Soboaba Band of Luiseño Indians water rights in accordance with the findings of the Court for the *Soboba Band of Luiseño Indians Water Settlement Agreement* in 2006. In 2008, the Soboba Settlement Act was signed by the President of the United States to provide an annual water supply and provide funds for economic development. The legislation also provides funds to construct recharge facilities and provisions for the Soboba Tribe to participate in restoration efforts.

The Eastern Municipal Water District adopted the West San Jacinto Groundwater Basin Management Plan in 1995. The management plan includes the Nuevo Water Company, City of Moreno Valley, City of Perris, and McCanna Ranch Water Company (MWDSC 2007).

Eastern Municipal Water District operates two desalination plants to treat brackish water within the San Jacinto Groundwater Basin as part of the Groundwater Salinity Management Program (EMWD 2011). Other wells within the Eastern Municipal Water District also include treatment facilities to reduce hydrogen sulfide, iron, and/or manganese.

Elsinore Groundwater Basin

The communities in the Elsinore Groundwater Basin use a combination of surface water and groundwater to meet water demands (EVMWD 2011; MWDSC 2007). The Elsinore Valley Municipal Water District provides wholesale and retail water supplies, including groundwater, in the areas that overlay the Elsinore Groundwater Basin. The cities of Lake Elsinore, Canyon Lake, and Wildomar; Elsinore Valley Municipal Water District and Elsinore Water District; and Farm Mutual Water Company provide retail water supplies, including groundwater, to users within their communities and to portions of Cleveland Ranch, Farm, Horsethief Canyon, Lakeland Village, Meadowbrook, Rancho Capistrano – El Cariso Village, and Temescal Canyon.

The Elsinore Groundwater Basin is not adjudicated. The Elsinore Valley Municipal Water District was responsible for over 90 percent of the groundwater withdrawals in mid-2000s (EVMWD 2011). The Elsinore Basin Groundwater

Management Plan, adopted by Elsinore Valley Municipal Water District in 2005, identifies conjunctive use projects, including direct recharge projects. The direct recharge projects use imported water, including SWP water.

Temecula Valley Groundwater Basin

The communities in the Temecula Valley Groundwater Basin use a combination of surface water and groundwater to meet water demands (MWDSC 2007; RCSD 2011; WMWD 2011). The Rancho California Water District and Western Municipal Water District (including Murrieta County Water District) provide wholesale and retail water supplies, including groundwater, in the areas that overlay the Temecula Valley Groundwater Basin, including the cities of Murrieta and Temecula. The Pechanga Indian Reservation operates groundwater wells within the Temecula Valley Groundwater Basin (MWDSC 2007).

The Temecula Valley Groundwater Basin is located within the Santa Margarita River watershed. As described above for the San Mateo Valley, San Onofre Valley, and Santa Margarita Valley Groundwater Basins, the groundwater basins that contribute direct or indirect flows into the Santa Margarita River have been adjudicated and are managed by the Santa Margarita River Watermaster in accordance with the 1940 Stipulated Judgment, the 1966 Modified Final Judgment and Decree, and subsequent court orders (MWDSC 2007; RCWD 2011; SMRW 2011; WMWD 2011). The court-appointed steering committee for the Watermaster includes Eastern Municipal Water District, Fallbrook Public Utility District, Metropolitan Water District of Southern California, Pechanga Band of Luiseno Mission Indians of the Pechanga Reservation, Rancho California Water District, Western Municipal Water District, and Marine Corps Base Camp Pendleton. In accordance with the judgment, the Rancho California Water District prepares the annual Groundwater Audit and Recommended Groundwater Production Report that allocates groundwater withdrawals based upon rainfall, recharge area, and pumping capacity. The subsequent orders adopted following 1966 included the Cooperative Water Resource Management Agreement between Rancho California Water District and the Marine Corps Base Camp Pendleton to manage groundwater levels and surface water flows; water rights to Vail Lake on Temecula Creek; and an agreement between the Rancho California Water District and the Pechanga Band of Luiseno Mission Indians of the Pechanga Reservation.

Rancho California Water District provides imported water, including SWP water, and natural runoff released from Vail Lake to the Valle de Los Caballos Recharge Basins (RCWD 2011). The district also has implemented the Vail Lake Stabilization and Conjunctive Use Project to store imported water in Vail Lake for subsequent groundwater recharge (RCWD et al. 2014).

7.3.6.5 Central Riverside County

The areas within the SWP service area which receive Colorado River water in-lieu of SWP water deliveries are located within the Coachella Valley Groundwater Basin. The Coachella Valley Groundwater Basin includes the

Desert Hot Springs, Indio, Mission Creek, and San Gorgonio Pass subbasins, as shown in Figure 7.12.

7.3.6.5.1 Hydrogeology and Groundwater Conditions

The Coachella Valley Groundwater Basin underlies the entire floor of the Coachella Valley. Primary water-bearing materials in the Coachella Valley Groundwater Basin are unconsolidated alluvial deposits along the valley floor which consist of older alluvium and a thick sequence of poorly bedded coarse sand and gravel; terrace deposits under the surrounding foothills in the Mission Creek subbasin; and partly consolidated fine to coarse sandstone in the surrounding mountains in the San Gorgonio Pass subbasin (DWR 2004cm, 2004cn, 2004co, 2004cp). The movement of groundwater is locally influenced by features such as faults, structural depressions, and constrictions; however, groundwater generally flows to the southeast towards the Salton Sea. Groundwater recharge occurs along stream beds and from groundwater inflows from adjacent subbasins. Within the Indio subbasin, groundwater also is recharged from spreading basins and injection wells.

The groundwater quality is characterized as calcium-sodium bicarbonate. Groundwater quality is adequate for community and agricultural water uses within the San Gorgonio Pass, Mission Creek, and Indio subbasins. There are localized areas with high fluoride near the Banning and San Andreas fault zones. Groundwater quality in the Desert Hot Springs subbasin is poor due to the geothermal activity which results in high sodium sulfate, TDS, and chlorides. The hot springs water is only used by a resort for bathing.

Desert Hot Springs Groundwater Basin was designated by the CASGEM program as low priority. Indio, Mission Creek, and San Gorgonio Pass groundwater basins were designated as medium priority.

7.3.6.5.2 Groundwater Use and Management

Coachella Valley Groundwater Basin

The Coachella Valley Groundwater Basin includes the San Gorgonio Pass, Mission Creek, Desert Hot Springs, and Indio subbasins.

San Gorgonio Pass Subbasin

The communities in the San Gorgonio Pass subbasin use a combination of surface water and groundwater to meet water demands (BCVWD 2013; City of Banning 2011; SGPWA 2010). The City of Banning, Beaumont-Cherry Valley Water District, Cabazon Water District, and High Valley Water District provide retail water supplies, including groundwater, in the areas that overlay the San Gorgonio Pass subbasin, including the City of Banning and the eastern portion of the City of Beaumont; Banning Heights Mutual Water Company; and the community of Cabazon. The Morongo Band of Mission Indians operates groundwater wells within the San Gorgonio Pass subbasin.

The western portion of the San Gorgonio Pass subbasin is located within the Beaumont Basin (USGS 1974). As described above, the City of Beaumont,

Beaumont-Cherry Valley Water District, South Mesa Water Company, and Yucaipa Valley Water District formed the San Timoteo Watershed Management Authority to enhance water supplies and water quality, manage groundwater, protect riparian habitat in San Timoteo Creek, and allocate benefits and costs of these programs (Beaumont Basin Watermaster 2013). One of the issues that the authority initiated was negotiations related to groundwater withdrawals by the City of Banning. A Stipulated Agreement was adopted in 2004 in accordance with the judgment for the *San Timoteo Watershed Management Authority, vs. City of Banning et al.* The judgment established a Watermaster committee of the cities of Banning and Beaumont, Beaumont-Cherry Valley Water District, South Mesa Water Company, and Yucaipa Valley Water District. The judgment allocated groundwater supplies in a manner that allows for storage of groundwater recharge from spreading basins or in-lieu programs.

Mission Creek, Desert Hot Springs, and Indio Subbasins

The communities in the Mission Creek, Desert Hot Springs, and Indio subbasins use a combination of surface water and groundwater to meet water demands (City of Coachella 2011; CVWD 2011, 2012; DWA 2011; IWA 2010; MSWD 2011). The City of Coachella, Coachella Valley Water District, Desert Water Agency, Indio Water Authority, and Mission Springs Water District provide retail water supplies, including groundwater, in the areas that overlay the Mission Creek, Desert Hot Springs, and Indio subbasins, including the cities of Cathedral City, Coachella, Desert Hot Springs, Indian Wells, Indio, La Quinta, Palm Desert, Palm Springs, and Rancho Mirage; and the communities of Barton Canyon, Bermuda Dunes, Bombay Beach, Desert Crest, Desert Edge, Indio Hills, Mecca, Mecca Hills, Palm Springs Crest, Salton City, Thermal, and West Palm Springs Village. The Cabazon Band of Mission Indians and the Torres-Martinez Desert Cahuilla Indians operate groundwater wells within the subbasins.

The Coachella Valley Water District, Desert Water Agency, and Mission Springs Water District all participate in groundwater management programs within the subbasins (CVWD 2011, 2012; DWA 2011; MSWD 2011). These programs include purchasing imported Colorado River water for groundwater recharge and in-lieu programs, conjunctive use programs, and conservation programs. Coachella Valley Water District and Desert Water Agency are SWP water contractors. However, because no conveyance facilities exist to deliver the SWP water, these districts have agreements with the Metropolitan Water District of Southern California to exchange SWP water for Colorado River water (CVWD 2012). Since 1973, these agencies have recharged more than 2.6 million acre-feet of water in the groundwater basin with delivery of Colorado River water to the Whitewater River Recharge Facility. The Metropolitan Water District of Southern California also has an agreement with Coachella Valley Water District and Desert Water Agency to store water in the Coachella Valley Groundwater Basin. The Coachella Valley Water District also operates the Thomas E. Levy Groundwater Replenishment Facility and the Martinez Canyon Pilot Recharge Facility. Coachella Valley Water District and Desert Water Agency also provide recycled water for in-lieu programs. The Coachella Valley Water District has agreed to operate groundwater recharge facilities to store Colorado River water for Imperial Irrigation District (CVWD 2011).

These groundwater recharge programs and broader groundwater management programs for the Indio subbasin have been developed in accordance with the Whitewater Basin Water Management Plan developed by Coachella Valley Water District and Desert Water Agency, and the Coachella Valley Water Management Plan developed by Coachella Valley Water District (CVWD 2011, 2012; DWA 2011).

The Coachella Valley Water District, Desert Water Agency, and Mission Springs Water District jointly manage the Mission Creek subbasin in accordance with the 2004 Mission Creek Settlement Agreement (DWA 2011; MSWD 2011). The Coachella Valley Water District and Desert Water Agency also manage portions of the subbasin in accordance with the 2003 Mission Creek Groundwater Replenishment Agreement. These agreements provide for the allocation of available Colorado River water under the SWP water exchange agreement with the Metropolitan Water District of Southern California between the Mission Creek and Indio (also known as the Whitewater) subbasins.

7.3.6.6 Antelope Valley and Mojave Valley

The areas within the SWP service area in the Antelope Valley and Mojave Valley include Salt Wells Valley, Cuddeback Valley, Pilot Knob Valley, Grass Valley, Superior Valley, El Mirage Valley, Upper Mojave River Valley, Middle Mojave River Valley, Lower Mojave River Valley, Caves Canyon Valley, Langford Valley, Cronise Valley, Coyote Lake Valley, Kane Wash Area, Iron Ridge Area, Bessemer Valley, Lucerne Valley, Johnson Valley, Means Valley, Deadman Valley, Twentynine Palms Valley, Joshua Tree, Ames Valley, Copper Mountain Valley, Warren Valley, and Morongo Valley groundwater basins in San Bernardino County; Harper Valley and Fremont Valley groundwater basins in San Bernardino Kern counties; Lost Horse Valley in Riverside and San Bernardino counties; Antelope Valley Groundwater Basin in San Bernardino, Kern, and Los Angeles counties; and Indian Wells and Searles Valley groundwater basin in San Bernardino, Inyo, and Kern counties, as shown in Figure 7.13.

7.3.6.6.1 Hydrogeology and Groundwater Conditions

Indian Wells Valley Groundwater Basin

Indian Wells Valley Groundwater Basin is located in Inyo, Kern, and San Bernardino Counties. Water bearing formations consist of unconsolidated lakebed, stream, and alluvial fan deposits with upper and lower aquifers (DWR 2004cn). The lower aquifer is more productive and has a saturated thickness of approximately 1000 feet. The upper aquifer provides low yield and has low quality. The lower aquifer is considered unconfined in most of the valley. There is indication that some faults within the valley could obstruct groundwater flow. Groundwater is recharged from runoff on the southwest to northeast sides of the valley. Groundwater levels have been declining since 1945. Groundwater quality varies throughout the groundwater basin from appropriate for beneficial uses to areas with poor water quality due to wastewater disposal practices. Areas near geothermal activity are characterized by high chloride, boron, and arsenic concentrations.

Indian Wells Valley Groundwater Basin was designated by the CASGEM program as medium priority.

Salt Wells Valley Groundwater Basin

Salt Wells Valley Groundwater Basin is located in San Bernardino County. Water bearing formations consist of unconsolidated to poorly consolidated alluvium (DWR 2004co). Groundwater is recharged from the Indian Wells Groundwater Basin and percolation of rainfall on the valley floor. The regional groundwater flow direction is towards the east into the Searles Valley Groundwater Basin. The groundwater has extremely high salinity, TDS, and boron.

Salt Wells Valley Groundwater Basin was designated by the CASGEM program as very low priority.

Searles Valley Groundwater Basin

Searles Valley Groundwater Basin is located in San Bernardino, Inyo, and Kern Counties. Water bearing formations consist of alluvium with unconsolidated to semi-consolidated deposits (DWR 2004cp). The Garlock fault may be a barrier to groundwater flow in the southern part of the basin. Groundwater is recharged from percolation of mountain runoff through the alluvial fan deposits and subsurface inflow from Salt Wells Valley and Pilot Knob Valley groundwater basins. Groundwater flows towards Searles Lake except in the northern portion of the basin where pumping by industrial water users has altered the groundwater flow. Groundwater levels near Searles Lake are close to the lake bed elevations. Groundwater quality is generally appropriate for beneficial uses with localized areas with high levels of fluoride and nitrate. In the vicinity of Searles Lake, the groundwater quality is poor with high levels of fluoride, boron, sodium, chloride, sulfate, and TDS.

Searles Valley Groundwater Basin was designated by the CASGEM program as very low priority.

Cuddeback Valley, Pilot Knob Valley, Grass Valley, and Superior Valley, Groundwater Basins

Cuddeback Valley, Pilot Knob Valley, Grass Valley, and Superior Valley Groundwater basins are located in northern San Bernardino County. Water bearing formations consist of unconsolidated to poorly consolidated alluvium (DWR 2004cq, 2004cr, 2004cs, 2004ct). Several fault zones restrict groundwater movement. Groundwater is recharged in the Cuddeback Valley, Pilot Knob Valley, Grass Valley, and Superior Valley groundwater basins primarily through groundwater inflow into the basins and percolation of precipitation at the valley margins. Groundwater within Cuddeback Valley, Grass Valley, and Superior Valley groundwater basins flows towards the Harper Valley Groundwater Basin.

Groundwater in the Cuddeback Valley Groundwater Basin also flows towards Cuddeback Lake. Groundwater in Pilot Knob Valley Groundwater Basin flows towards the Searles Valley and Brown Mountain Valley groundwater basins. Groundwater quality is characterized as sodium chloride-bicarbonate with high salinity and TDS in the Cuddeback Valley Groundwater Basin and high concentrations of sodium and fluoride in the Superior Valley Groundwater Basin.

Cuddeback Valley, Pilot Knob Valley, Grass Valley, and Superior Valley groundwater basins were designated by the CASGEM program as very low priority.

Harper Valley Groundwater Basin

Harper Valley Groundwater Basin is located in western San Bernardino County and eastern Kern County. Water bearing formations consist of lacustrine deposits and unconsolidated to semi-consolidated alluvial deposits (DWR 2004cu). The alluvial deposits at the center of the basin are generally more interbedded with lacustrine silty clay. Faults in the Harper Valley Groundwater Basin cause at least partial barriers to groundwater flow. Groundwater is recharged from percolation of rainfall and runoff through alluvial fan material at the valley edges and underflow from Cuddeback Valley, Grass Valley, Superior Valley, and Middle Mojave River Valley groundwater basins. Regional groundwater flows toward the south and Harper Lake. Groundwater quality is characterized as sodium chloride-bicarbonate with high concentrations of boron, fluoride, and sodium.

Harper Valley Groundwater Basin was designated by the CASGEM program as low priority.

Fremont Valley Groundwater Basin

The Fremont Valley Groundwater Basin is located in eastern Kern County and in northwestern San Bernardino County. Water bearing formations consist of alluvial and lacustrine deposits (DWR 2004cv). The alluvial deposits are generally unconfined and the lacustrine deposits may exhibit locally confined conditions. Fault zones, including the Garlock and El Paso fault zones, are barriers to groundwater flow. Groundwater is recharged along streambeds in the Sierra Nevada Mountains. Groundwater flow is generally toward the center of the valley and Koehn Lake. Groundwater is characterized as sodium bicarbonate with high concentrations of calcium, chloride, fluoride, and sodium.

Fremont Valley Groundwater Basin was designated by the CASGEM program as low priority.

Antelope Valley Groundwater Basin

The Antelope Valley Groundwater Basin is located in Kern, Los Angeles, and San Bernardino counties. Water bearing formations consist of unconsolidated alluvial and lacustrine deposits consisting of compact gravels, sand, silt, and clay (DWR 2004cw). Several fault zones restrict groundwater movement. Groundwater is recharged along streams from the surrounding mountains, including Big Rock Creek and Little Rock Creek. The regional groundwater flow direction historically was towards the dry lakebeds of Rosamond, Rogers, and Buckhorn

Lakes. However, extensive groundwater pumping has caused subsidence and reduced the groundwater storage and flow direction. The groundwater is characterized as sodium bicarbonate with localized areas of high nitrate and boron.

Antelope Valley Groundwater Basin was designated by the CASGEM program as high priority.

El Mirage Valley Groundwater Basin

The El Mirage Valley Groundwater Basin is located in San Bernardino County. Water bearing formations consist of unconsolidated to semi-consolidated alluvium (DWR 2003c). Several fault zones restrict groundwater movement. Groundwater is recharged in alluvial deposits at the mouth of Sheep Creek. The regional groundwater flow direction is generally north toward El Mirage Lake. The groundwater is characterized as sodium bicarbonate with localized areas of high levels of fluoride, sulfate, sodium, and TDS.

El Mirage Valley Groundwater Basin was designated by the CASGEM program as medium priority.

Upper Mojave River Valley, Middle Mojave River Valley, Lower Mojave River Valley, and Caves Canyon Valley Groundwater Basins

The Upper Mojave River Valley, Middle Mojave River Valley, Lower Mojave River Valley, and Caves Canyon Valley groundwater basins are located along the Mojave River in southwestern and central San Bernardino County. The water bearing formations consist of alluvial fan deposits overlain by river channel, floodplain, or lake deposits (DWR 2004cx, 2004cy, 2003d, 2003e). The general groundwater flow direction follows the Mojave River north through the Upper Mojave River Valley Groundwater Basin, and east through the Middle Mojave River Valley, Lower Mojave River Valley, and Caves Canyon Valley groundwater basins. Several fault zones restrict groundwater movement. Groundwater is recharged from precipitation on the valley floor, underflow from the Mojave River, streamflow, and flow between the basins. Treated wastewater and irrigation return flows also provide a source of groundwater recharge in these basins. Groundwater quality in the Upper Mojave River Valley, Middle Mojave River Valley, Lower Mojave River Valley, and Caves Canyon Valley groundwater basins varies throughout the basins due to geological formations and includes areas dominated by calcium bicarbonate, calcium-sodium bicarbonate, calcium-sodium sulfate, sodium-calcium sulfate, and sodium sulfate-chloride. There are localized areas of high nitrate, iron, and manganese in the Upper Mojave River Valley Groundwater Basin; and areas with high nitrates, fluoride, and boron in the Middle Mojave River Valley and Lower Mojave River Valley groundwater basins. Localized areas with high volatile organic compounds occur in the Upper Mojave River Valley and Lower Mojave River Valley groundwater basins.

Upper Mojave River Valley Groundwater Basin was designated by the CASGEM program as high priority. Lower Mojave River Valley Groundwater Basin was designated as medium priority. Middle Mojave River Valley Groundwater Basin was designated as low priority. Caves Canyon Valley Groundwater Basin was designated as very low priority.

Langford Valley Groundwater–Langford Well Lake Subbasin, and Cronise Valley and Coyote Lake Valley Groundwater Basins

The Langford Well Lake subbasin and the Cronise Valley and Coyote Lake Valley groundwater basins are located in central San Bernardino County. Water bearing formations consist of unconsolidated to semi-consolidated alluvium (DWR 2004cz, 2004da, 2004db). Groundwater is recharged from precipitation, stream flows into alluvial deposits along the mountains at the basin boundaries, and subsurface inflow from other groundwater basins including the Superior Valley Groundwater Basin. Groundwater quality is poor due to high concentrations of fluoride, boron, and TDS, and localized areas with high iron in the Langford Well Lake subbasin.

Langford Well Lake subbasin and the Cronise Valley and Coyote Lake Valley groundwater basins were designated by the CASGEM program as very low priority.

Kane Wash Area Groundwater Basin

The Kane Wash Area Groundwater Basin is located in San Bernardino County. Water bearing formations consist of unconsolidated to semi-consolidated alluvium with undissected coarse gravel to sand in the younger deposits and dissected gravel sand and silt in the older deposits (DWR 2004dc). Groundwater is recharged from precipitation and stream flows. The groundwater is characterized as sodium sulfate-bicarbonate with moderate TDS concentrations.

Kane Wash Area Groundwater Basin was designated by the CASGEM program as very low priority.

Iron Ridge Area Groundwater Basin

The Iron Ridge Area Groundwater Basin is located in southern San Bernardino County. Water bearing formations consist of unconsolidated to semi-consolidated alluvium (DWR 2004dd). Several fault zones restrict groundwater movement. Groundwater is recharged from precipitation and stream flows from the nearby mountains.

Iron Ridge Area Groundwater Basin was designated by the CASGEM program as very low priority.

Bessemer Valley Groundwater Basin

The Bessemer Valley Groundwater Basin is located in eastern San Bernardino County. Water bearing formations consist of unconsolidated to semi-consolidated alluvial deposits, fanglomerate, and playa lake deposits (DWR 2004de). More recent deposits consist of unconsolidated, undissected coarse gravel to sand. Older deposits consist of gravel, sand, and silt from dissected alluvial fans. Several fault zones restrict groundwater movement. Groundwater is recharged from precipitation and stream flows at the valley margins.

Bessemer Valley Groundwater Basin was designated by the CASGEM program as very low priority.

Lucerne Valley Groundwater Basin

The Lucerne Valley Groundwater basin is located in San Bernardino County. Water bearing formations consist of unconsolidated or semi-consolidated alluvial deposits and dune sand deposits composed of gravel, sand, silt, clay, and occasional boulders (DWR 2004df). Several fault zones restrict groundwater movement. Groundwater is recharged from precipitation and stream flows. Groundwater levels have declined throughout the basin and caused subsidence. The groundwater is characterized as calcium-magnesium bicarbonate or magnesium-sodium sulfate with TDS and nitrates.

Lucerne Valley Groundwater Basin was designated by the CASGEM program low priority.

Johnson Valley Groundwater Basin

The Johnson Valley Groundwater Basin is located in San Bernardino County and includes the Soggy Lake and Upper Johnson Valley subbasins. Water bearing formations in both subbasins consist of alluvial deposits with mainly sand and gravel in the Soggy Lake subbasin and silt, clay, sand, and gravel in the Upper Johnson Valley subbasin (DWR 2004dg, 2004dh). Springs occur throughout the Soggy Lake subbasin. Groundwater flows from Soggy Lake subbasin into the Upper Johnson Valley subbasin. Several fault zones restrict groundwater movement. The groundwater is characterized with moderate to high TDS and localized areas with high fluoride.

Johnson Valley Groundwater Basin was designated by the CASGEM program as very low priority.

Means Valley Groundwater Basin

The Means Valley Groundwater Basin is located in south central part of San Bernardino County. Water bearing formations consist of alluvial and lacustrine deposits with unconsolidated fine to coarse grained sand, pebbles, and boulders; and varying silt and clay deposits throughout the basin (DWR 2004di). Several fault zones restrict groundwater movement. Groundwater is recharged from precipitation and subsurface inflow from the Johnson Valley Groundwater Basin. The groundwater is characterized as sodium-chloride bicarbonate with high TDS, fluoride, and nitrates.

Means Valley Groundwater Basin was designated by the CASGEM program as very low priority.

Deadman Valley Groundwater Basin

The Deadman Valley Groundwater Basin is located in San Bernardino County. The Deadman Valley Groundwater Basin includes the Deadman Lake and Surprise Spring subbasins. Water bearing formations consist of unconsolidated to partly consolidated continental deposits including interbedded gravels, conglomerates, clays, and silts in alluvial fan units (DWR 2004dj, 2004dk). Several fault zones restrict groundwater movement. Groundwater is recharged from precipitation and stream flows. Groundwater flows from the Surprise Spring subbasin into the Deadman Lake subbasin, and from Deadman Lake subbasin to the dry Mesquite Lake. Groundwater also flows from the Ames Valley Groundwater Basin into the Surprise Spring subbasin. The groundwater is characterized as sodium bicarbonate with moderate to high TDS and localized areas of high fluoride.

Deadman Valley Groundwater Basin was designated by the CASGEM program as very low priority.

Twentynine Palms Valley, Joshua Tree, Ames Valley, Copper Mountain Valley, and Warren Valley Groundwater Basins

The Twentynine Palms Valley, Ames Valley, and Copper Mountain Valley groundwater basins are located in southern San Bernardino County. The Joshua Tree and Warren Valley groundwater basins are located in southern San Bernardino County and northern Riverside County. Water bearing formations consist of unconfined, unconsolidated to partly consolidated continental deposits with interbedded gravels, conglomerates, lake playa, silts, clays, and sandy-clay deposits (DWR 2004di, 2004dj, 2004dk, 2004dl, 2004dm). Several fault zones restrict groundwater movement. Groundwater is recharged from precipitation, stream flows, and wastewater effluent disposal. Groundwater flows from the Joshua Tree Groundwater Basin into the Copper Mountain Valley Groundwater Basin. Groundwater recharge in the Warren Valley Groundwater Basin also occurs at spreading grounds. The groundwater is characterized as calcium-sodium bicarbonate or sodium sulfate with moderate to high TDS in all of the basins except the Copper Mountain Valley Groundwater Basin; and localized areas with high fluoride, nitrate, sulfate, and chloride.

Warren Valley Groundwater Basin was designated by the CASGEM program as medium priority. Twentynine Palms Valley was designated as low priority. Joshua Tree, Ames, and Copper Mountain Valley groundwater basins were designated as very low priority.

Morongo Valley Groundwater Basin

The Morongo Valley Groundwater basin is located in southern San Bernardino County. Water bearing formations consist of alluvial deposits composed of sand, gravel, silt, and clay (DWR 2003f). Several fault zones restrict groundwater movement. Groundwater is recharged from precipitation and stream flows in the Big Morongo and Little Morongo creeks. The groundwater is characterized as calcium-sodium bicarbonate with moderate TDS.

Morongo Valley Groundwater Basin was designated by the CASGEM program as very low priority.

Lost Horse Valley Groundwater Basin

The Lost Horse Valley Groundwater Basin is located on the border between southeastern San Bernardino County and northeastern Riverside County. Water bearing formations consist of unconsolidated to semi-consolidated alluvial deposits (DWR 2004dn). Groundwater is recharged from precipitation and stream flows.

Lost Horse Valley Groundwater Basin was designated by the CASGEM program as very low priority.

7.3.6.6.2 Groundwater Use and Management

Within the Antelope Valley and Mojave Valley, groundwater management is facilitated by the Antelope Valley-East Kern Water Agency and Mojave Water Agency. These agencies purchase SWP water and other water supplies to be used for groundwater recharge or in-lieu uses to protect groundwater within the Antelope and Mojave valleys.

Antelope Valley

The Antelope Valley-East Kern Water Agency (AVEK) provides SWP water to areas that overlay portions of the Antelope Valley, Fremont Valley, and Indian Wells Valley groundwater basins. To maintain groundwater aquifers in the area, the AVEK provides treated SWP water to users through the Domestic-Agricultural Water Network and untreated SWP water to some agricultural users (AVEK 2011a). The AVEK participates in groundwater banking programs. Communities within the AVEK service area also use groundwater, including the cities of California City, Lancaster, and Palmdale; Edwards Air Force Base; County of Los Angeles Waterworks District No. 40; Boron Community Services District, Desert Lake Community Services District, Indian Wells Water District (including the City of Ridgecrest), Mojave Public Utilities District, Palmdale Water District, Palm Ranch Irrigation District, Quartz Hill Water District, and Rosamond Community Services District; and California Water Service Company (Antelope Valley, Lake Hughes, areas outside of the City of Lancaster, and Leona Valley), Edgemont Crest Municipal Water Company, El Dorado Mutual Water Company, Lake Elizabeth Mutual Water Company, Shadow Acres Mutual Water Company, Sunnyside Farm Mutual Water Company, Westside Park Mutual Water Company, and White Fence Farms Mutual Water Company provide retail groundwater supplies (AVEK 2011a; AVRWC 2011; California Water Service Company 2011f; City of California City 2013; IWVWD 2011; Los Angeles County et al. 2011; PWD 2011; Rosamond CSD 2011).

In 2004, the County of Los Angeles Waterworks District No. 40 and Palmdale Water District filed for the adjudication of the Antelope Valley Groundwater Basin (DWR 2014a; Los Angeles County et al. 2011; PWD 2011). The request of the filing is to allocate groundwater rights within the basin to these districts, other municipal and industrial water users, and Overlying Landowners and provide for a program to replace groundwater withdrawals in excess of a specified yield in order to stabilize or reverse groundwater declines.

Mojave Valley

Within the Mojave Water Agency service area, most of the water supply is from groundwater (AVRWC 2011; City of Adelanto 2011; Golden State Water Company 2011k; HDWD 2011; Hesperia Water District 2011; JBWD 2011;

MWA 2011; PPHCSD 2011; San Bernardino County 2012; TPWD 2014; Victorville Water District 2011). The Mojave Water Agency uses natural surface water flows, recycled water imported from outside of the agency's service area, SWP water, and return flows from water users of groundwater within the service area to recharge groundwater. These water supplies are provided as wholesale water supplies to retail groundwater users to maintain groundwater levels in the area. The Mojave Water Agency overlays all or portions of all of the groundwater basins described in this subsection. The City of Adelanto; Hesperia Water District, Hi-Desert Water District, Joshua Water District, Twentynine Palms Water District, Victorville Water District, Apple Foothill County Water District, Apple Heights County Water District, Juniper Riviera County Water District, Thunderbird County Water District, Daggett Community Services District, Helendale Community Services District, Phelan Piñon Hills Community Services District, Yermo Community Services District, Bighorn-Desert View Water Agency, and San Bernardino County Service Areas numbers 64 and 70; and Golden State Water Company, Apple Valley Ranchos Water Company, Jubilee Water Company, and Rancheritos Mutual Water Company provide retail groundwater supplies. These entities provide water to the cities of Adelanto, Barstow, Hesperia, Twentynine Palms, Victorville; towns of Apple Valley and Yucca; Joshua Tree National Park; Twentynine Palms Marine Corps Base; and the communities of Apple Heights, Apple Valley, Daggett, Flamingo Heights, Helendale, Johnson Valley, Landers, Lucerne Valley, Newberry Springs, Oak Hills, Spring Valley Lake, Yermo, and users between these communities. The Morongo Band of Mission Indians also rely upon groundwater from this area.

The Mojave Water Agency has implemented 13 groundwater recharge facilities (MWA 2011). The SWP water is delivered to the recharge facilities throughout the Mojave Water Agency service area.

The area known as the Mojave Basin Area has been adjudicated. This area includes all or portions of Cuddeback Valley, Superior Valley, Harper Valley, Antelope Valley, El Mirage Valley, Upper Mojave River Valley, Middle Mojave River Valley, Lower Mojave River Valley, Caves Canyon Valley, Langford Valley, Cronise Valley, Coyote Lake Valley, Kane Wash Area, Iron Ridge Area, Lucerne Valley, and Johnson Valley groundwater basins (Golden State Water Company 2011k; MWA 2011). The Mojave Basin Judgment allocated groundwater withdrawals in the area and required groundwater users that withdraw more than the allocated amount to purchase replenishment SWP water from the Watermaster or from another entity within the judgment. The judgment considers local surface water sources, including groundwater recharge near Hesperia with treated wastewater effluent from Lake Arrowhead Community Services District (LACSD 2011). The judgment also provides for carry over storage between water years. The Mojave Water Agency has been appointed as the Watermaster.

The Warren Valley Groundwater Basin was adjudicated in 1977 (MWA 2011). The Hi-Desert Water District was appointed as the Watermaster to manage groundwater withdrawals and groundwater quality; to provide SWP water, captured stormwater, and recycled water; and to encourage conservation.

In 1991, the Bighorn-Desert Water Agency and the Hi-Desert Water District agreed to the court approved Ames Valley Basin Water Management Agreement. In accordance with this agreement, the Hi-Desert Water District implemented the Mainstream Wells and expansion to conveyance and monitoring approaches.

7.4 Impact Analysis

This section describes the potential mechanisms and analytical methods for change in groundwater resources, results of the impact analysis, potential mitigation measures, and cumulative effects.

7.4.1 Potential Mechanisms for Change and Analytical Methods

As described in Chapter 4, Approach to Environmental Analysis, the impact analysis considers changes in groundwater conditions related to changes in CVP and SWP operations under the alternatives as compared to the No Action Alternative and Second Basis of Comparison.

7.4.1.1 Changes in Groundwater Use and Groundwater Levels

Changes in availability of CVP and SWP water supplies could result in changes in groundwater use. For example, if CVP and SWP water supplies are decreased, water users may increase the amount of groundwater withdrawals in response.

Historically, groundwater resources were the only source of water supply in the Central Valley. The heavy use of groundwater has caused groundwater quality issues, drainage issues, groundwater overdraft, and land subsidence (as discussed in Section 7.3). Throughout many areas of the San Joaquin Valley, shallow groundwater is characterized by high salinity. Use of this groundwater for irrigation deposited salts along with agricultural chemicals (nutrients and fertilizers) in the upper soil layer. These constituents leached into the underlying shallow groundwater aquifers and caused them to be unsuitable for irrigation. Surface water was provided though the CVP and SWP to provide irrigation water of higher quality than was available in local groundwater. The expanded use of surface water for irrigation has resulted in a reduction in the degree of groundwater overdraft of local groundwater basins.

Generally, when available, agricultural water users in the San Joaquin Valley prefer to use surface water for irrigation because the water quality is better than for groundwater. When adequate surface water is not available, they will use groundwater (USGS 2009).

As previously described in Section 7.2.3, Sustainable Groundwater Management Act, most groundwater users in California must develop Groundwater Sustainability Plans (GSPs) by 2020 or 2022, and meet the sustainable goal within 20 years after adoption of the plan. The timeframe of this EIS analysis is 2030. Therefore, the EIS analysis assumes that groundwater users have developed the

GSPs before that timeframe (by 2020 or 2022), and have begun to plan, design, and possibly construct alternative water supply facilities or implement water conservation measures to achieve full compliance by 2040 or 2042. However, this EIS analysis assumes that the new facilities or conservation measures are not fully implemented by 2030. Therefore, reductions in groundwater use in accordance with the SGMA are not anticipated until after 2030 and are discussed under Section 7.4.39, Cumulative Effects Analysis.

Changes in groundwater use by users of or providers to CVP and SWP water supplies could result in changes in groundwater storage and groundwater levels. For example, if CVP and SWP water supplies are decreased and water users increase the amount of groundwater withdrawals, groundwater levels could decline. Changes in groundwater levels resulting in levels declining could result in a decrease in well yields. Changes in groundwater levels also could result in different groundwater pumping costs, as analyzed in Chapter 12, Agricultural Resources, and Chapter 14, Socioeconomics, for agricultural and municipal water users of CVP and SWP water supplies, respectively.

7.4.1.1.1 Use of Central Valley Hydrologic Model

There are many groundwater models that have been developed for portions of the Central Valley. However, most of these models were not developed in a manner that would allow for analysis of groundwater changes throughout the Central Valley which includes the majority of CVP and SWP agricultural water users. As described in Appendix 7A, Groundwater Model Documentation, changes in groundwater use, and levels in the Central Valley have been evaluated using the Central Valley Hydrologic Model (CVHM) because this model is readily available and covers the entire Central Valley. CVHM is a regional-scale calibrated historical finite-difference, block-centered saturated groundwater flow model application developed by the USGS and uses the MODFLOW-2000 computer code (USGS 2000b). The CVHM model spans a 42-year simulation period between water years 1962 and 2003.

CVHM is used to estimate the changes in groundwater levels and groundwater withdrawals under the alternatives as compared to the No Action Alternative and Second Basis of Comparison. CVHM model output is also used as input files of the State Wide Agricultural Production (SWAP) model to simulate agricultural production changes based on groundwater pumping costs, as described in Chapter 12, Agricultural Resources.

The CVHM domain is subdivided into 21 WBSs, as summarized in Figure 7.14 (USGS 2009). Applied water requirements for each WBS are computed based on crop type and available water from precipitation, shallow groundwater uptake, and surface water, as limited by surface water rights and CVP and SWP water supply deliveries.

CVHM simulates primarily subsurface and limited surface hydrologic processes over the entire Central Valley at a uniform grid-cell spacing of 1 mile. Boundary conditions were modified to reflect anticipated changes in surface water availability, including the effects of climate change.

Surface water inflows from the CalSim II model were used to define boundary conditions for CVHM for each alternative and the Second Basis of Comparison. The CalSim II model simulates the operation of the major SWP and CVP facilities in the Central Valley by calculating river flows; and CVP and SWP reservoir storage, exports, and deliveries (see Appendix 5A for more details on CalSim II). The CalSim II outputs are included in the CVHM input files.

The CVHM uses the FMP process (described in Appendix 7A) to estimate agricultural water supply needs and assumes that when surface water deliveries are available, they are used first, before groundwater is pumped for additional water supplies.

Changes in agricultural groundwater pumping under the alternatives are compared to groundwater pumping under the No Action Alternative and Second Basis of Comparison. The data for these results were processed from the FMP output files, which include the amount of water used from each available source by the farm, based on the computed crop water demand for each WBS.

For the analyses presented in this chapter, changes in groundwater use, elevation, and pumping volumes between the alternatives, No Action Alternative, and Second Basis of Comparison are described for agricultural water users only in the Central Valley Region.

7.4.1.1.2 Analysis of Changes in Municipal and Industrial Groundwater Use

Due to the regional scale of the CVHM model, municipal and industrial groundwater use is a very small portion of total groundwater use due to the predominance of agricultural groundwater use. Therefore, in the CVHM model, municipal and industrial groundwater use in the Central Valley was assumed to continue at the 2003 calibrated volume throughout the predictive simulations.

For municipal and industrial groundwater use in the Central Valley, the CWEST model is a more appropriate model than CVHM. The CWEST model evaluates total water use by municipal and industrial water users in the Central Valley, San Francisco Bay Area, Central Coast, and Southern California regions based upon economic decisions.

It is recognized that municipal and industrial pumping in urban areas in the Central Valley could cause localized impacts to groundwater levels from increased drawdown. The increased withdrawals could also impact groundwater quality due to the migration of existing plumes, as described in the Affected Environment section.

7.4.1.1.3 Analysis of Changes in Agricultural Groundwater Use Outside of the Central Valley Region

Agricultural groundwater use by CVP and SWP water users located outside of the Central Valley primarily occurs in Santa Clara and San Benito counties in the San Francisco Bay Area Region; San Luis Obispo and Santa Barbara counties in the Central Coast Region; and Ventura, Orange, San Bernardino, and Riverside counties in the Southern California Region. Basin adjudication programs in many portions of these counties will minimize changes in groundwater use and levels as a result of changes in CVP and SWP water supplies. There are no regional groundwater flow models available that uniformly help analyze groundwater use and elevation in these areas linked to CVP and SWP water supply deliveries, in a similar manner as CVHM simulates in the Central Valley, however in some areas local models have been developed to support groundwater management activities. Therefore, changes in groundwater use and related changes in groundwater levels are assumed to be correlated to availability of CVP and SWP water supplies. It is generally assumed that an increase in CVP and SWP water supplies would result in a decrease in groundwater use in these areas. Similarly, a decrease in CVP and SWP water supplies could result in a short-term increase in groundwater use and associated groundwater level decrease. In adjudicated basins, groundwater use restrictions limit the amount of groundwater that can be pumped, even when surface water availability is reduced. In those basins, long-term groundwater use is assumed to not increase, and agricultural production could decrease if CVP and SWP water supplies decrease.

7.4.1.2 Changes in Land Subsidence

Extensive groundwater withdrawals from confined and unconfined aquifers increases the potential for land subsidence. In aquifers with clay and silt lenses, decreased groundwater levels can result in compaction of fine-grained deposits which could lead to irreversible land subsidence. Subsidence could result in structural damage to roads, railroad tracks, pipelines and associated structures, drainage, buildings, and wells. Subsidence can also result in the permanent loss of groundwater storage potential within an aquifer system.

Subsidence is related to changes in groundwater levels; and a review of simulated changes in groundwater elevation output from the CVHM model as compared between alternatives is used to provide an indication of the potential occurrence of subsidence.

CVHM includes a module known as the SUB package that computes the cumulative compaction of each model layer during the model simulation. The cumulative layer compactions at the end of the simulation are summed into a total subsidence. However, this version of the SUB package does not consider the potential reduction in the rate of subsidence that would occur as the magnitude of compaction approaches the physical thickness of the affected fine-grained interbeds. Thus, subsidence forecasts from the predictive versions of CVHM were not used as they may not accurately depict long-term changes in subsidence using the current version of the SUB package. Therefore, a qualitative approach was used for the estimation of the potential for increased land subsidence in areas of the Central Valley that have historically experienced inelastic subsidence due to the compaction of fine-grained interbeds.

Potential changes in subsidence due to changes in municipal and industrial groundwater use were qualitatively analyzed for regions with historic or existing subsidence issues, such as in Santa Clara County in the San Francisco Bay Area Region.

7.4.1.3 Changes in Groundwater Quality

Changes in groundwater quality could occur in several ways under implementation of the alternatives as compared to the No Action Alternative and Second Basis of Comparison. Reductions in groundwater levels could change groundwater flow directions, potentially causing poorer quality groundwater to migrate into areas with higher quality groundwater, or cause intrusion of poor water quality (e.g. from aquitards) as water levels decline.

Groundwater quality also could change due to changes in availability of CVP and/or SWP water supplies used by agricultural water users. For example, if reductions in CVP and/or SWP water supplies result in increased use of groundwater with higher salinity than CVP and/or SWP supplies, shallow groundwater could become more saline and soil salinity could increase, as described in Chapter 11, Geology and Soils. In addition, the reduced availability of higher quality surface water for use in recharge facilities may decrease the overall groundwater quality in those localized areas.

Changes in groundwater quality due to changes in CVP and SWP water supply availability could occur under the following mechanisms:

- Migration of reduced quality groundwater towards areas of groundwater withdrawals, including seawater intrusion and migration of contaminant plumes
- Depletion of the freshwater aquifer that overlays poorer quality groundwater, and the upwelling of the poorer quality groundwater into the upper aquifers
- Percolation of applied water with poorer water quality than underlying groundwater

Within the Central Valley, changes in groundwater use and groundwater flow direction are analyzed using the CVHM. The model does not directly simulate changes in groundwater quality. However, in regions with existing poorer quality groundwater, changes in groundwater levels or flow directions can be used to evaluate potential impacts to groundwater quality. For example, declines in groundwater levels that result in seawater intrusion, or the migration of good quality groundwater into areas with poor quality can result in groundwater quality degradation. Further, reduction in groundwater quality could also occur due to migration or upwelling of poorer quality groundwater into areas with good quality groundwater.

Long-term use of poorer quality groundwater due to changes in CVP and SWP water supplies could also result in a reduction in shallow aquifer groundwater quality. Application of poorer quality groundwater also could increase soil salinity, as described in Chapter 11, Geology and Soils Resources.

7.4.1.4 Effects Related to Water Transfers

Historically water transfer programs have been developed on an annual basis.

The demand for water transfers is dependent upon the availability of water supplies to meet water demands. Water transfer transactions have increased over time as CVP and SWP water supply availability has decreased, especially during drier water years.

Parties seeking water transfers generally acquire water from sellers who have available surface water who can make the water available through releasing previously stored water, pump groundwater instead of using surface water (groundwater substitution); idle crops; or substitute crops that uses less water in order to reduce normal consumptive use of surface water.

Water transfers using CVP and SWP Delta pumping plants and south of Delta canals generally occur when there is unused capacity in these facilities. These conditions generally occur during drier water year types when the flows from upstream reservoirs plus unregulated flows are adequate to meet the Sacramento Valley water demands and the CVP and SWP export allocations. In non-wet years, the CVP and SWP water allocations would be less than full contract amounts; therefore, capacity may be available in the CVP and SWP conveyance facilities to move water from other sources.

Projecting future groundwater conditions related to water transfer activities is difficult because specific water transfer actions required to make the water available, convey the water, and/or use the water would change each year due to changing hydrological conditions, CVP and SWP water availability, specific local agency operations, and local cropping patterns. Reclamation recently prepared a long-term regional water transfer environmental document which evaluated potential changes in groundwater conditions related to water transfer actions (Reclamation 2014c). Results from this analysis were used to inform the impact assessment of potential effects of water transfers under the alternatives as compared to the No Action Alternative and the Second Basis of Comparison.

7.4.2 Conditions in Year 2030 without implementation of Alternatives 1 through 5

The impact analysis in this EIS is based upon the comparison of the alternatives to the No Action Alternative and the Second Basis of Comparison in the Year 2030. Changes that would occur over the next 15 years without implementation of the alternatives are not analyzed in this EIS. However, the changes that are assumed to occur by 2030 under the No Action Alternative and the Second Basis of Comparison are summarized in this section. Many of the changed conditions would occur in the same manner under both the No Action Alternative and the Second Basis of Comparison.

This section of Chapter 7 provides qualitative projections of the No Action Alternative as compared to existing conditions described under the Affected Environment; and qualitative projections of the Second Basis of Comparison as compared to “recent historical conditions.” Recent historical conditions are not the same as existing conditions which include implementation of the 2008 U.S. Fish and Wildlife Service (USFWS) biological opinion (BO) and 2009 National Marine Fisheries Service (NMFS) BO; and consider changes that would have occurred without implementation of the 2008 USFWS BO and the 2009 NMFS BO.

7.4.2.1 Common Changes in Conditions under the No Action Alternative and Second Basis of Comparison

Conditions in 2030 would be different than existing conditions due to:

- Climate change and sea-level rise
- General plan development throughout California, including increased water demands in portions of Sacramento Valley
- Implementation of reasonable and foreseeable water resources management projects to provide water supplies

These changes would result in a decline of the long-term average CVP and SWP water supply deliveries by 2030 as compared to recent historical long-term average deliveries, as described in Chapter 5, Surface Water Resources and Water Supplies.

7.4.2.1.1 Changes in Conditions due to Climate Change and Sea-Level Rise

It is anticipated that climate change would result in more short-duration high-rainfall events and less snowpack in the winter and early spring months. The reservoirs would be full more frequently by the end of April or May by 2030 than in recent historical conditions. However, as the water is released in the spring, there would be less snowpack to refill the reservoirs. This condition would reduce reservoir storage and available water supplies to downstream uses in the summer. The reduced end of September storage also would reduce the ability to release stored water to downstream regional reservoirs. These conditions would occur for all reservoirs in the California foothills and mountains, including non-CVP and SWP reservoirs.

Climate change also would reduce groundwater supplies due to reduced groundwater recharge potential and increased groundwater overdraft potential as surface water supplies decline. However, in some locations, sustainable groundwater supplies could remain similar to recent historical conditions or rise due to implementation of groundwater management plans to reduce groundwater overdraft, including the completion of ongoing groundwater recharge and recovery programs.

7.4.2.1.2 General Plan Development in California

Counties and cities throughout California have adopted general plans which identify land use classifications including those for municipal and industrial uses and those for agricultural uses. Preparation of general plans includes an environmental evaluation under the California Environmental Quality Act to identify adverse impacts to the physical environment and to provide mitigation measures to reduce those impacts to a level of less than significance. Most of the counties where CVP and SWP water supplies are delivered have adopted general plans following the environmental review of the plans and appropriate alternatives. Population projections from those general plan evaluations are provided to the State Department of Finance and are used to project future water needs and the potential for conversion of existing undeveloped lands and agricultural lands. Many of the existing general plans for counties with municipal areas recently have been modified to include land use and population projections through 2030. The No Action Alternative and the Second Basis of Comparison assume that land uses will develop through 2030 in accordance with existing general plans.

The assumptions related to 2030 municipal water demands are based upon a review of the 2010 Urban Water Management Plans (UWMPs) prepared by CVP and SWP water users. The No Action Alternative and the Second Basis of Comparison assumptions related to future water supplies presented in the UWMPs were evaluated to determine if the projects were reasonable and certain to occur by 2030. Projects that had undergone environmental review, were under design, or under construction were included in the future water supply assumptions for 2030 in the No Action Alternative and the Second Basis of Comparison. Projects described in the UWMPs that currently were under evaluation were included in the Cumulative Effects analysis for future water supplies.

Under the No Action Alternative and Second Basis of Comparison, it is assumed that water demands would be met on a long-term basis and in dry and critical dry years using a combination of conservation, CVP and SWP water supplies, other imported water supplies, groundwater, recycled water, infrastructure improvements, desalination water treatment, and water transfers and exchanges. It is anticipated that individual communities or users could be in a situation that would not allow for affordable water supply options, and that water demands could not be fully met. However, on a regional scale, it is anticipated that water demands would be met.

7.4.2.1.3 Reasonable and Foreseeable Water Resources Management Projects

The No Action Alternative and the Second Basis of Comparison assumes completion of water resources management and environmental restoration projects that would have occurred without implementation of the 2008 USFWS BO and 2009 NMFS BO by 2030, as described in Chapter 3, Description of Alternatives. Many of these future actions could affect groundwater conditions and use of groundwater.

The No Action Alternative and the Second Basis of Comparison assume that groundwater would continue to be used even if groundwater overdraft conditions continue or become worse. It is recognized that SGMA was enacted in September 2014. The SGMA requires the formation of GSPs in groundwater basins or subbasins that DWR designates as medium or high priority based upon groundwater conditions identified using the CASGEM results by 2022. Sustainable groundwater operations must be achieved within 20 years following completion of the GSPs. In some areas with adjudicated groundwater basins, sustainable groundwater management could be achieved and/or maintained by 2030. However, to achieve sustainable conditions in many areas, measures could require several years to design and construct water supply facilities to replace groundwater, such as seawater desalination. Therefore, it does not appear to be reasonable and foreseeable that sustainable groundwater management would be achieved by 2030; and it is assumed that groundwater pumping will continue to be used to meet water demands not fulfilled with surface water supplies or other alternative water supplies in 2030.

7.4.2.1.4 Potential Future Groundwater Conditions in 2030 due to Common Changes

Groundwater Conditions

In the Central Valley Region, the combination of increased groundwater withdrawals due to reductions in CVP and SWP water deliveries as compared to recent historical long-term deliveries and reduced groundwater recharge due to climate change could result in continued reductions in groundwater levels in the same manner as recent declines of up to 10 feet in the Sacramento Valley and more than 20 feet in the San Joaquin Valley, as described in Section 7.3.4, Central Valley Region. It is also assumed that full implementation of SGMA GSPs would not occur by 2030; and therefore, groundwater pumping will continue to be used to meet water demands not fulfilled with surface water supplies or other alternative water supplies in 2030, as described above.

Under the No Action Alternative and Second Basis of Comparison, groundwater banks and other management programs would continue to be implemented, and possibly expanded, including ongoing groundwater recharge efforts in the Eastern San Joaquin, Kings, Kaweah, and Kern subbasins in the San Joaquin Valley Groundwater Basin. These programs could result in groundwater levels that are similar or higher as compared to recent groundwater conditions. If local agencies fully implement GSPs in accordance with the state SGMA prior to the regulatory deadline, groundwater levels could remain similar to recent conditions or rise.

Localized groundwater levels in portions of the Central Valley Region could increase due to seepage in lands adjacent to the ecosystem restoration areas in the Yolo Bypass, Cache Slough, and Suisun Marsh areas depending upon local geological and soil conditions.

In the Southern California Region, several SWP water users have purchased transferred water, expanded groundwater storage within their service areas, implemented wastewater recycling and stormwater recycling programs to provide water supplies for groundwater recharge, and participated in groundwater banks outside of their service areas as part of ongoing sustainable groundwater management programs. Under the No Action Alternative and the Second Basis of Comparison, groundwater banks and other management programs would continue to be implemented, and possibly expanded. Several of the programs include expansion of groundwater storage by Kern County and Antelope Valley-East Kern Water Agency; groundwater recharge programs using recycled stormwater by the Los Angeles Department of Water and Power; groundwater recharge programs using recycled wastewater by the Water Replenishment District; and groundwater treatment by City of Oxnard and Western Municipal Water District (AVEK 2011b; City of Los Angeles 2011; City of Oxnard 2013; Reclamation 2010b; WMWD 2012; WRD 2015). Expansion of these programs could result in maintenance of groundwater levels in accordance with objectives in the current groundwater management plans even with reduced SWP water supplies under the No Action Alternative and Second Basis of Comparison.

Potential Land Subsidence

Land subsidence due to groundwater withdrawals historically occurred in the Yolo subbasin of the Sacramento Valley Groundwater Basin and Delta-Mendota and Westside subbasins of the San Joaquin Valley Groundwater Basin in the Central Valley Region; Santa Clara Valley Groundwater Basin in the San Francisco Bay Area Region; and the Antelope Valley and Lucerne Valley groundwater basins in the Southern California Region. Under the No Action Alternative, it is anticipated that increased groundwater withdrawals due to reductions in CVP and SWP water supplies and reduced groundwater recharge due to climate change could result in increased irreversible land subsidence in these areas.

Groundwater Quality

Central Valley Region

As described in Section 7.3, Affected Environment, in the Central Valley, there are localized areas of high salinity related to natural geologic formations and/or historic land uses; high naturally occurring arsenic, calcium, iron, and/or manganese; and high levels of boron, and/or phosphates related to historic land use practices. High concentrations of nitrates due to current anthropogenic sources and legacy sources occur in many locations in the San Joaquin Valley Groundwater Basin, especially in the Eastern San Joaquin, Modesto, Merced, Kings, Kaweah, Tule, and Tulare Lake subbasins. Under the No Action Alternative, it is anticipated that these conditions would continue to occur; and that groundwater quality could be further degraded due to reduction of groundwater elevation that can cause adjacent poorer quality water to flow towards the groundwater withdrawals.

Groundwater quality in the Grasslands Drainage Area and near Mud Slough and the San Joaquin River is anticipated to improve as compared with historic conditions due to the implementation of the Grasslands Bypass project. This program would reduce seepage from unlined canals and capture, treat, and/or reuse drainage flows (Reclamation 2009).

In the Tulare Lake Area of the San Joaquin Valley Groundwater Basin (in the Westside, Tulare Lake, Kings, Kaweah, and Tule subbasins within Fresno, Kern, Kings, and Tulare counties) high salinity groundwater occurs in the shallow aquifers due to agricultural drainage issues and naturally occurring high saline soils. Salts are imported into the Tulare Lake Area through the use of CVP and SWP irrigation water supplies and introduced into groundwater from dissolution of salts in the local soil from agricultural land use. Groundwater salinity increases because the Tulare Lake Area is a closed basin.

The CV-SALTS program is preparing a Salinity and Nitrate Management Plan for publication in 2016 (CVRWQCB 2015). The plan will include sustainable salt management alternatives, including treatment and salt recovery technologies, such as, reverse osmosis; and related brine disposal/storage options that could range from deep well injection to dedicated disposal locations to conveyance of brine to locations outside of the San Joaquin Valley. This plan also will address current and legacy sources of nitrates; assimilative capacity of the groundwater subbasins and aquifers; drinking water protection measures, including waste discharge requirements from irrigated lands and dairies; and measurable and enforceable milestones that do not disproportionately impact disadvantaged communities; and measures that minimize costs and maximize benefits to the community and water users. The 2015 CV-SALTS work plan projects completion of Central Valley Basin Plan amendments and Water Quality Control Plans for the Sacramento Valley and San Joaquin Valley updates to incorporate recommendations of CV-SALTS by 2018, including source control strategies and real time management strategies (CVRWQCB 2015; SWRCB 2015). The *2015 CV-SALTS Annual Report* indicated that structural best management practices would not be fully selected until 2018 and may not be implemented until after 2030 (SWRCB 2015). Under the No Action Alternative and Second Basis of Comparison it is assumed that non-structural measures would be implemented by 2030 to reduce salinity and nitrate loadings; however, structural improvements that would reduce total groundwater salinity and nitrate concentrations generally would not be implemented. Therefore, water quality under the No Action Alternative and the Second Basis of Comparison is anticipated to be poorer in some portions of the Central Valley than under recent groundwater quality conditions.

Poor groundwater quality occurs near urban areas in the Central Valley due to contamination from municipal and industrial land use practices. In many of these areas, groundwater quality improvement programs have been implemented, as described above. However, in many areas, groundwater quality is managed by reducing groundwater drawdown near contaminant plumes to avoid transporting the contaminants into other portions of the aquifer. Under the No Action Alternative and the Second Basis of Comparison, it is assumed that these programs would continue. However, as CVP and SWP water supplies become less available in 2030 as compared to recent conditions, increased reliance on groundwater could cause groundwater contamination of portions of the aquifers near existing wells.

San Francisco Bay Area Region

In the San Francisco Bay Area Region, there are localized areas of moderate to high salinity due to natural geologic formations and/or seawater intrusion near San Francisco Bay. High levels of boron due to natural geologic formations and nitrates related to historic land use practices occur in the Livermore Valley and the Gilroy-Hollister- Valley groundwater basins. Under the No Action

Alternative and the Second Basis of Comparison, it is anticipated that these conditions would continue to occur; and that groundwater quality could be further degraded due to reduction of groundwater elevation that can cause adjacent poorer quality water to flow towards the groundwater withdrawals, especially in locations with seawater intrusion near the coast.

Central Coast Region

In the Central Coast Region, there are localized areas of moderate to high salinity due to seawater intrusion near the coast. High levels of iron and manganese due to natural geologic formations and nitrates related to historic land use practices occur in local areas of the Central Coast Region. Under the No Action Alternative and Second Basis of Comparison, it is anticipated that these conditions would continue to occur. Seawater intrusion could increase and further degrade groundwater quality in groundwater adjacent to the coast if groundwater levels decline in the future.

Southern California Region

In the Southern California Region, there are localized areas of moderate to high salinity due to natural geologic formations, percolation of high salinity applied water supplies, and/or seawater intrusion near the coast. High levels of calcium, sulfate, magnesium, iron, manganese, and fluoride due to natural geologic formations, and nitrates and organic compounds related to historic land use practices. Under the No Action Alternative and the Second Basis of Comparison, it is anticipated that these conditions would continue to occur; and that groundwater quality could be further degraded due to reduction of groundwater elevation that can cause adjacent poorer quality water or seawater to flow towards the groundwater withdrawals.

7.4.2.2 Changes in Conditions under the No Action Alternative

Due to the climate change and sea-level rise and increased water demands in the Sacramento Valley, CVP and SWP water deliveries would be less in 2030 than under recent historical conditions. It is anticipated that these reductions in CVP and SWP water availability would result in a greater reliance on groundwater, especially during dry and critical dry year.

7.4.2.3 Changes in Conditions under the Second Basis of Comparison

Due to the climate change and sea-level rise and increased water demands in the Sacramento Valley, CVP and SWP water deliveries would be less in 2030 than under recent historical conditions. It is anticipated that these reductions in CVP and SWP water availability would result in a greater reliance on groundwater, especially during dry and critical dry year. However, as described in Chapter 5, Surface Water Resources and Water Supplies, the availability of CVP and SWP water supplies would be greater under the Second Basis of Comparison as compared to the No Action Alternative because CVP and SWP water operations would not include requirements of the 2008 USFWS BO and 2009 NMFS BO. However, reliance on groundwater in 2030 under the Second Basis of Comparison is anticipated to increase as compared to recent historical conditions due to the climate change and sea-level rise and increased water demands in the Sacramento Valley.

7.4.3 Evaluation of Alternatives

As described in Chapter 4, Approach to Environmental Analysis, Alternatives 1 through 5 have been compared to the No Action Alternative; and the No Action Alternative and Alternatives 1 through 5 have been compared to the Second Basis of Comparison.

During review of the numerical modeling analyses used in this EIS, an error was determined in the CalSim II model assumptions related to the Stanislaus River operations for the Second Basis of Comparison, Alternative 1, and Alternative 4 model runs. Appendix 5C includes a comparison of the CalSim II model run results presented in this chapter and CalSim II model run results with the error corrected. Appendix 5C also includes a discussion of changes in the comparison of groundwater conditions for the following alternative analyses.

- No Action Alternative compared to the Second Basis of Comparison
- Alternative 1 compared to the No Action Alternative
- Alternative 3 compared to the Second Basis of Comparison
- Alternative 5 compared to the Second Basis of Comparison.

7.4.3.1 No Action Alternative

The No Action Alternative is compared to the Second Basis of Comparison.

7.4.3.1.1 Trinity River Region

Groundwater conditions in the Trinity River Region are not directly related to CVP and SWP water supplies or operations. Therefore, groundwater use, related groundwater levels, potential for land subsidence, and groundwater quality under the No Action Alternative would be the same as under the Second Basis of Comparison.

7.4.3.1.2 Central Valley Region

Groundwater Use and Elevation

In areas of the Central Valley Region that do not use CVP and SWP water supplies, areas that use CVP water under Sacramento River Exchange Settlement Contracts, and areas that use San Joaquin River Exchange Contracts water, under the No Action Alternative water supplies would be the same as under the Second Basis of Comparison. Therefore, in these areas of the Central Valley Region, groundwater use and groundwater levels under the No Action Alternative would be the same as under the Second Basis of Comparison.

In areas of the Central Valley Region that use CVP water service contract and SWP entitlement contract water supplies, the CVP and SWP water supplies would be less under the No Action Alternative as compared to the Second Basis of Comparison. The differences would result in increased groundwater use and decreased groundwater levels in the San Joaquin Valley Groundwater Basin under the No Action Alternative as compared to the Second Basis of Comparison. Results of CVHM simulations indicate that groundwater levels would be similar in the Redding and Sacramento Valley Groundwater Basins and the northern portion of the San Joaquin Valley Groundwater Basin, as shown in Figures 7.15 through 7.19. The CVHM simulation primarily focuses on changes in agricultural groundwater use in response to changes in the availability of CVP and SWP water. However, it is recognized that in the vicinity of some communities, such as in the area in the American River watershed served with CVP water supplies, groundwater use also would increase with the reduction in surface water availability. However, these changes are not considered to be substantial under the No Action Alternative as compared to the Second Basis of Comparison because the long-term reductions in CVP municipal water supplies are anticipated to be up to 7,000 acre-feet per year (or 6 percent) over the long-term condition, up to 8,000 acre-feet per year (or 8 percent) in dry years, and similar (or 5 percent or less) in critical dry years. The water demands are consistent between the No Action Alternative and Second Basis of Comparison; therefore, it is anticipated that reduced surface water supplies would result in increased groundwater use.

Groundwater levels decline under the No Action Alternative in the central and southern San Joaquin Valley Groundwater Basin as compared to the Second Basis of Comparison with greater reductions occurring in wet years than in critical dry years. Figures 7.20 and 7.21 present the simulated changes in groundwater levels over the 42-year CVHM study period. Simulated average July agricultural groundwater pumping under the No Action Alternative as compared to the Second Basis of Comparison is presented in Figures 7.22 and 7.23.

Overall, under the No Action Alternative as compared to the Second Basis of Comparison, July average groundwater levels decrease approximately 2 to 10 feet in most of the central and southern San Joaquin Valley Groundwater Basin in all water year types. July average groundwater levels decline 10 to 50 feet in the Delta-Mendota, Tulare Lake, and Kern County subbasins; and 50 to 200 feet in the Westside subbasin in all water year types. In critical dry years, groundwater levels decline by up to 100 feet on average in the Westside subbasin. Groundwater level changes in the Sacramento Valley are forecast to be less than 2 feet. The groundwater level change hydrographs show that in the central and southern San Joaquin Valley, groundwater levels can fluctuate up to 200 feet in some areas due to climatic variations under the No Action Alternative compared to the Second Basis of Comparison.

The change in groundwater pumping in the Sacramento Valley would result in similar conditions (less than 5 percent change). Therefore, groundwater pumping in the Sacramento Valley is similar under the No Action Alternative compared to the Second Basis of Comparison.

Groundwater pumping in the San Joaquin and Tulare Basins would increase by approximately 8 percent under the No Action Alternative as compared to the Second Basis of Comparison. Figure 7.23 shows that the biggest change in groundwater pumping under the No Action Alternative as compared to the

Second Basis of Comparison occurs in the Westside subbasin, with an average July increase close to 40 thousand acre-feet (TAF).

Land Subsidence

Land subsidence due to groundwater withdrawals historically occurred in the Yolo subbasin of the Sacramento Valley Groundwater Basin. CVP and SWP water supplies are not used extensively in this area. The conditions under the No Action Alternative would be similar as conditions under the Second Basis of Comparison.

Under the No Action Alternative, potential for land subsidence due to groundwater withdrawals in the Delta-Mendota and Westside subbasins of the San Joaquin Valley Groundwater Basin would increase as compared to the Second Basis of Comparison due to the increased groundwater withdrawals.

Groundwater level-induced land subsidence has the highest potential to occur in the San Joaquin Groundwater Basin, based on historical data, if groundwater pumping substantially increases. Under the No Action Alternative, CVP and SWP water supplies are expected to decrease in the San Joaquin Valley as compared to the Second Basis of Comparison. Decreased surface water deliveries could result in an increase in groundwater pumping. The increased groundwater pumping would result in lower groundwater levels, and therefore, the potential for groundwater level-induced land subsidence is increased under the No Action Alternative as compared to the Second Basis of Comparison.

Groundwater Quality

Under the No Action Alternative, groundwater conditions, including groundwater quality, in areas that do not use CVP and SWP water supplies would be the same as under the Second Basis of Comparison.

In areas that use CVP and SWP water supplies, groundwater quality under the No Action Alternative could be reduced as compared to the Second Basis of Comparison in the central and southern San Joaquin Valley Groundwater Basin due to increased groundwater withdrawals and resulting potential changes in groundwater flow patterns. For example, potential impacts to groundwater quality may arise from deeper pumping close to the base of freshwater, where higher TDS water exists. Large areas in the San Joaquin Valley also experience impairments due to nitrate and other fertilizers used in agriculture, which could migrate to areas with better quality water due to increased pumping and potential changes in groundwater flow directions.

As described above, it is assumed that measures implemented in accordance with the CV-SALTS program or future sustainable groundwater management plans implemented in accordance with SGMA would not be fully implemented by 2030. Therefore, groundwater quality could decline under the No Action Alternative as compared to the Second Basis of Comparison.

Effects Related to Cross Delta Water Transfers

Potential effects to groundwater resources could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c). Potential effects to groundwater were identified as reduced groundwater levels and potentially subsidence in areas that sold water using groundwater substitution practices. Because all water transfers would be required to avoid adverse impacts to other water users and biological resources (see Section 3.A.6.3, Transfers), including impacts to other groundwater users, the analysis indicated that water transfers would not result in substantial changes in groundwater because mitigation and monitoring plans would be required. The mitigation measures would require reductions in providing water from groundwater substitutions if the monitoring results indicated substantial declines in groundwater levels. For the purposes of this EIS, it is anticipated that similar conditions would occur during implementation of cross Delta water transfers under the No Action Alternative and the Second Basis of Comparison.

Groundwater use in areas that purchase the transferred water could be reduced if additional surface water is provided. However, if the transferred water is used to meet water demands that would not have been met (e.g., crops that had been idled), groundwater conditions would be similar with or without water transfers.

Under the No Action Alternative, the timing of cross Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Under the Second Basis of Comparison, water could be transferred throughout the year without an annual volumetric limit. Overall, the potential for cross Delta water transfers would be less under the No Action Alternative than under the Second Basis of Comparison.

7.4.3.1.3 San Francisco Bay Area, Central Coast, and Southern California Regions

Groundwater Use and Elevation

Under the No Action Alternative, it is anticipated that CVP and SWP water supplies in the San Francisco Bay Area, Central Coast, and Southern California regions would be reduced as compared to CVP and SWP water supplies under the Second Basis of Comparison, as discussed in Chapter 5, Surface Water Resources and Water Supplies. The reduction in surface water supplies could result in increased groundwater withdrawals, decreased groundwater recharge, and decreased groundwater levels in areas with CVP and SWP water users. It may be legally impossible to extract additional groundwater in adjudicated basins without gaining the permission of watermasters and accounting for groundwater pumping entitlements and various parties under their adjudicated rights.

Land Subsidence

Increased use of groundwater and reductions in groundwater levels would result in an increased potential for additional land subsidence under the No Action Alternative as compared to the Second Basis of Comparison in the Santa Clara Valley Groundwater Basin in the San Francisco Bay Area Region, and the Antelope Valley and Lucerne Valley groundwater basins in the Southern California Region.

Groundwater Quality

As described in Section 7.3, Affected Environment, there are localized areas of moderate to high salinity due to natural geologic formations and/or seawater intrusion in the San Francisco Bay Area, Central Coast, and Southern California regions. Under the No Action Alternative as compared to the Second Basis of Comparison, it is anticipated that the increased groundwater withdrawals would cause poorer quality groundwater to flow towards the groundwater withdrawals, especially near the coast. This would result in poorer quality groundwater in some areas under the No Action Alternative as compared to the Second Basis of Comparison.

7.4.3.2 Alternative 1

Alternative 1 is identical to the Second Basis of Comparison. As described in Chapter 4, Approach to Environmental Analysis, Alternative 1 is compared to the No Action Alternative and the Second Basis of Comparison. However, because groundwater conditions under Alternative 1 are identical to groundwater conditions under the Second Basis of Comparison; Alternative 1 is only compared to the No Action Alternative.

7.4.3.2.1 Alternative 1 Compared to the No Action Alternative

Trinity River Region

Groundwater conditions in the Trinity River Region are not directly related to CVP and SWP water supplies or operations. Therefore, groundwater use, related groundwater levels, potential for land use subsidence, and groundwater quality degradation under Alternative 1 would be the same as under the No Action Alternative.

Central Valley Region

Groundwater Use and Elevation

In areas of the Central Valley Region that do not use CVP and SWP water supplies, areas that use CVP water under Sacramento River Exchange Settlement Contracts, and areas that use San Joaquin River Exchange Contracts under Alternative 1 water supplies would be the same as under the No Action Alternative. Therefore, in these areas of the Central Valley Region, groundwater use and groundwater levels under Alternative 1 would be the same as under the No Action Alternative.

In areas of the Central Valley Region that use CVP water service contract and SWP entitlement contract water supplies, the CVP and SWP water supplies would be greater under Alternative 1 as compared to the No Action Alternative. The differences would result in decreased groundwater use and increased groundwater levels in the San Joaquin Valley Groundwater Basin under Alternative 1 as compared to the No Action Alternative. Results of CVHM simulation indicate that groundwater levels would be similar in the Redding and Sacramento Valley groundwater basins and the northern portion of the San Joaquin Valley Groundwater Basin, as shown in Figures 7.24 through 7.28. The CVHM simulation primarily focuses on changes in agricultural groundwater use in response to changes in the availability of CVP and SWP water. However, it is recognized that in the vicinity of some communities, such as in the area in the American River watershed served with CVP water supplies, groundwater use also would increase with the reduction in surface water availability. However, these changes are not considered to be substantial under Alternative 1 as compared to the No Action Alternative because the long-term increases in CVP municipal water supplies are anticipated to be up to 7,000 acre-feet per year (or up to 6 percent) over the long-term condition, up to 8,000 acre-feet per year (or up to 8 percent) in dry years, and up to 5,000 acre-feet per year (or up to 7 percent) in critical dry years. The water demands are consistent between Alternative 1 and the No Action Alternative; therefore, it is anticipated that increased surface water supplies would result in reduced groundwater use.

Groundwater levels increase under Alternative 1 in the central and southern San Joaquin Valley Groundwater Basin as compared to the No Action Alternative with greater increases occurring in wet years than in critical dry years (up to 100 feet). Figures 7.29 and 7.30 present the simulated changes in groundwater levels over the 42-year CVHM study period. Simulated average July agricultural groundwater pumping under Alternative 1 as compared to the No Action Alternative is presented in Figures 7.31 and 7.32.

Overall, under Alternative 1 as compared to the No Action Alternative, July average groundwater levels increase approximately 2 to 10 feet in most of the central and southern San Joaquin Valley Groundwater Basin in all water year types. July average groundwater levels rise 10 to 50 feet in the Delta-Mendota, Tulare Lake, and Kern County subbasins; and 50 to 200 feet in the Westside subbasin in most water year types. In critical dry years, groundwater levels increase by up to 100 feet on average in the Westside subbasin. The groundwater level change hydrographs show that in the central and southern San Joaquin Valley subbasins, groundwater levels can fluctuate up to 200 feet in some areas due to climatic variations under Alternative 1 compared to the No Action Alternative.

The change in groundwater pumping in the Sacramento Valley is less than 5 percent. Therefore, groundwater pumping in the Sacramento Valley is similar under Alternative 1 as compared to the No Action Alternative.

Groundwater pumping in the San Joaquin and Tulare Basins would decrease by approximately 8 percent under Alternative 1 as compared to the No Action Alternative. Figure 7.32 shows that the biggest change in groundwater pumping under the Alternative 1 compared to the No Action Alternative occurs in the Westside subbasin with an average July decrease close to 40 TAF.

Land Subsidence

Land subsidence due to groundwater withdrawals historically occurred in the Yolo subbasin of the Sacramento Valley Groundwater Basin. CVP and SWP water supplies are not used extensively in this area. The conditions under Alternative 1 would be similar as conditions under the No Action Alternative.

Under Alternative 1, potential for land subsidence due to groundwater withdrawals in the Delta-Mendota and Westside subbasins of the San Joaquin Valley Groundwater Basin would decrease under Alternative 1 as compared to the No Action Alternative due to the decreased groundwater withdrawals.

Groundwater level-induced land subsidence has the highest potential to occur in the San Joaquin Valley Groundwater Basin, based on historical data, if groundwater pumping substantially increases. Under Alternative 1 CVP and SWP water supplies are expected to increase in the San Joaquin Valley as compared to the No Action Alternative. Increased surface water deliveries could result in a decrease in groundwater pumping. The decreased groundwater pumping would result in higher groundwater levels, and therefore, the potential for groundwater level-induced land subsidence is reduced under Alternative 1 as compared to the No Action Alternative.

Groundwater Quality

Under Alternative 1, groundwater conditions, including groundwater quality, in areas that do not use CVP and SWP water supplies would be the same as under the No Action Alternative.

In areas that use CVP and SWP water supplies, groundwater quality under Alternative 1 could be improved as compared to the No Action Alternative in the central and southern San Joaquin Valley Groundwater Basin due to decreased groundwater withdrawals. As described above, it is assumed that measures implemented in accordance with the CV-SALTS program or future sustainable groundwater management plans implemented in accordance with SGMA would not be fully implemented by 2030. However, due to the increased availability of CVP and SWP water supplies and related reduction in groundwater use, the groundwater quality would be improved under Alternative 1 as compared to the No Action Alternative.

Effects Related to Water Transfers

Potential effects to groundwater resources could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c), as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions would occur during implementation of cross Delta water transfers under Alternative 1 and the No Action Alternative, and that groundwater impacts would not be substantial in the seller's service area due implementation requirements of the transfer programs.

Groundwater use in areas that purchase the transferred water could be reduced if additional surface water is provided. However, if the transferred water is used to meet water demands that would not have been met (e.g., crops that had been idled), groundwater conditions would be similar with or without water transfers.

Under Alternative 1, water could be transferred throughout the year without an annual volumetric limit. Under the No Action Alternative, the timing of cross

Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Overall, the potential for cross Delta water transfers would be greater under Alternative 1 as compared to the No Action Alternative.

San Francisco Bay Area, Central Coast, and Southern California Regions

Groundwater Use and Elevation

Under Alternative 1, it is anticipated that CVP and SWP water supplies in the San Francisco Bay Area, Central Coast, and Southern California regions would be increased as compared to CVP and SWP water supplies under the No Action Alternative, as discussed in Chapter 5, Surface Water Resources and Water Supplies. The increase in surface water supplies could result in decreased groundwater withdrawals by CVP and SWP water users, resulting in increased groundwater recharge, and increased groundwater levels in areas with CVP and SWP water users.

Land Subsidence

Decreased use of groundwater and higher groundwater levels would result in a decreased potential for additional land subsidence under Alternative 1 as compared to the No Action Alternative in the Santa Clara Valley Groundwater Basin in the San Francisco Bay Area Region, and the Antelope Valley and Lucerne Valley groundwater basins in the Southern California Region.

Groundwater Quality

As described in Section 7.3, Affected Environment, there are localized areas of moderate to high salinity due to natural geologic formations and/or seawater intrusion in the San Francisco Bay Area, Central Coast, and Southern California regions. Under Alternative 1 as compared to the No Action Alternative, it is anticipated that the decreased groundwater withdrawals would cause improved groundwater quality, especially near the coast.

7.4.3.2.2 Alternative 1 Compared to the Second Basis of Comparison

Alternative 1 is identical to the Second Basis of Comparison.

7.4.3.3 Alternative 2

The CVP and SWP operations under Alternative 2 are identical to the CVP and SWP operations under the No Action Alternative; therefore, the groundwater conditions under Alternative 2 is only compared to the Second Basis of Comparison.

7.4.3.3.1 Alternative 2 Compared to the Second Basis of Comparison

Changes to groundwater resources under Alternatives 2 as compared to the Second Basis of Comparison would be the same as the impacts described in Section 7.4.3.1, No Action Alternative.

7.4.3.4 Alternative 3

As described in Chapter 3, Description of Alternatives, CVP and SWP operations under Alternative 3 are similar to the Second Basis of Comparison and

Alternative 1 with modified Old and Middle River flow criteria. Alternative 3 is compared to the No Action Alternative and the Second Basis of Comparison.

7.4.3.4.1 Alternative 3 Compared to the No Action Alternative

Trinity River Region

Groundwater conditions in the Trinity River Region are not directly related to CVP and SWP water supplies or operations. Therefore, groundwater use, related groundwater levels, potential for land use subsidence, and groundwater quality under Alternative 3 would be the same as under the No Action Alternative.

Central Valley Region

Groundwater Use and Elevation

In areas of the Central Valley Region that do not use CVP and SWP water supplies, areas that use CVP water under Sacramento River Exchange Settlement Contracts, and areas that use San Joaquin River Exchange Contracts under Alternative 3 water supplies would be the same as under the No Action Alternative. Therefore, in these areas of the Central Valley Region, groundwater use and groundwater levels under Alternative 3 would be the same as under the No Action Alternative. The CVHM simulation primarily focuses on changes in agricultural groundwater use in response to changes in the availability of CVP and SWP water. However, it is recognized that in the vicinity of some communities, such as in the area in the American River watershed served with CVP water supplies, groundwater use also would increase with the reduction in surface water availability. However, these changes are not considered to be substantial under Alternative 3 as compared to the No Action Alternative because the long-term increases in CVP municipal water supplies are anticipated to be up to 7,000 acre-feet (up to 7 percent) in dry years, and similar (or 5 percent or less) in long-term conditions and critical dry years. The water demands are consistent between Alternative 3 and the No Action Alternative; therefore, it is anticipated that increased surface water supplies would result in reduced groundwater use.

In areas of the Central Valley Region that use CVP water service contract and SWP entitlement contract water supplies, the CVP and SWP water supplies would be greater under Alternative 3 as compared to the No Action Alternative. The differences would result in decreased groundwater use and increased groundwater levels in the San Joaquin Valley Groundwater Basin under Alternative 3 as compared to the No Action Alternative. Results of CVHM simulation indicate that groundwater levels would be similar in the Redding and Sacramento Valley groundwater basins and the northern portion of the San Joaquin Valley Groundwater Basin (changes would be plus/minus 2 feet), as shown in Figures 7.33 through 7.37.

Groundwater levels increase under Alternative 3 in the central and southern San Joaquin Valley Groundwater Basin as compared to the No Action Alternative with greater increases occurring in wet years than in critical dry years. Figures 7.38 and 7.39 present the simulated changes in groundwater levels over the 42-year CVHM model study period. Simulated average July agricultural groundwater pumping under Alternative 3 as compared to the No Action Alternative is presented in Figures 7.31 and 7.32.

Overall, under Alternative 3 as compared to the No Action Alternative, July average groundwater levels increase approximately 2 to 10 feet in most of the central and southern San Joaquin Valley Groundwater Basin in all water year types. July average groundwater levels increase 10 to 50 feet in the Delta-Mendota, Tulare Lake, and Kern County subbasins; and 50 to 200 feet in the Westside subbasin in most water year types. In critical dry years, groundwater levels increase by up to 50 feet on average in the Westside subbasin. The groundwater level change hydrographs show that in the central and southern San Joaquin Valley, groundwater levels can fluctuate up to 200 feet in some areas due to climatic variations under Alternative 3 compared to the No Action Alternative.

The change in groundwater pumping in the Sacramento Valley is less than 5 percent. Therefore, groundwater pumping in the Sacramento Valley is similar under Alternative 3 compared to the No Action Alternative.

Groundwater pumping in the San Joaquin and Tulare Basins decreases by approximately 6 percent under Alternative 3 as compared to the No Action Alternative. Figure 7.32 shows that the largest change in groundwater pumping under Alternative 3 as compared to the No Action Alternative occurs in the Westside subbasin with an average July decrease of approximately 35 TAF.

Land Subsidence

Land subsidence due to groundwater withdrawals historically occurred in the Yolo subbasin of the Sacramento Valley Groundwater Basin. CVP and SWP water supplies are not used extensively in this area. The conditions under Alternative 3 would be similar as conditions under the No Action Alternative.

Under Alternative 3, potential for land subsidence due to groundwater withdrawals in the Delta-Mendota and Westside subbasins of the San Joaquin Valley Groundwater Basin would decrease under Alternative 3 as compared to the No Action Alternative due to the decreased groundwater withdrawals.

Groundwater level-induced land subsidence has the highest potential to occur in the San Joaquin Valley Groundwater Basin, based on historical data, if groundwater pumping substantially increases. Under Alternative 3 CVP and SWP water supplies are expected to increase in the San Joaquin Valley as compared to the No Action Alternative. Increased surface water deliveries could result in a decrease in groundwater pumping. The decreased groundwater pumping would result in higher groundwater levels, and therefore, the potential for groundwater level-induced land subsidence is reduced under Alternative 3 as compared to the No Action Alternative.

Groundwater Quality

Under Alternative 3, groundwater conditions, including groundwater quality, in areas that do not use CVP and SWP water supplies would be the same as under the No Action Alternative.

In areas that use CVP and SWP water supplies, groundwater quality under Alternative 3 could be improved as compared to the No Action Alternative in the central and southern San Joaquin Valley Groundwater Basin due to decreased groundwater withdrawals. As described above, it is assumed that measures implemented in accordance with the CV-SALTS program or future sustainable groundwater management plans implemented in accordance with SGMA would not be fully implemented by 2030. However, due to the increased availability of CVP and SWP water supplies and related reduction in groundwater use, the groundwater quality would be improved under Alternative 3 as compared to the No Action Alternative.

Effects Related to Water Transfers

Potential effects to groundwater resources could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c), as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions would occur during implementation of cross Delta water transfers under Alternative 3 and the No Action Alternative, and that groundwater impacts would not be substantial in the seller's service area due implementation requirements of the transfer programs.

Groundwater use in areas that purchase the transferred water could be reduced if additional surface water is provided. However, if the transferred water is used to meet water demands that would not have been met (e.g., crops that had been idled), groundwater conditions would be similar with or without water transfers.

Under Alternative 3, water could be transferred throughout the year without an annual volumetric limit. Under the No Action Alternative, the timing of cross Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Overall, the potential for cross Delta water transfers would be greater under Alternative 3 as compared to the No Action Alternative.

San Francisco Bay Area, Central Coast, and Southern California Regions

Groundwater Use and Elevation

Under Alternative 3, it is anticipated that CVP and SWP water supplies in the San Francisco Bay Area, Central Coast, and Southern California regions would be increased as compared to CVP and SWP water supplies under the No Action Alternative, as discussed in Chapter 5, Surface Water Resources and Water Supplies. The increase in surface water supplies could result in decreased groundwater withdrawals by CVP and SWP water users, resulting in increased groundwater recharge, and increased groundwater levels. It may be legally impossible to extract additional groundwater in adjudicated basins without gaining the permission of watermasters and accounting for groundwater pumping entitlements and various parties under their adjudicated rights.

Land Subsidence

Decreased use of groundwater and higher groundwater levels would result in a decreased potential for additional land subsidence under Alternative 3 as compared to the No Action Alternative in the Santa Clara Valley Groundwater Basin in the San Francisco Bay Area Region, and the Antelope Valley and Lucerne Valley groundwater basins in the Southern California Region.

Groundwater Quality

As described in Section 7.3, Affected Environment, there are localized areas of moderate to high salinity due to natural geologic formations and/or seawater intrusion in the San Francisco Bay Area, Central Coast, and Southern California regions. Under Alternative 3 as compared to the No Action Alternative, it is anticipated that the decreased groundwater withdrawals would cause improved groundwater quality, especially near the coast.

7.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison

Trinity River Region

Groundwater conditions in the Trinity River Region are not directly related to CVP and SWP water supplies or operations. Therefore, groundwater use, related groundwater levels, potential for land use subsidence, and groundwater quality under Alternative 3 would be the same as under the Second Basis of Comparison.

Central Valley Region

Groundwater Use and Elevation

In areas of the Central Valley Region that do not use CVP and SWP water supplies, areas that use CVP water under Sacramento River Exchange Settlement Contracts, and areas that use San Joaquin River Exchange Contracts under Alternative 3 water supplies would be the same as under the Second Basis of Comparison. Therefore, in these areas of the Central Valley Region, groundwater use and groundwater levels under Alternative 3 would be the same as under the Second Basis of Comparison. The CVHM simulation primarily focuses on changes in agricultural groundwater use in response to changes in the availability of CVP and SWP water. However, it is recognized that in the vicinity of some communities, such as in the area in the American River watershed served with CVP water supplies, groundwater use also would increase with the reduction in surface water availability. However, these changes are considered to be similar under Alternative 3 as compared to the Second Basis of Comparison because the CVP municipal water supplies are similar (or 5 percent or less) in long-term conditions, dry years, and critical dry years. The water demands are consistent between Alternative 3 and the Second Basis of Comparison; therefore, it is anticipated that similar surface water supplies would result in similar groundwater use.

In areas of the Central Valley Region that use CVP water service contract and SWP entitlement contract water supplies, the CVP and SWP water supplies would be less under Alternative 3 as compared to the Second Basis of Comparison. The differences would result in increased groundwater use and decreased groundwater levels in the San Joaquin Valley Groundwater Basin under Alternative 3 as compared to the Second Basis of Comparison. Results of CVHM simulation indicate that groundwater levels would be similar in the Redding and Sacramento Valley groundwater basins and the northern portion of the San Joaquin Valley Groundwater Basin, as shown in Figures 7.40 through 7.44.

Groundwater levels generally decrease under Alternative 3 in the central and southern San Joaquin Valley Groundwater Basin as compared to the Second Basis of Comparison. Figures 7.45 and 7.46 present the simulated change in groundwater levels over the 42-year CVHM study period. Simulated average July agricultural groundwater pumping under Alternative 3 as compared to the Second Basis of Comparison is presented in Figures 7.22 and 7.23.

Overall, under Alternative 3 as compared to the Second Basis of Comparison, July average groundwater levels decrease approximately 2 to 10 feet areas of the western and southern San Joaquin Valley Groundwater Basin in all water year types. July average groundwater levels decline up to 25 feet in the Delta-Mendota, Tulare Lake, and Kern County subbasins; and decline up to 25 feet in Westside subbasin, in most water year types. However, groundwater levels in the Westside subbasin increase by up to 10 feet on average in wet years, due to increased CVP water deliveries to this region in wet years. Groundwater level changes in the Sacramento Valley are forecast to be less than 2 feet. The groundwater level change hydrographs show that in the central and southern San Joaquin Valley, groundwater levels can fluctuate up to 200 feet in some areas due to climatic variations under Alternative 3 compared to the Second Basis of Comparison.

The change in groundwater pumping in the Sacramento Valley is less than 5 percent. Therefore, groundwater pumping in the Sacramento Valley is similar under Alternative 3 compared to the Second Basis of Comparison.

Groundwater pumping in the San Joaquin and Tulare Basins changes by less than 5 percent under Alternative 3 as compared to the Second Basis of Comparison, and is therefore considered similar. Figure 7.23 shows that the biggest change in groundwater pumping under Alternative 3 compared to the Second Basis of Comparison occurs in WBS 18, with an average July increase close to 10 TAF.

Land Subsidence

Groundwater pumping would be similar in the Sacramento and San Joaquin valleys, therefore, the potential for groundwater level-induced land subsidence would be similar under Alternative 3 as compared to the Second Basis of Comparison.

Groundwater Quality

Groundwater pumping would be similar in the Sacramento and San Joaquin valleys, therefore, groundwater quality would be similar under Alternative 3 as compared to the Second Basis of Comparison.

Effects Related to Water Transfers

Potential effects to groundwater resources could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c), as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions would occur during implementation of cross Delta water transfers under Alternative 3 and the Second Basis of Comparison, and that groundwater impacts would not be substantial in the seller's service area due implementation requirements of the transfer programs.

Groundwater use in areas that purchase the transferred water could be reduced if additional surface water is provided. However, if the transferred water is used to meet water demands that would not have been met (e.g., crops that had been idled), groundwater conditions would be similar with or without water transfers.

Under Alternative 3 and the Second Basis of Comparison, water could be transferred throughout the year without an annual volumetric limit. Therefore, the potential for cross Delta water transfers would be similar under Alternative 3 and the Second Basis of Comparison.

San Francisco Bay Area, Central Coast, and Southern California Regions

Groundwater Use and Elevation

Under Alternative 3, it is anticipated that CVP and SWP water supplies in the San Francisco Bay Area, Central Coast, and Southern California regions would be decreased as compared to CVP and SWP water supplies under the Second Basis of Comparison, as discussed in Chapter 5, Surface Water Resources and Water Supplies. The decrease in surface water supplies could result in increased groundwater withdrawals by CVP and SWP water users, resulting in decreased groundwater recharge, and decreased groundwater levels in areas with CVP and SWP water users.

Land Subsidence

Increased use of groundwater and lower groundwater levels would result in an increased potential for additional land subsidence under Alternative 3 as compared to the Second Basis of Comparison in the Santa Clara Valley Groundwater Basin in the San Francisco Bay Area Region, and the Antelope Valley and Lucerne Valley groundwater basins in the Southern California Region.

Groundwater Quality

As described in Section 7.3, Affected Environment, there are localized areas of moderate to high salinity due to natural geologic formations and/or seawater intrusion in the San Francisco Bay Area, Central Coast, and Southern California regions. Under Alternative 3 as compared to the Second Basis of Comparison, it is anticipated that the increased groundwater withdrawals would cause poorer groundwater quality, especially near the coast.

7.4.3.5 Alternative 4

Groundwater conditions under Alternative 4 would be identical to groundwater conditions under the Second Basis of Comparison; therefore, Alternative 4 is only compared to the No Action Alternative.

7.4.3.5.1 Alternative 4 Compared to the No Action Alternative

Changes in groundwater conditions under Alternative 4 as compared to the No Action Alternative would be the same as the impacts described in Section 7.4.3.2.1, Alternative 1 Compared to the No Action Alternative.

7.4.3.6 Alternative 5

CVP and SWP operations under Alternative 5 are similar to the No Action Alternative with modified Old and Middle River flow criteria and New Melones Reservoir operations. As described in Chapter 4, Approach to Environmental Analysis, Alternative 5 is compared to the No Action Alternative and the Second Basis of Comparison.

7.4.3.6.1 Alternative 5 Compared to the No Action Alternative

Trinity River Region

Groundwater conditions in the Trinity River Region are not directly related to CVP and SWP water supplies or operations. Therefore, groundwater use, related groundwater levels, potential for land use subsidence, and groundwater quality under Alternative 5 would be the same as under the No Action Alternative.

Central Valley Region

Groundwater Use and Elevation

In areas of the Central Valley Region that do not use CVP and SWP water supplies, areas that use CVP water under Sacramento River Exchange Settlement Contracts, and areas that use San Joaquin River Exchange Contracts under Alternative 5 water supplies would be the same as under the No Action Alternative. Therefore, in these areas of the Central Valley Region, groundwater use and groundwater levels under Alternative 5 would be the same as under the No Action Alternative. The CVHM simulation primarily focuses on changes in agricultural groundwater use in response to changes in the availability of CVP and SWP water. However, it is recognized that in the vicinity of some communities, such as in the area in the American River watershed served with CVP water supplies, groundwater use also would increase with the reduction in surface water availability. However, these changes are not considered to be substantial under Alternative 5 as compared to the No Action Alternative because the CVP municipal water supplies are anticipated to be similar in long-term conditions, dry years, and critical dry years. The water demands are consistent between Alternative 5 and the No Action Alternative; therefore, it is anticipated that similar surface water supplies would result in similar groundwater use.

In areas of the Central Valley Region that use CVP water service contract and SWP entitlement contract water supplies, the CVP and SWP water supplies would be slightly lower under Alternative 5 as compared to the No Action Alternative.

The differences would result in increased groundwater use and decreased groundwater levels in the San Joaquin Valley Groundwater Basin under Alternative 5 as compared to the No Action Alternative. Results of CVHM simulations indicate that groundwater levels would be similar in the Redding and Sacramento Valley groundwater basins and the northern portion of the San Joaquin Valley Groundwater Basin, as shown in Figures 7.47 through 7.51.

Groundwater levels decrease under Alternative 5 in the central and southern San Joaquin Valley Groundwater Basin as compared to the No Action Alternative with the greatest decreases occurring in above normal years. Figures 7.52 and 7.53 present the simulated change in groundwater levels over the 42-year CVHM study period. Simulated average July agricultural groundwater pumping under Alternative 5 as compared to the No Action Alternative is presented in Figures 7.31 and 7.32.

Overall, under Alternative 5 as compared to the No Action Alternative, July average groundwater levels decrease approximately 2 to 10 feet on average in some of the Westside subbasin and the northern portion of the Kern County subbasin in most water year types, and decrease approximately by up to 25 feet in dry and above normal water years in the Westside subbasin. The groundwater level change hydrographs show that in the central and southern San Joaquin Valley, groundwater levels usually fluctuate by no more than 50 feet in some areas due to seasonal and climatic variations under Alternative 5 compared to the No Action Alternative.

The change in groundwater pumping in the Sacramento Valley is less than 5 percent. Therefore, groundwater pumping in the Sacramento Valley is similar under Alternative 5 compared to the No Action Alternative.

Groundwater pumping in the San Joaquin and Tulare Basins changes by less than 5 percent under Alternative 5 as compared to the No Action Alternative, and is therefore considered similar. Figure 7.32 shows that the biggest change in groundwater pumping under Alternative 5 compared to the No Action Alternative occurs in the Western San Joaquin Valley.

Land Subsidence

Groundwater pumping would be similar in the Sacramento and San Joaquin valleys, therefore, the potential for groundwater level-induced land subsidence would be similar under Alternative 5 as compared to the No Action Alternative.

Groundwater Quality

Groundwater pumping would be similar in the Sacramento and San Joaquin valleys, therefore, groundwater quality would be similar under Alternative 5 as compared to the No Action Alternative.

Effects Related to Water Transfers

Potential effects to groundwater resources could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c), as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions would occur during implementation of cross Delta water transfers under Alternative 5 and the No Action Alternative, and that groundwater impacts would not be substantial in the seller's service area due implementation requirements of the transfer programs.

Groundwater use in areas that purchase the transferred water could be reduced if additional surface water is provided. However, if the transferred water is used to meet water demands that would not have been met (e.g., crops that had been idled), groundwater conditions would be similar with or without water transfers.

Under Alternative 5 and the No Action Alternative, the timing of cross Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Overall, the potential for cross Delta water transfers would be similar under Alternative 5 as compared to the No Action Alternative.

San Francisco Bay Area, Central Coast, and Southern California Regions Groundwater Use and Elevation

Under Alternative 5, it is anticipated that CVP and SWP water supplies in the San Francisco Bay Area, Central Coast, and Southern California regions would be similar to CVP and SWP water supplies under the No Action Alternative, as discussed in Chapter 5, Surface Water Resources and Water Supplies. Therefore, groundwater pumping would be similar.

Land Subsidence

Because the groundwater pumping would be similar under Alternative 5 as compared to the No Action Alternative; therefore, the potential for additional land subsidence would be similar.

Groundwater Quality

Because the groundwater pumping would be similar under Alternative 5 as compared to the No Action Alternative; therefore, groundwater quality would be similar.

7.4.3.6.2 Alternative 5 Compared to the Second Basis of Comparison

Trinity River Region

Groundwater conditions in the Trinity River Region are not directly related to CVP and SWP water supplies or operations. Therefore, groundwater use, related groundwater levels, potential for land use subsidence, and groundwater quality under Alternative 5 would be the same as under the Second Basis of Comparison.

Central Valley Region

Groundwater Use and Elevation

In areas of the Central Valley Region that do not use CVP and SWP water supplies, areas that use CVP water under Sacramento River Exchange Settlement Contracts, and areas that use San Joaquin River Exchange Contracts under Alternative 5 water supplies would be the same as under the Second Basis of

Comparison. Therefore, in these areas of the Central Valley Region, groundwater use and groundwater levels under Alternative 5 would be the same as under the Second Basis of Comparison. The CVHM simulation primarily focuses on changes in agricultural groundwater use in response to changes in the availability of CVP and SWP water. However, it is recognized that in the vicinity of some communities, such as in the area in the American River watershed served with CVP water supplies, groundwater use also would increase with the reduction in surface water availability. However, these changes are not considered to be substantial under Alternative 5 as compared to the Second Basis of Comparison because the long-term reductions in CVP municipal water supplies are anticipated to be up to 7,000 acre-feet per year (up to 6 percent) over the long-term condition, up to 9,000 acre-feet per year (up to 9 percent) in dry years, and up to 6,000 acre-feet per year (up to 8 percent) in critical dry years. The water demands are consistent between Alternative 5 and the Second Basis of Comparison; therefore, it is anticipated that reduced surface water supplies would result in increased groundwater use.

In areas of the Central Valley Region that use CVP water service contract and SWP entitlement contract water supplies, the CVP and SWP water supplies would be lower under Alternative 5 as compared to the Second Basis of Comparison. The differences would result in increased groundwater use and decreased groundwater levels in the San Joaquin Valley Groundwater Basin under Alternative 5 as compared to the Second Basis of Comparison. Results of CVHM simulations indicate that groundwater levels would be similar in the Redding and Sacramento Valley groundwater basins and the northern portion of the San Joaquin Valley Groundwater Basin, as shown in Figures 7.54 through 7.58.

Groundwater levels generally decrease under Alternative 5 in the central and southern San Joaquin Valley Groundwater Basin as compared to the Second Basis of Comparison. Figures 7.59 and 7.60 present the simulated change in groundwater levels over the 42-year CVHM study period. Simulated average July agricultural groundwater pumping under Alternative 5 as compared to the Second Basis of Comparison is presented in Figures 7.22 and 7.23.

Overall, under Alternative 5 as compared to the Second Basis of Comparison, July average groundwater levels decrease approximately 2 to 10 feet in most of the central and southern San Joaquin Valley Groundwater Basin in all water year types. July average groundwater levels decline 10 to 50 feet in the Delta-Mendota, Tulare Lake, and Kern County subbasins; and can decline up to 200 feet in the Westside subbasin, in below normal, above normal and dry water year types. Groundwater level changes in the Sacramento Valley are forecast to be less than 2 feet. The groundwater level change hydrographs show that in the central and southern San Joaquin Valley, groundwater levels can fluctuate up to 200 feet in some areas due to seasonal and climatic variations under Alternative 5 compared to the Second Basis of Comparison.

The change in groundwater pumping in the Sacramento Valley is less than 5 percent. Therefore, groundwater pumping in the Sacramento Valley is similar under Alternative 5 compared to the Second Basis of Comparison.

Groundwater pumping in the San Joaquin and Tulare Basins increases by approximately 8 percent under the Alternative 5 as compared to the Second Basis of Comparison. Figure 7.23 shows that the biggest change in groundwater pumping under Alternative 5 compared to the Second Basis of Comparison occurs in WBS 14, with an average July increase of almost 40 TAF.

Land Subsidence

Land subsidence due to groundwater withdrawals historically occurred in the Yolo subbasin of the Sacramento Valley Groundwater Basin. CVP and SWP water supplies are not used extensively in this area. The conditions under Alternative 5 would be similar as conditions under the Second Basis of Comparison.

Under Alternative 5, potential for land subsidence due to groundwater withdrawals in the Delta-Mendota and Westside subbasins of the San Joaquin Valley Groundwater Basin would increase under Alternative 5 as compared to the Second Basis of Comparison due to the increased groundwater withdrawals.

Groundwater level-induced land subsidence has the highest potential to occur in the San Joaquin Groundwater Basin, based on historical data, if groundwater pumping substantially increases. Under Alternative 5, CVP and SWP water supplies are expected to decrease in the San Joaquin Valley as compared to the Second Basis of Comparison. Decreased surface water deliveries could result in an increase in groundwater pumping. The increased groundwater pumping would result in lower groundwater levels, and therefore, the potential for groundwater level-induced land subsidence is increased under Alternative 5 as compared to the Second Basis of Comparison.

Groundwater Quality

Under Alternative 5, groundwater conditions, including groundwater quality, in areas that do not use CVP and SWP water supplies would be the same as under the Second Basis of Comparison.

In areas that use CVP and SWP water supplies, groundwater quality under Alternative 5 could be reduced as compared to the Second Basis of Comparison in the central and southern San Joaquin Valley Groundwater Basin due to increased groundwater withdrawals and resulting potential changes in groundwater flow patterns. As described above, it is assumed that measures implemented in accordance with the CV-SALTS program or future sustainable groundwater management plans implemented in accordance with SGMA would not be fully implemented by 2030. Therefore, groundwater quality may be affected under Alternative 5 as compared to the Second Basis of Comparison.

Effects Related to Water Transfers

Potential effects to groundwater resources could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c), as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions would occur during implementation of cross Delta water transfers under Alternative 5 and the Second Basis of Comparison, and that groundwater impacts would not be substantial in the seller's service area due implementation requirements of the transfer programs.

Groundwater use in areas that purchase the transferred water could be reduced if additional surface water is provided. However, if the transferred water is used to meet water demands that would not have been met (e.g., crops that had been idled), groundwater conditions would be similar with or without water transfers.

Under Alternative 5 and the Second Basis of Comparison, water could be transferred throughout the year without an annual volumetric limit. Therefore, the potential for cross Delta water transfers would be similar under Alternative 5 and the Second Basis of Comparison.

San Francisco Bay Area, Central Coast, and Southern California Regions Groundwater Use and Elevation

Under Alternative 5, it is anticipated that CVP and SWP water supplies in the San Francisco Bay Area, Central Coast, and Southern California regions would be decreased as compared to CVP and SWP water supplies under the Second Basis of Comparison, as discussed in Chapter 5, Surface Water Resources and Water Supplies. The decrease in surface water supplies could result in increased groundwater withdrawals by CVP and SWP water users, resulting in decreased groundwater recharge, and decreased groundwater levels in areas with CVP and SWP water users. It may be legally impossible to extract additional groundwater in adjudicated basins without gaining the permission of watermasters and accounting for groundwater pumping entitlements and various parties under their adjudicated rights.

Land Subsidence

Increased use of groundwater and lower groundwater levels would result in a decreased potential for additional land subsidence would increase under Alternative 5 as compared to the Second Basis of Comparison in the Santa Clara Valley Groundwater Basin in the San Francisco Bay Area Region, and the Antelope Valley and Lucerne Valley groundwater basins in the Southern California Region.

Groundwater Quality

As described in Section 7.3, Affected Environment, there are localized areas of moderate to high salinity due to natural geologic formations and/or seawater intrusion in the San Francisco Bay Area, Central Coast, and Southern California regions. Under Alternative 5 as compared to the Second Basis of Comparison, it is anticipated that the increased groundwater withdrawals would cause poorer groundwater quality, especially near the coast.

7.4.3.7 Summary of Impact Analysis

The results of the impact analysis of implementation of Alternatives 1 through 5 as compared to the No Action Alternative and the Second Basis of Comparison are presented in Tables 7.3 and 7.4.

Table 7.3 Comparison of Alternatives 1 through 5 to No Action Alternative

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	**Trinity River Region** Groundwater conditions would be similar. **Central Valley Region** Groundwater pumping and levels in the Sacramento Valley would be similar. Groundwater pumping in the San Joaquin Valley would decrease by approximately 8 percent. July groundwater levels in all water year types would be higher by approximately 2 to 10 feet in most of the central and southern San Joaquin Valley; 10 to 50 feet in the Delta-Mendota, Tulare Lake, and Kern County subbasins; and 50 to 200 feet in the Westside subbasin. The higher groundwater levels would reduce the potential for land subsidence. Groundwater quality in the San Joaquin Valley Groundwater Basin could decline. **San Francisco Bay Area, Central Coast, and Southern California Regions** Increases in CVP and SWP water supplies, could decrease groundwater pumping and decrease the potential for land subsidence.	None needed
Alternative 2	No effects on groundwater resources or water supplies.	None needed
Alternative 3	**Trinity River Region** Groundwater conditions would be similar. **Central Valley Region** Groundwater pumping and levels in the Sacramento Valley would be similar. Groundwater pumping in the San Joaquin Valley would decrease by approximately 6 percent. July groundwater levels in all water year types would be higher by approximately 2 to 10 feet in most of the central and southern San Joaquin Valley; 10 to 50 feet in the Delta-Mendota, Tulare Lake, and Kern County subbasins; and 50 to 200 feet in the Westside subbasin. The higher groundwater levels would reduce the potential for land subsidence. Groundwater quality in the San Joaquin Valley Groundwater Basin could decline. **San Francisco Bay Area, Central Coast, and Southern California Regions** Increases in CVP and SWP water supplies, could decrease groundwater pumping and decrease the potential for land subsidence.	None needed

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 4	Same effects as described for Alternative 1 compared to the No Action Alternative.	None needed
Alternative 5	**Trinity River Region** Groundwater conditions would be similar. **Central Valley Regions** Groundwater pumping and levels in the Sacramento Valley would be similar. Groundwater pumping, levels, and quality in the San Joaquin Valley would be similar. July groundwater levels in all water year types would decline approximately 2 to 10 feet in most of the central and southern San Joaquin Valley; and up to 25 feet in the Westside subbasin. **San Francisco Bay Area, Central Coast, and Southern California Regions** Because the CVP and SWP water deliveries would be similar; groundwater pumping would be similar the potential for land subsidence would be similar.	None needed

Note:
*Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools, incremental differences of 5 percent or less between alternatives and the Second Basis of Comparison are considered to be “similar.”

Table 7.4 Comparison of No Action Alternative and Alternatives 1 through 5 to Second Basis of Comparison

Alternative	Potential Change	Consideration for Mitigation Measures
No Action Alternative	**Trinity River Region** Groundwater conditions would be similar. **Central Valley Regions** Groundwater pumping and levels in the Sacramento Valley would be similar. Groundwater pumping in the San Joaquin Valley would increase by approximately 8 percent. July groundwater levels in all water year types would decline approximately 2 to 10 feet in most of the central and southern San Joaquin Valley; 10 to 50 feet in the Delta-Mendota, Tulare Lake, and Kern County subbasins; and 100 to 200 feet in the Westside subbasin. The reduction in groundwater levels could cause additional land subsidence. Groundwater quality in the San Joaquin Valley Groundwater Basin could decline. **San Francisco Bay Area, Central Coast, and Southern California Regions** Reductions in CVP and SWP water supplies, could increase groundwater pumping and increase the potential for land subsidence.	Not considered for this comparison.
Alternative 1	No effects on groundwater resources or water supplies.	None needed.
Alternative 2	Same effects as described for No Action Alternative as compared to the Second Basis of Comparison.	Not considered for this comparison.
Alternative 3	**Trinity River Region** Groundwater conditions would be similar. **Central Valley Regions** Groundwater pumping and levels in the Sacramento Valley would be similar. Groundwater pumping, levels, and quality in the San Joaquin Valley would be similar. July groundwater levels in all water year types would decline approximately 2 to 10 feet in the areas of the western and southern San Joaquin Valley; up to 25 feet in the Delta-Mendota, Tulare Lake, Kern County and in Westside subbasins. **San Francisco Bay Area, Central Coast, and Southern California Regions** Reductions in CVP and SWP water supplies, could increase groundwater pumping and increase the potential for land subsidence.	Not considered for this comparison.

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 4	No effects on groundwater resources or water supplies.	None needed
Alternative 5	**Trinity River Region** Groundwater conditions would be similar. **Central Valley Regions** Groundwater pumping and levels in the Sacramento Valley would be similar. Groundwater pumping in the San Joaquin Valley would increase by approximately 8 percent. July groundwater levels in all water year types would decline approximately 2 to 10 feet in most of the central and southern San Joaquin Valley; 10 to 50 feet in the Delta-Mendota, Tulare Lake and Kern County subbasins; and up to 200 feet in the Westside subbasin. The reduction in groundwater levels could cause additional land subsidence. Groundwater quality in the San Joaquin Valley Groundwater Basin could decline. **San Francisco Bay Area, Central Coast, and Southern California Regions** Reductions in CVP and SWP water supplies, could increase groundwater pumping and increase the potential for land subsidence.	Not considered for this comparison.

Note:
*Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools, incremental differences of 5 percent or less between alternatives and the Second Basis of Comparison are considered to be “similar.”

7.4.3.8 Potential Mitigation Measures

Mitigation measures are presented in this section to avoid, minimize, rectify, reduce, eliminate, or compensate for adverse environmental effects of Alternatives 1 through 5 as compared to the No Action Alternative. Mitigation measures were not included to address adverse impacts under the alternatives as compared to the Second Basis of Comparison because this analysis was included in this EIS for information purposes only.

As described above and summarized in Table 7.3, implementation of Alternatives 1 through 5 as compared to the No Action Alternative would result in either similar or less groundwater pumping and potential for land subsidence; and similar groundwater quality conditions. Therefore, there would be no adverse impacts to groundwater; and no mitigation measures are needed.

7.4.3.9 Cumulative Effects Analysis

As described in Chapter 3, the cumulative effects analysis considers projects, programs, and policies that are not speculative; and are based upon known or reasonably foreseeable long-range plans, regulations, operating agreements, or other information that establishes them as reasonably foreseeable.

The cumulative effects analysis for Alternatives 1 through 5 for Groundwater Resources are summarized in Table 7.5.

Table 7.5 Summary of Cumulative Effects on Groundwater Resources of Alternatives 1 through 5 as Compared to the No Action Alternative

Scenarios	Actions	Cumulative Effects of Actions
Past & Present, and Future Actions included in the No Action Alternative in All Alternatives in Year 2030	Consistent with Affected Environment conditions plus: Actions in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives), including climate change and sea level rise Actions not included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives): - Implementation of Federal and state policies and programs, including Clean Water Act (e.g.,Total Maximum Daily Loads); Safe Drinking Water Act; Clean Air Act; and flood management programs - General plans for 2030. - Trinity River Restoration Program. - Central Valley Project Improvement Act programs - Iron Mountain Mine Superfund Site - Nimbus Fish Hatchery Fish Passage Project - Folsom Dam Water Control Manual Update	These effects would be the same in all alternatives. Climate change and sea level rise, development under the general plans, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce availability of CVP and SWP water supplies; and therefore, increase groundwater use, reduce groundwater elevations, and increase potential subsidence. Future water supply projects are anticipated to both increase surface water supply reliability due to increased surface water supplies and to accommodate planned growth in the general plans. Most of these programs were initiated prior to implementation of the 2008 USFWS BO and 2009 NMFS BO which reduced CVP and SWP water supply reliability. Developments under the general plans and future water supply, water quality improvement, and restoration projects are anticipated to potentially affect future groundwater resources.

Scenarios	Actions	Cumulative Effects of Actions
	- FERC Relicensing for the Middle Fork of the American River Project - Lower Mokelumne River Spawning Habitat Improvement Project - Dutch Slough Tidal Marsh Restoration	However, development of these future programs would include preparation of environmental documentation that would identify methods to minimize adverse impacts to groundwater resources.
	- Suisun Marsh Habitat Management, Preservation, and Restoration Plan Implementation - Tidal Wetland Restoration: Yolo Ranch, Northern Liberty Island Fish Restoration Project, Prospect Island Restoration Project, and Calhoun Cut/Lindsey Slough Tidal Habitat Restoration Project - San Joaquin River Restoration Program - Stockton Deep Water Ship Channel Dissolved Oxygen Project - Grasslands Bypass Project - Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) - Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects with completed environmental documents)	Some of the future actions would reduce the effects of agricultural drainage and/or reduce salinity in the San Joaquin River and the Delta. These programs would result in a beneficial impact to groundwater quality.

Scenarios	Actions	Cumulative Effects of Actions
Future Actions considered as Cumulative Effects Actions in All Alternatives in Year 2030	Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives): - Bay-Delta Water Quality Control Plan Update - FERC Relicensing Projects - Bay Delta Conservation Plan (including California WaterFix alternative) - Shasta Lake Water Resources, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations - El Dorado Water and Power Authority Supplemental Water Rights Project - Sacramento River Water Reliability Project	These effects would be the same in all alternatives. Most of the future reasonably foreseeable actions are anticipated to reduce water supply impacts due to climate change, sea level rise, increased water allocated to improve habitat conditions, and future growth. Some of the future reasonably foreseeable actions related to improved water quality and habitat conditions (e.g., Water Quality Control Plan Update and FERC Relicensing Projects), could in further reductions in CVP and SWP water deliveries.
	- Semitropic Water Storage District Delta Wetlands - North Bay Aqueduct Alternative Intake - Irrigated Lands Regulatory Program - San Luis Reservoir Low Point Improvement Project - Westlands Water District v. United States Settlement - Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects that did not have completed environmental documents during preparation of the EIS)	Developments under the future projects are anticipated to potentially affect groundwater resources. However, development of these future programs would include preparation of environmental documentation that would identify methods to minimize adverse impacts to groundwater resources. Some of the future reasonably foreseeable actions would reduce the effects of agricultural drainage and/or reduce salinity in the San Joaquin River and the Delta. These programs would result in a beneficial impact to groundwater quality.

Scenarios	Actions	Cumulative Effects of Actions
No Action Alternative with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS	Climate change and sea level rise, development under the general plans, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce availability of CVP and SWP water supplies, and increase groundwater use as compared to past conditions. Future water supply projects are anticipated to both increase water supply reliability due to increased surface water supplies and to accommodate planned growth in the general plans. Some of the future actions would reduce the effects of agricultural drainage and/or reduce salinity in the San Joaquin River and the Delta, and improve groundwater quality.
		Groundwater substitution water transfers could result in reduced groundwater levels and potential subsidence in areas that sell water using groundwater substitution practices. Because all water transfers would be required to avoid adverse impacts to other water users and biological resources, including impacts to other groundwater users, it is anticipated that water transfers would not result in substantial changes in groundwater conditions
Alternative 1 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternative 1 with future reasonably foreseeable would result in increased surface water availability and reduced groundwater use as compared to the No Action Alternative with the added actions.

Scenarios	Actions	Cumulative Effects of Actions
Alternative 2 with Associated Cumulative Effects in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions No implementation of structural improvements or other actions that require further study to develop a more detailed action description.	Implementation of Alternative 2 with future reasonably foreseeable would result in similar surface water availability and similar groundwater use as compared to the No Action Alternative with the added actions.
Alternative 3 with Associated Cumulative Effects in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant) Slight increase in positive Old and Middle River flows in the winter and spring months	Implementation of Alternative 3 with future reasonably foreseeable would result in increased surface water availability and reduced groundwater use as compared to the No Action Alternative with the added actions.
Alternative 4 with Associated Cumulative Effects in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternative 4 with future reasonably foreseeable would result in increased surface water availability and reduced groundwater use as compared to the No Action Alternative with the added actions.
Alternative 5 with Associated Cumulative Effects in Year 20530	Full implementation of the 2008 USFWS BO and 2009 NMFS BO Positive Old and Middle River flows and increased Delta outflow in spring months	Implementation of Alternative 5 with future reasonably foreseeable would result in similar surface water availability and similar groundwater use as compared to the No Action Alternative with the added actions.

There would be no adverse impacts associated with implementation of the alternatives as compared to the No Action Alternative. Therefore, Alternatives 1 through 5 would not contribute cumulative impacts to groundwater as compared to the No Action Alternative. However, implementation of No Action Alternative and Alternative 5 (in the Central Valley, San Francisco Bay Area, Central Coast, and Southern California regions) and Alternative 3 (in the San Francisco Bay Area, Central Coast, and Southern California regions) as compared to the Second Basis of Comparison would result in increased groundwater pumping and associated potential for land subsidence and poorer groundwater quality; and could contribute to cumulative impacts related to groundwater conditions as compared to the Second Basis of Comparison conditions.

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Figure 7.1 California Groundwater Basins and Subbasins Defined in DWR Bulletin 118

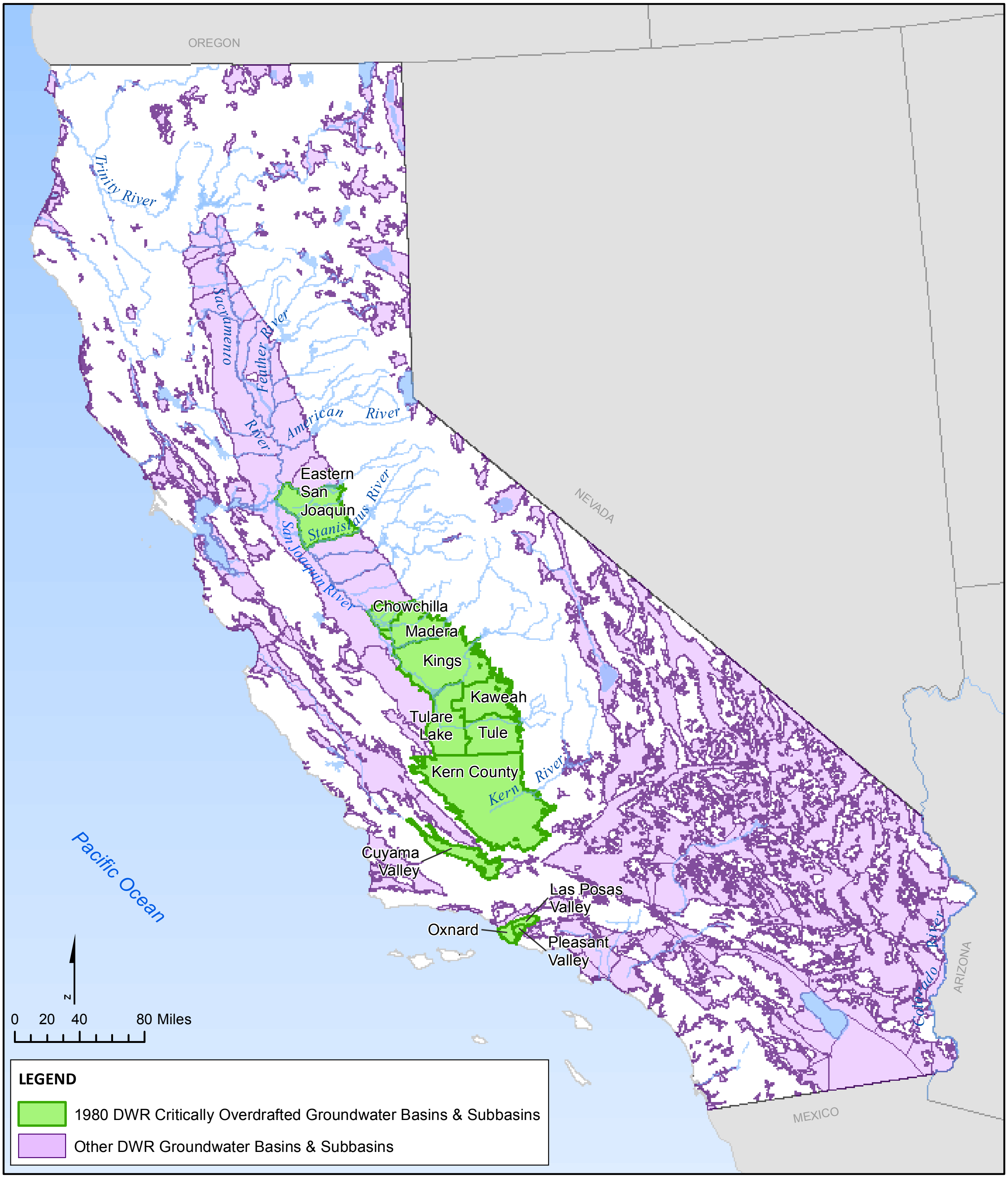


Figure 7.2 Overdrafted Groundwater Basins Defined in DWR Bulletin 118

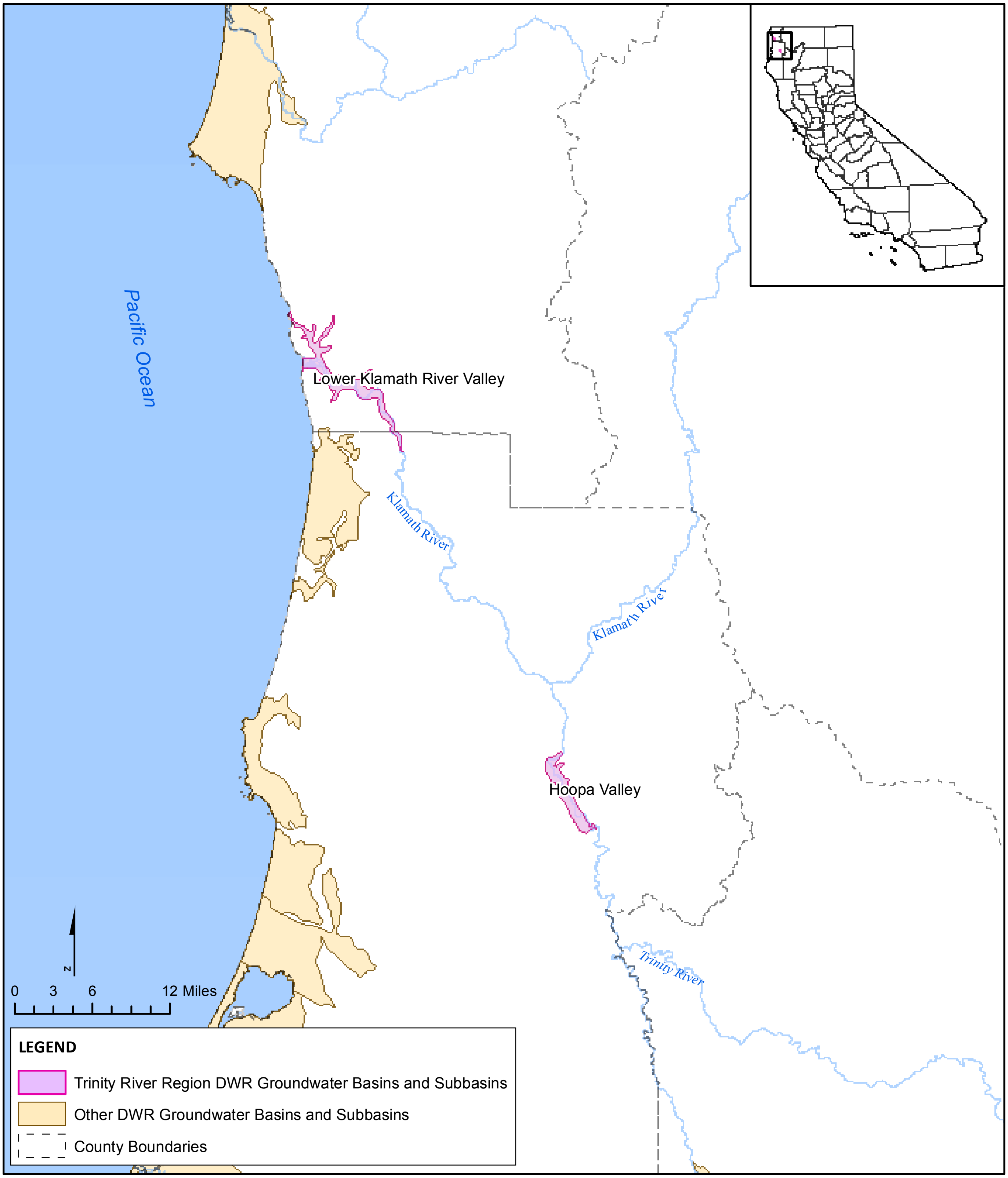


Figure 7.3 North Coast Groundwater Basins Defined in DWR Bulletin 118

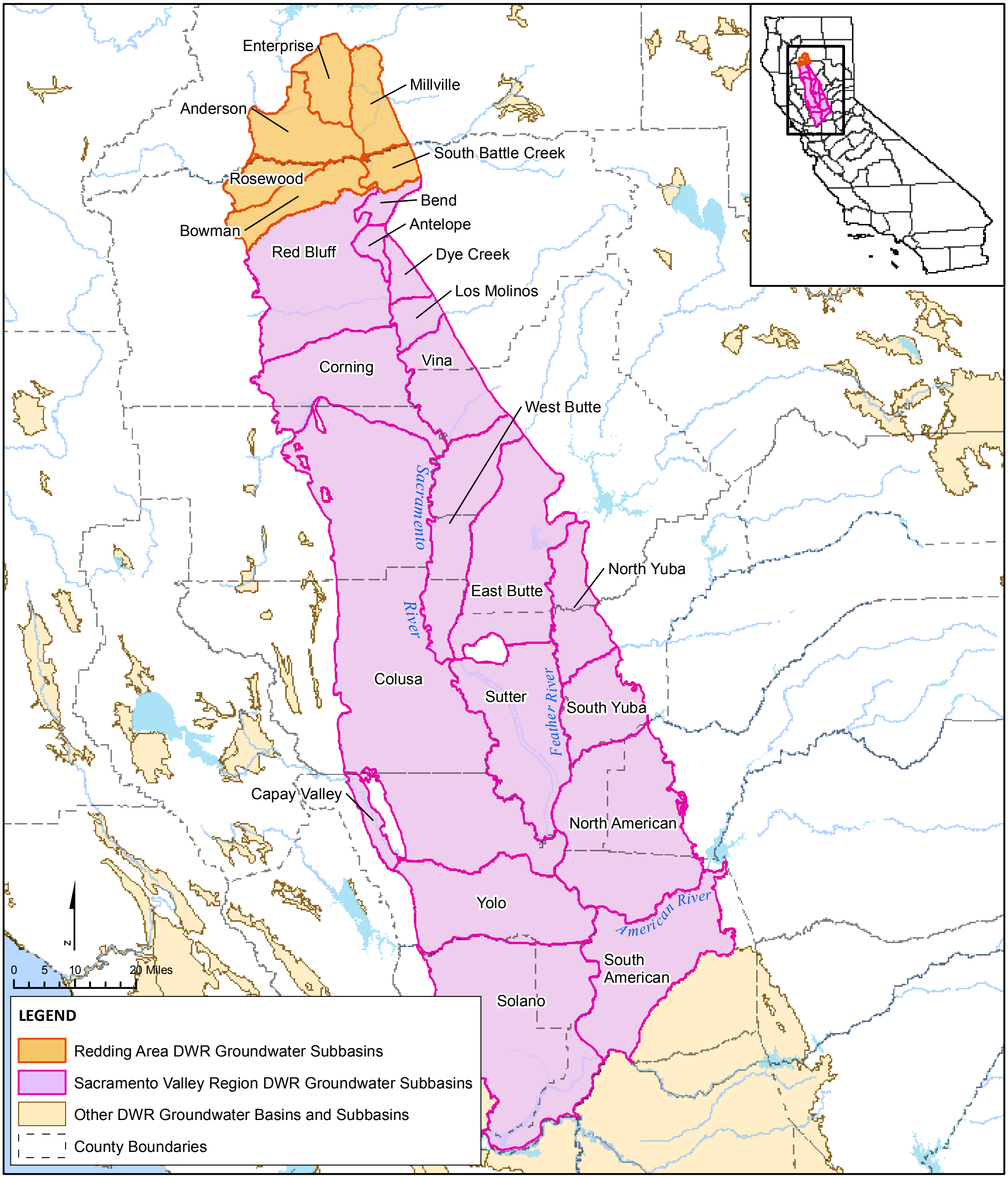


Figure 7.4 Sacramento Valley Groundwater Basin Defined in DWR Bulletin 118

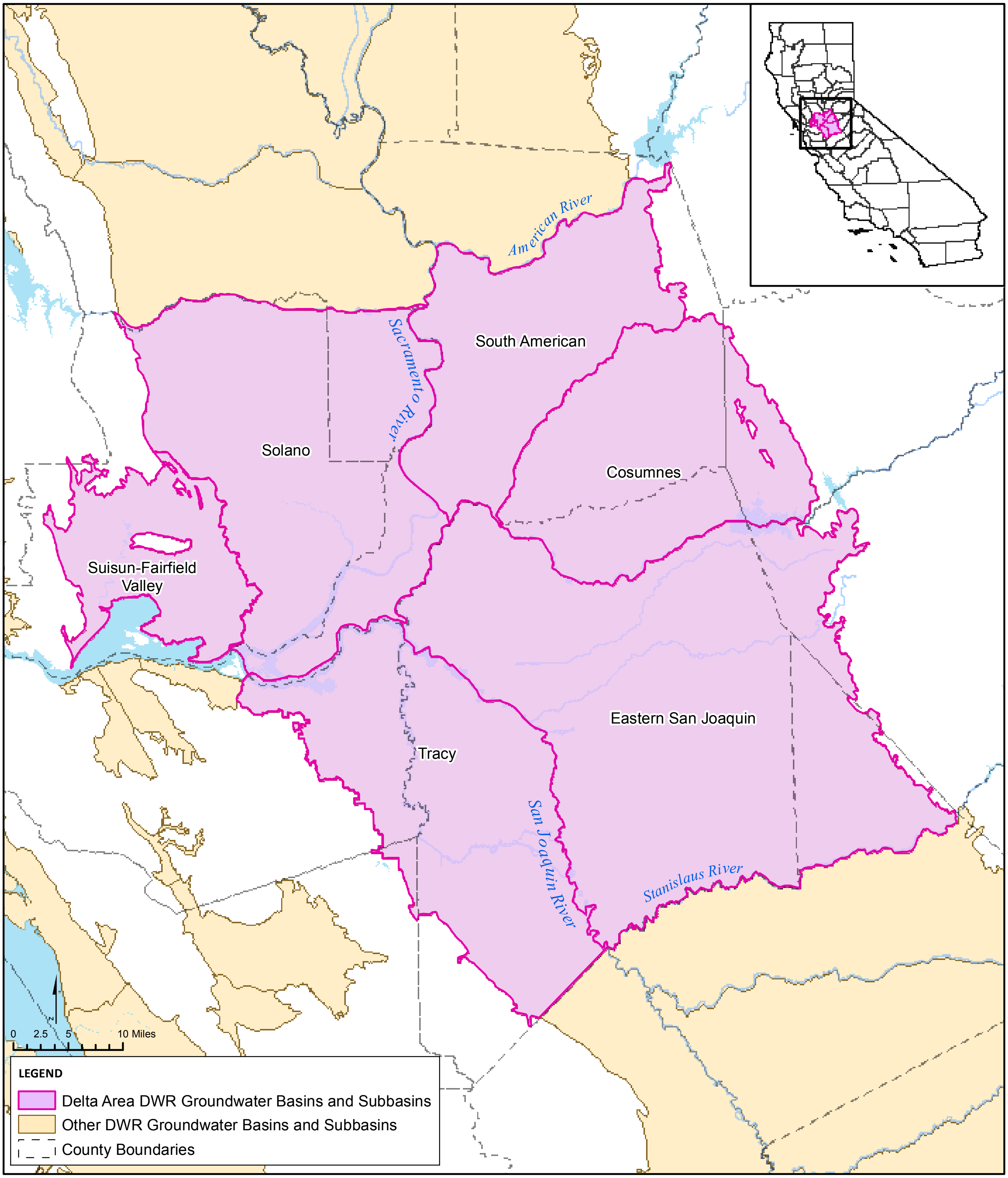


Figure 7.5 Groundwater Subbasins in the Delta Area Defined in DWR Bulletin 118

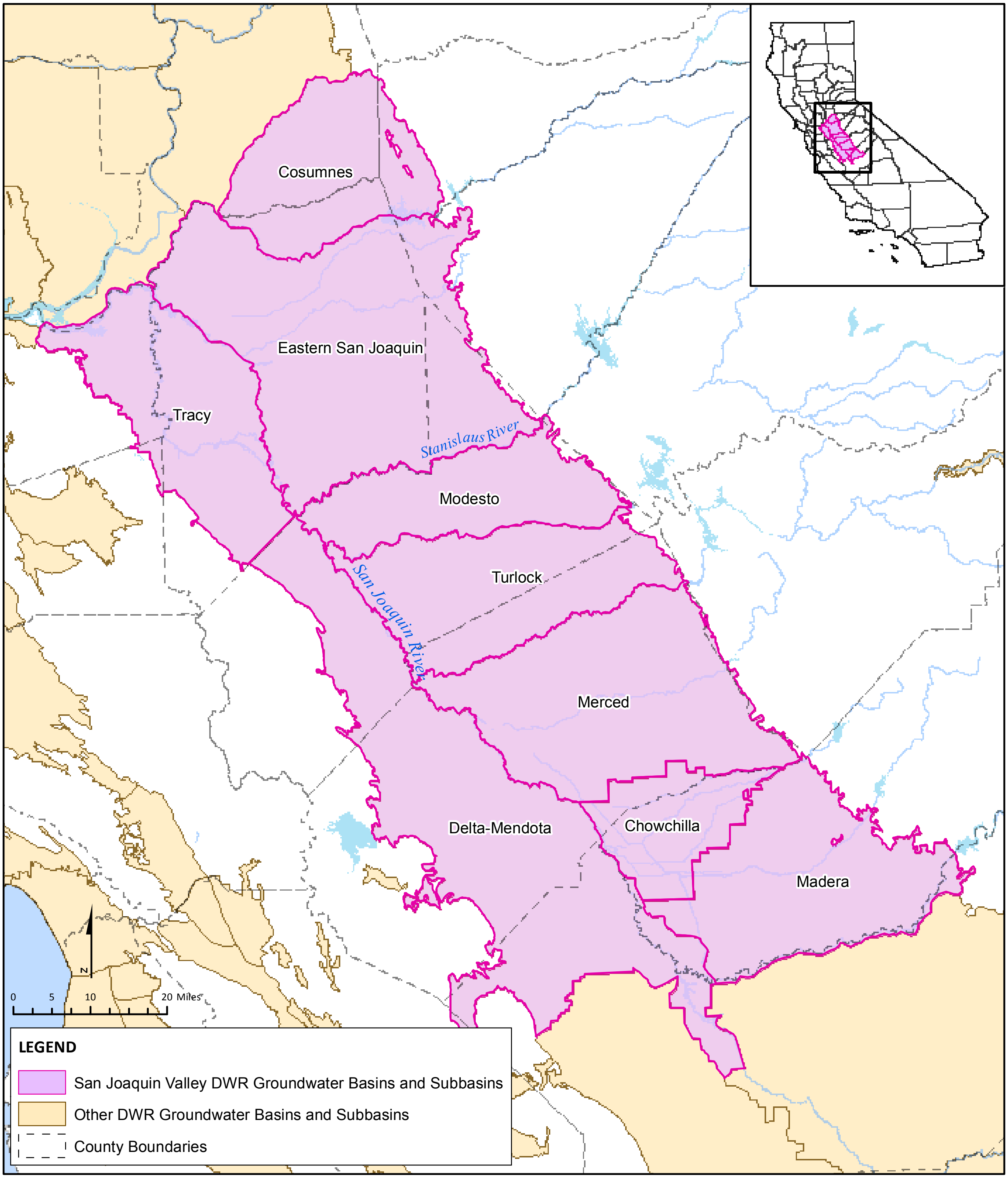


Figure 7.6 San Joaquin Valley Region Groundwater Basin Defined in DWR Bulletin 118

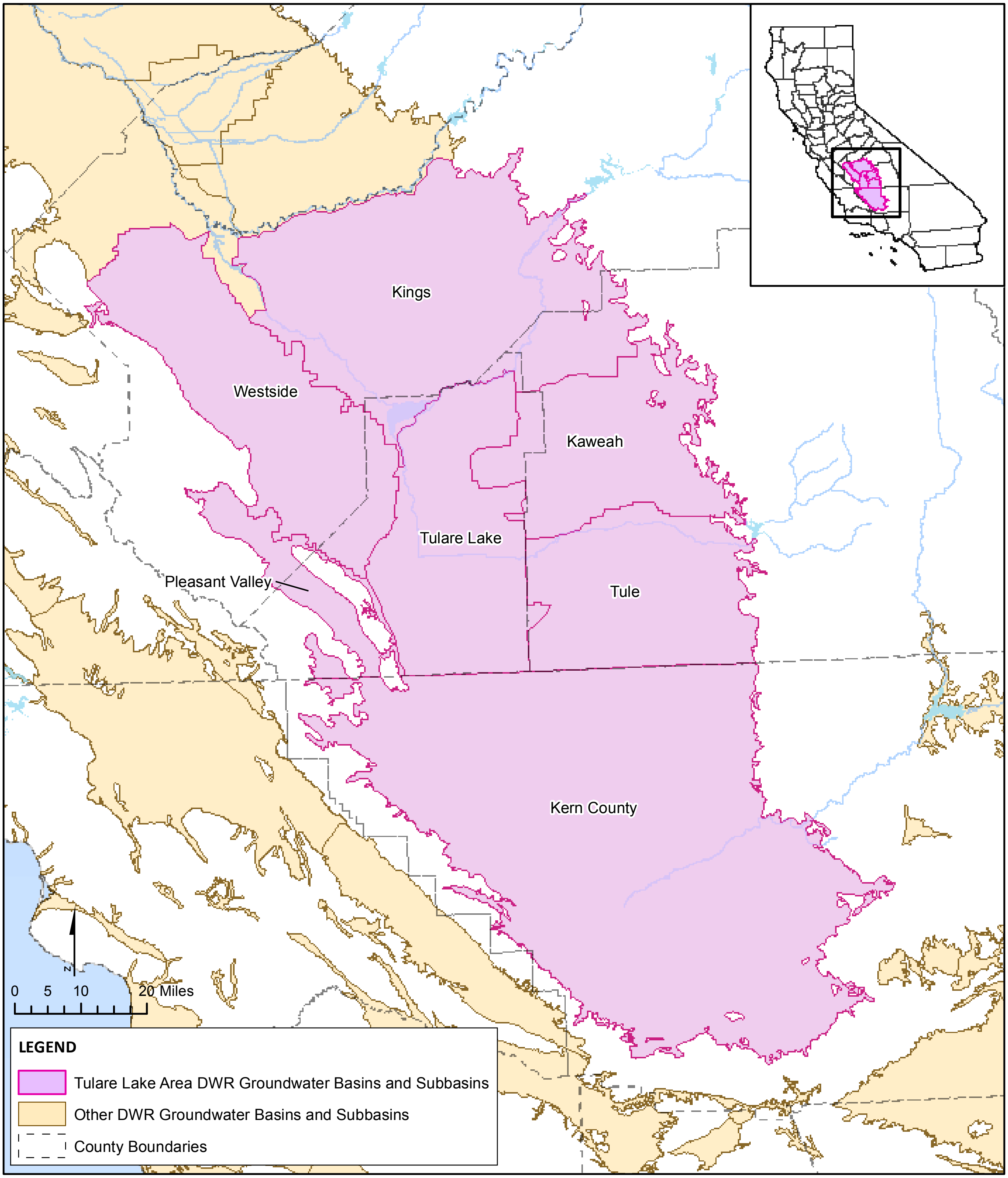


Figure 7.7 Tulare Lake Area Groundwater Basin Defined in DWR Bulletin 118

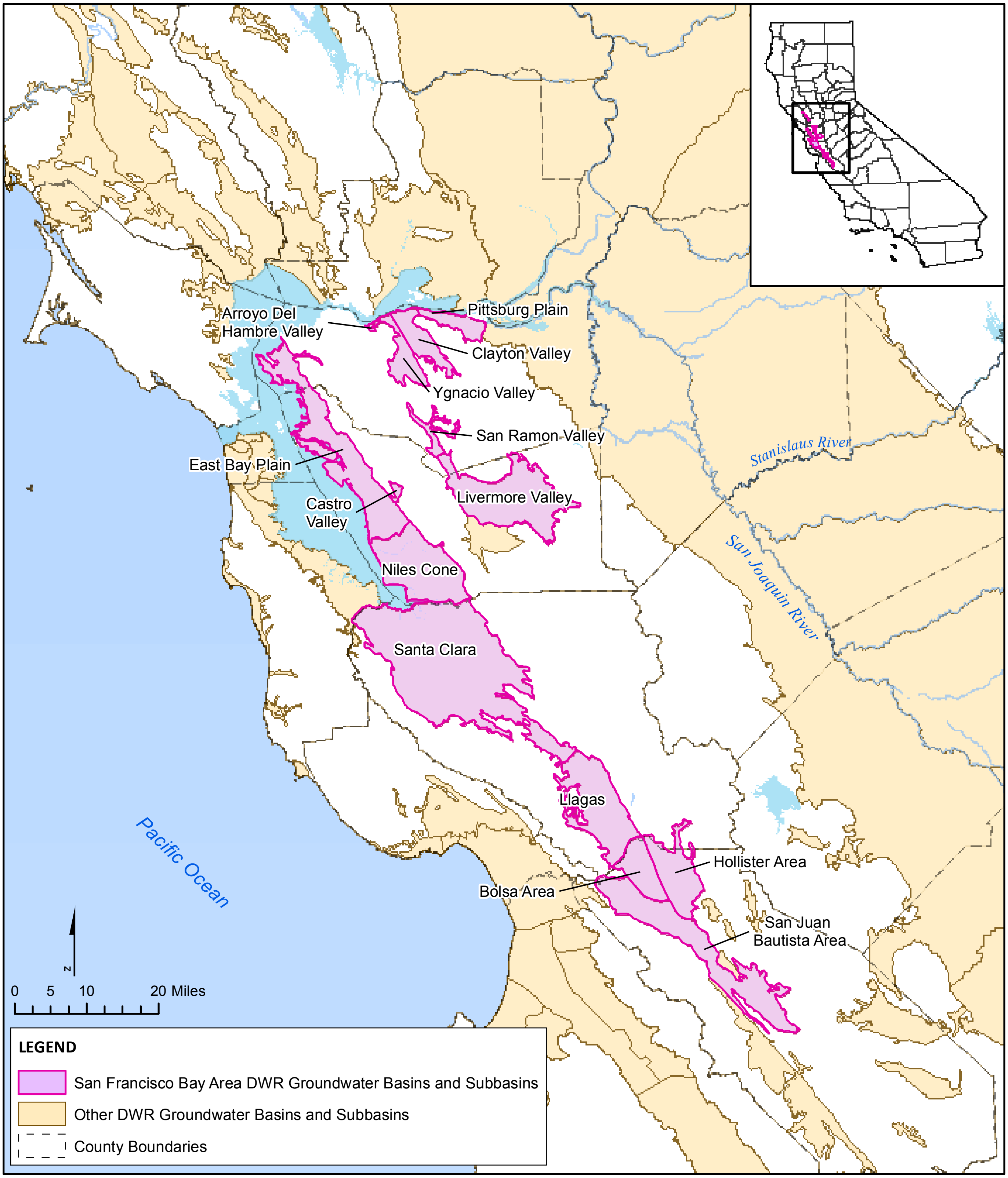


Figure 7.8 San Francisco Bay Area Groundwater Basins Defined in DWR Bulletin 118

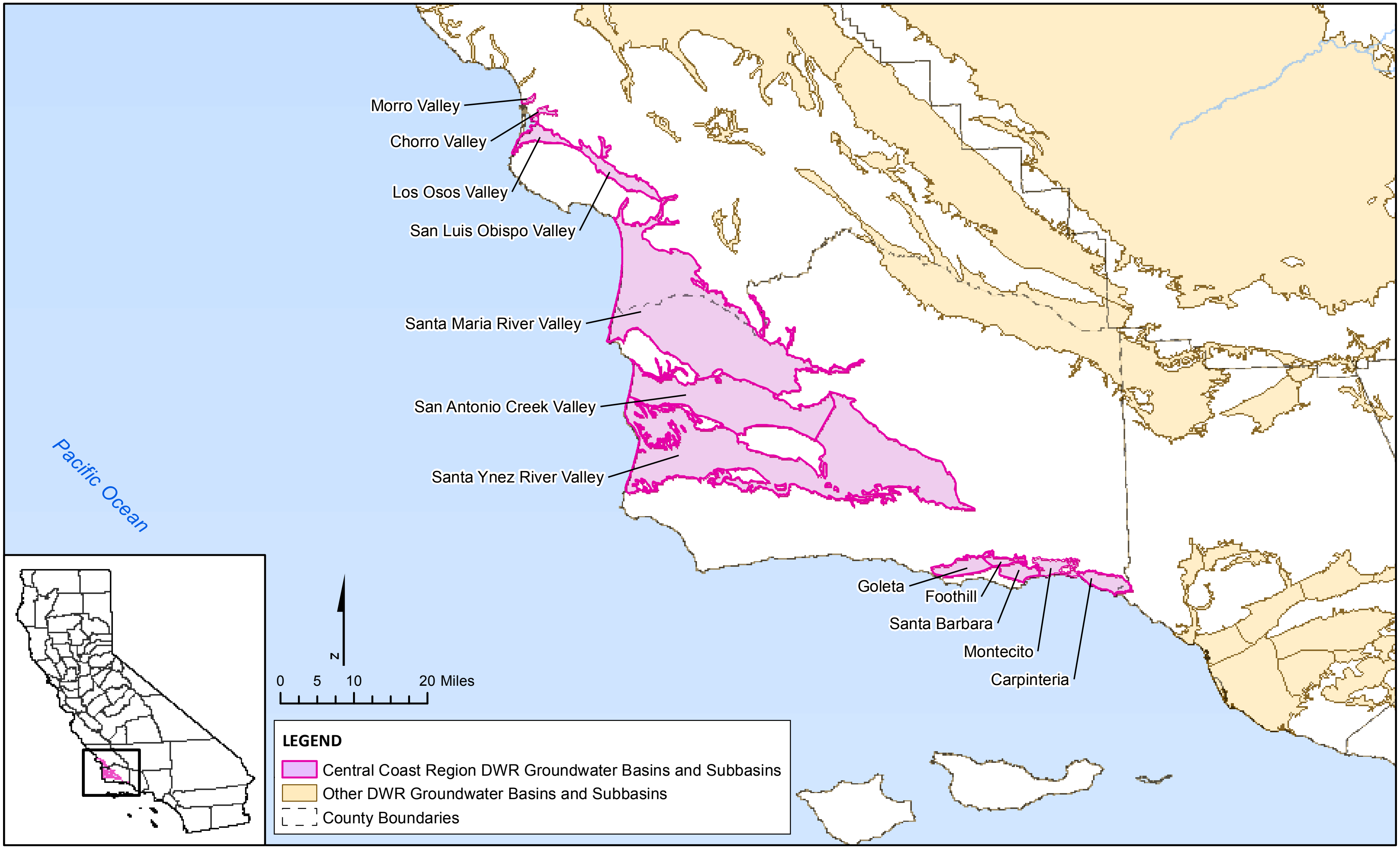


Figure 7.9 Central Coast Region Groundwater Basins defined in DWR Bulletin 118

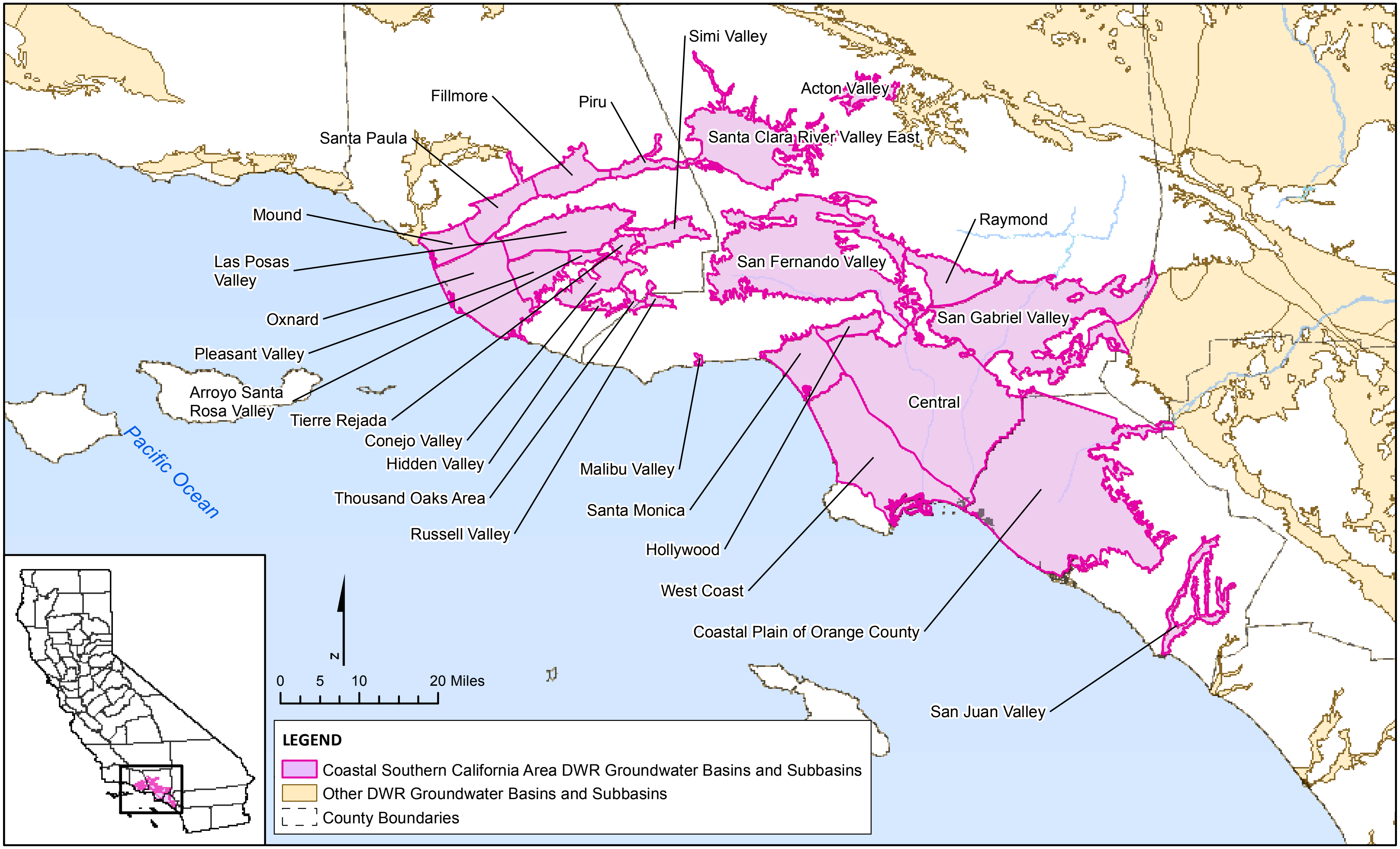


Figure 7.10 Coastal Southern California Area Groundwater Basins Defined in DWR Bulletin 118

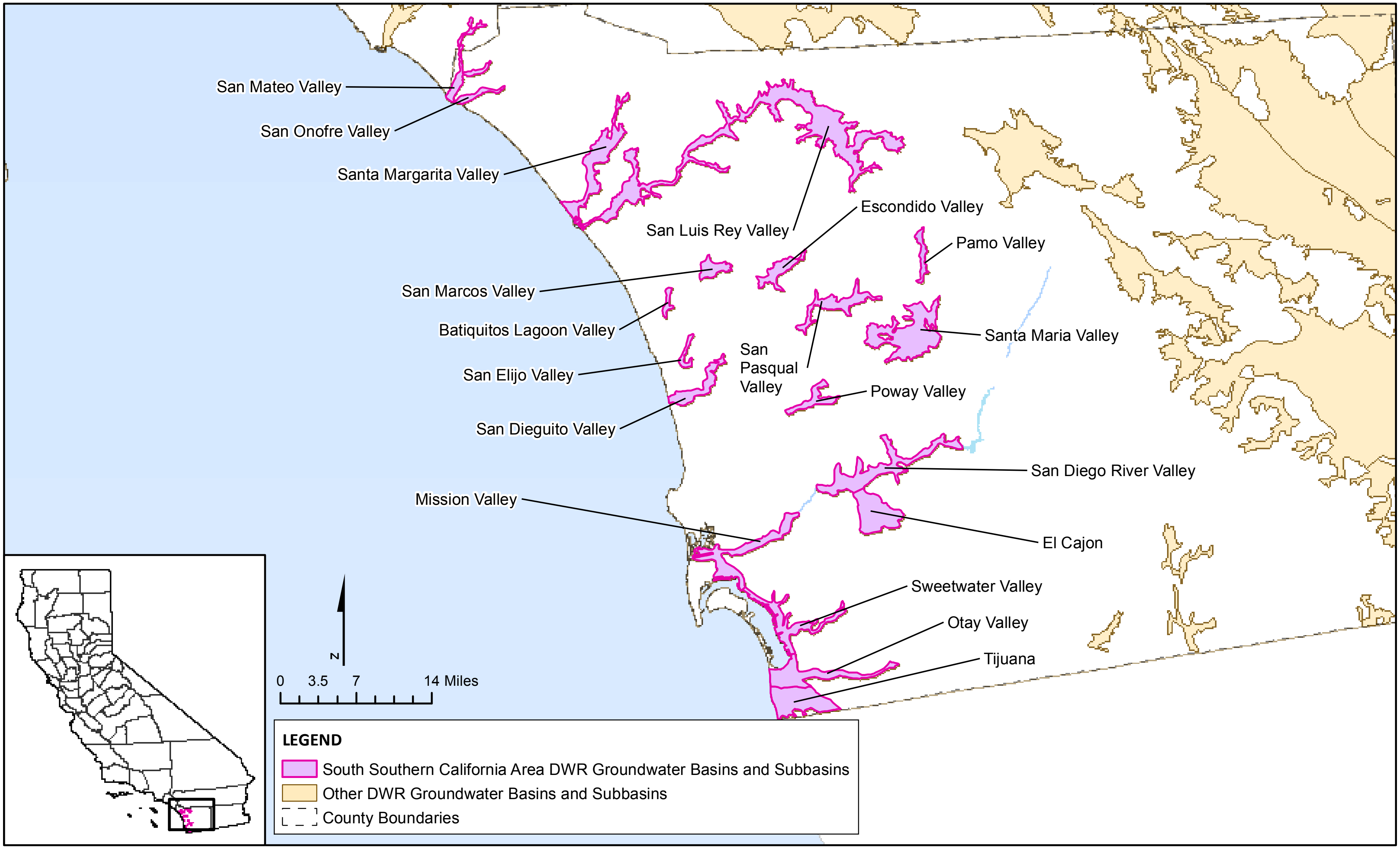


Figure 7.11 San Diego Area Groundwater Basins Defined in DWR Bulletin 118

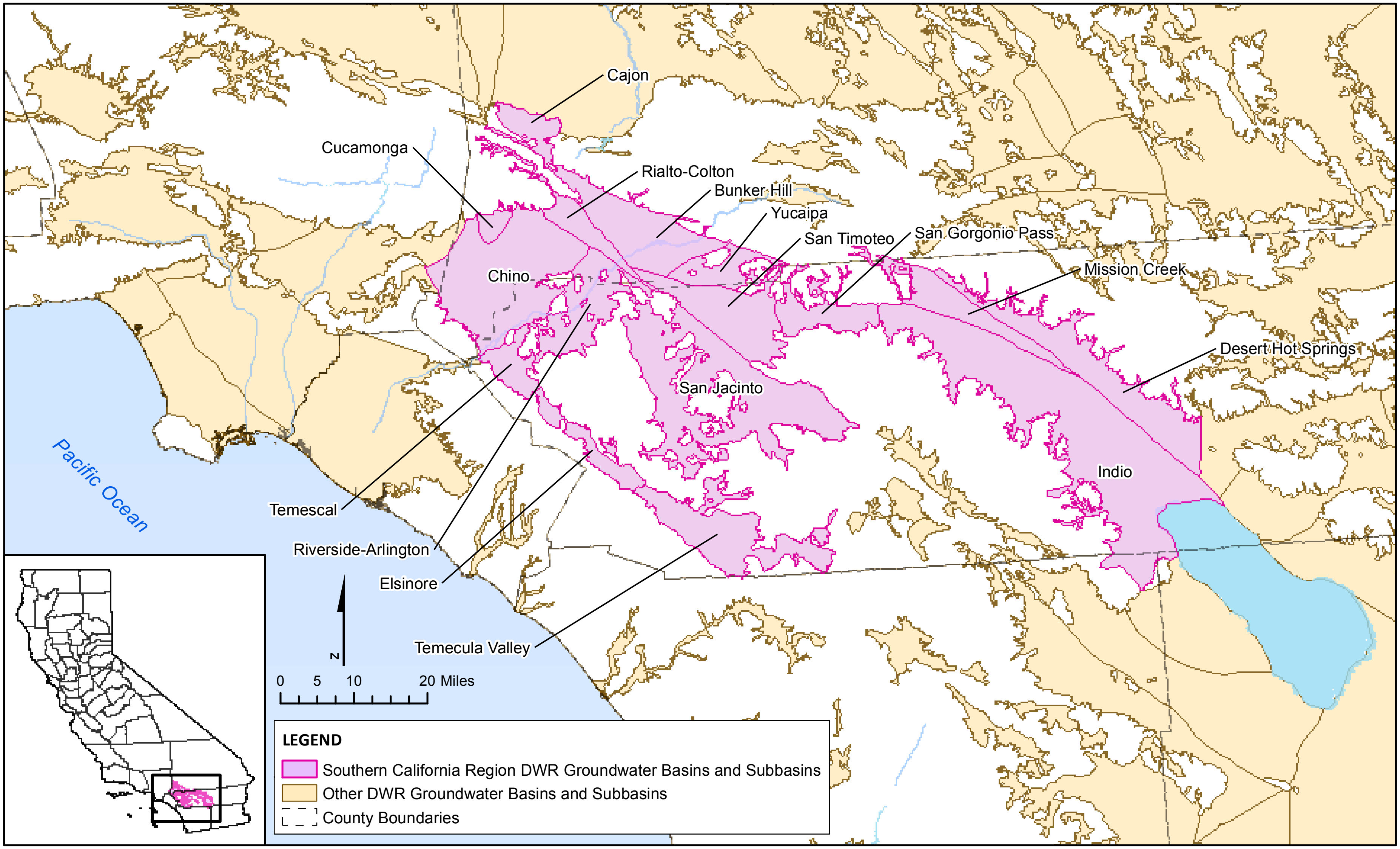


Figure 7.12 Southern California Region Groundwater Basins Defined in DWR Bulletin 118

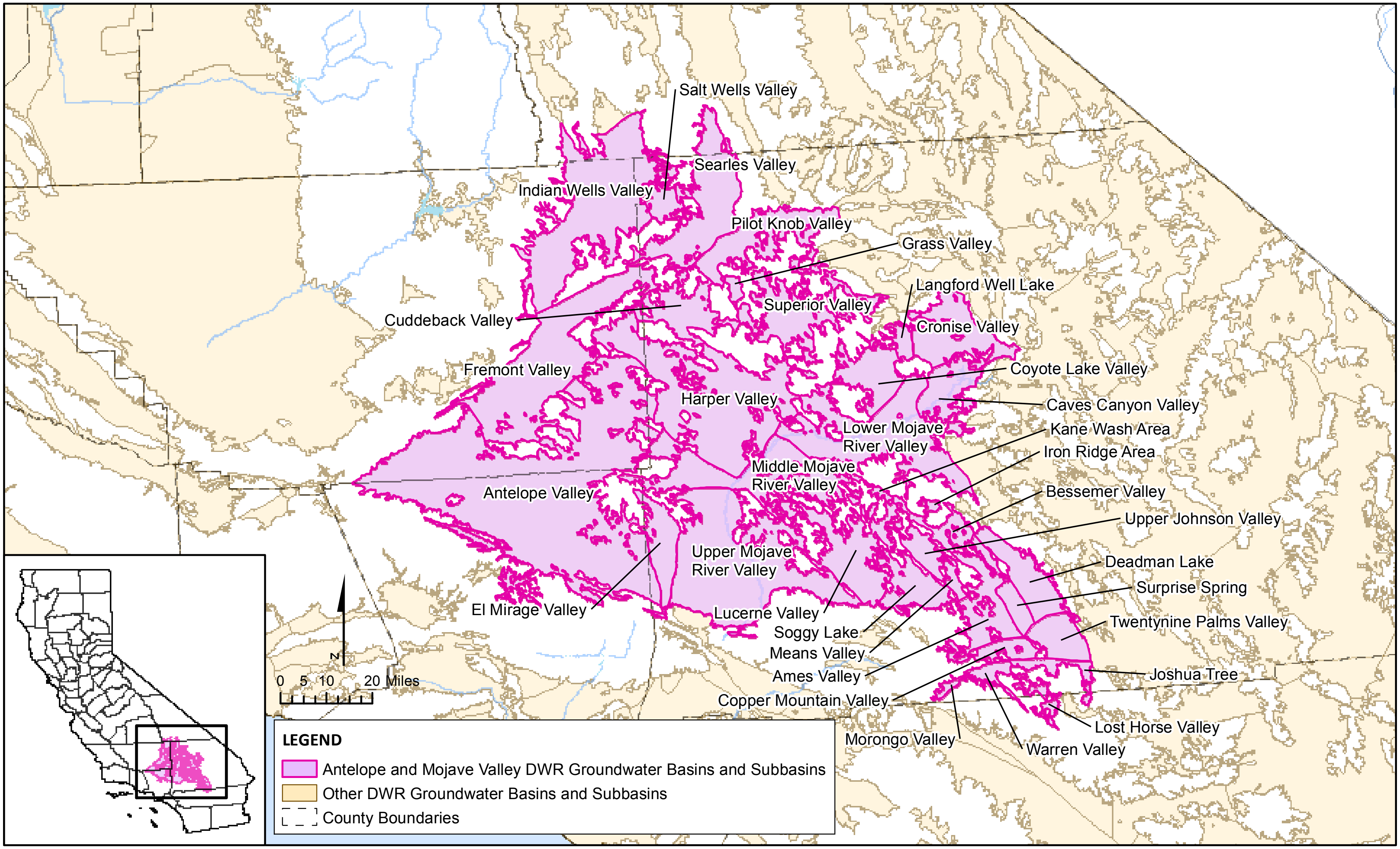
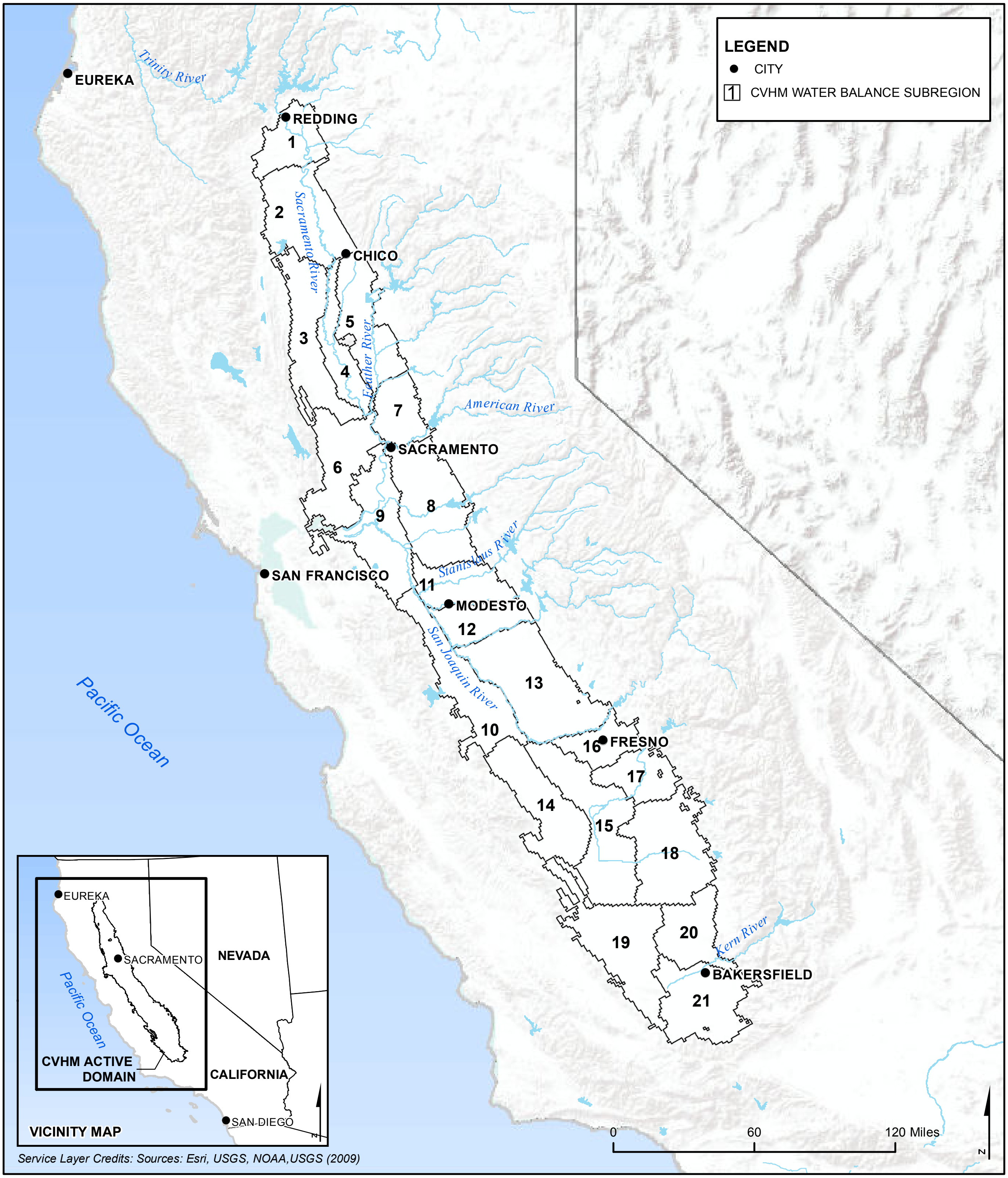


Figure 7.13 Antelope Valley and Mojave Valley Groundwater Basins Defined in DWR Bulletin 118



Service Layer Credits: Sources: Esri, USGS, NOAA,USGS (2009)

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Figure 7.14 Groundwater Model Domain and Water Balance Subregions in the Central Valley

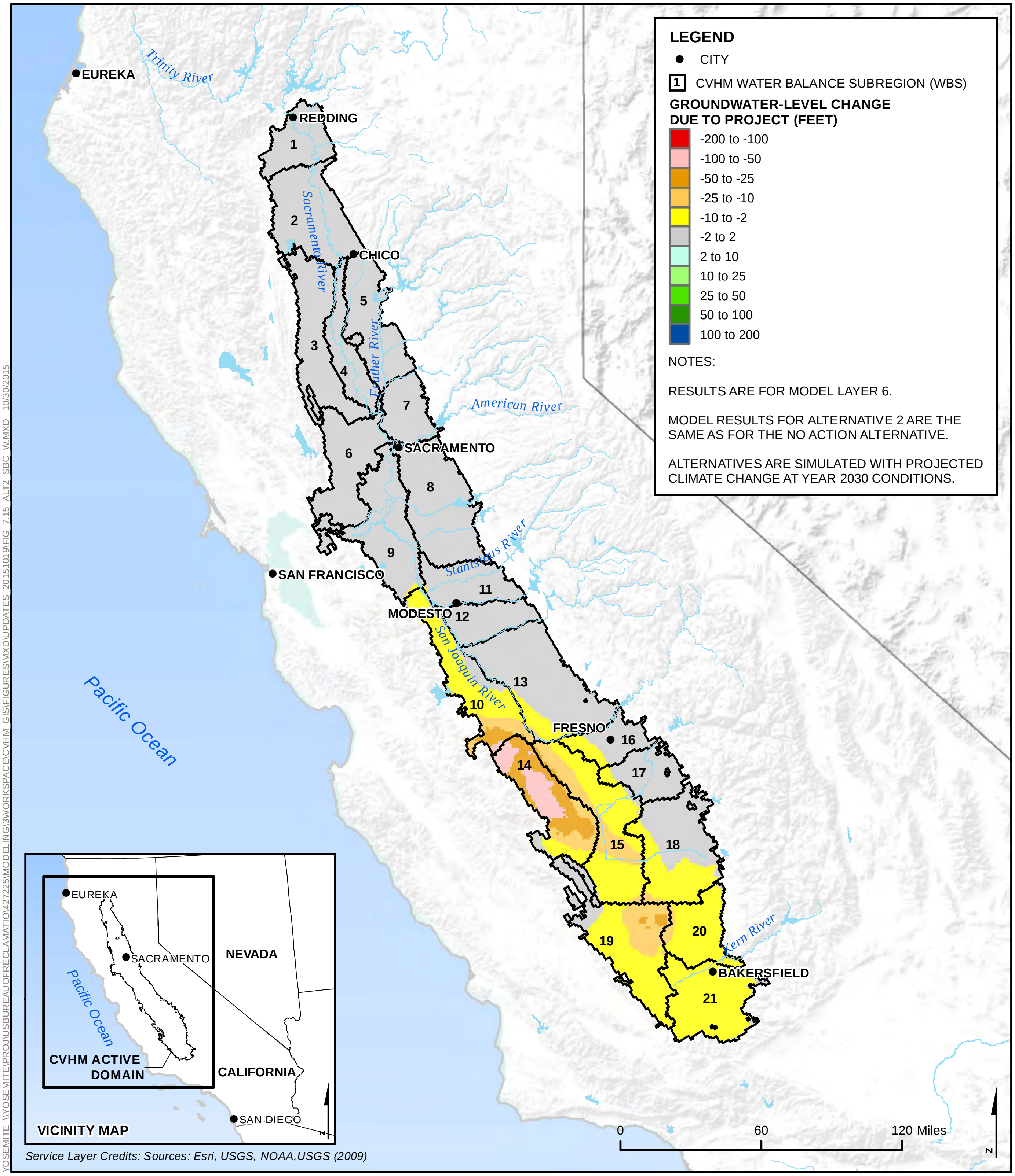

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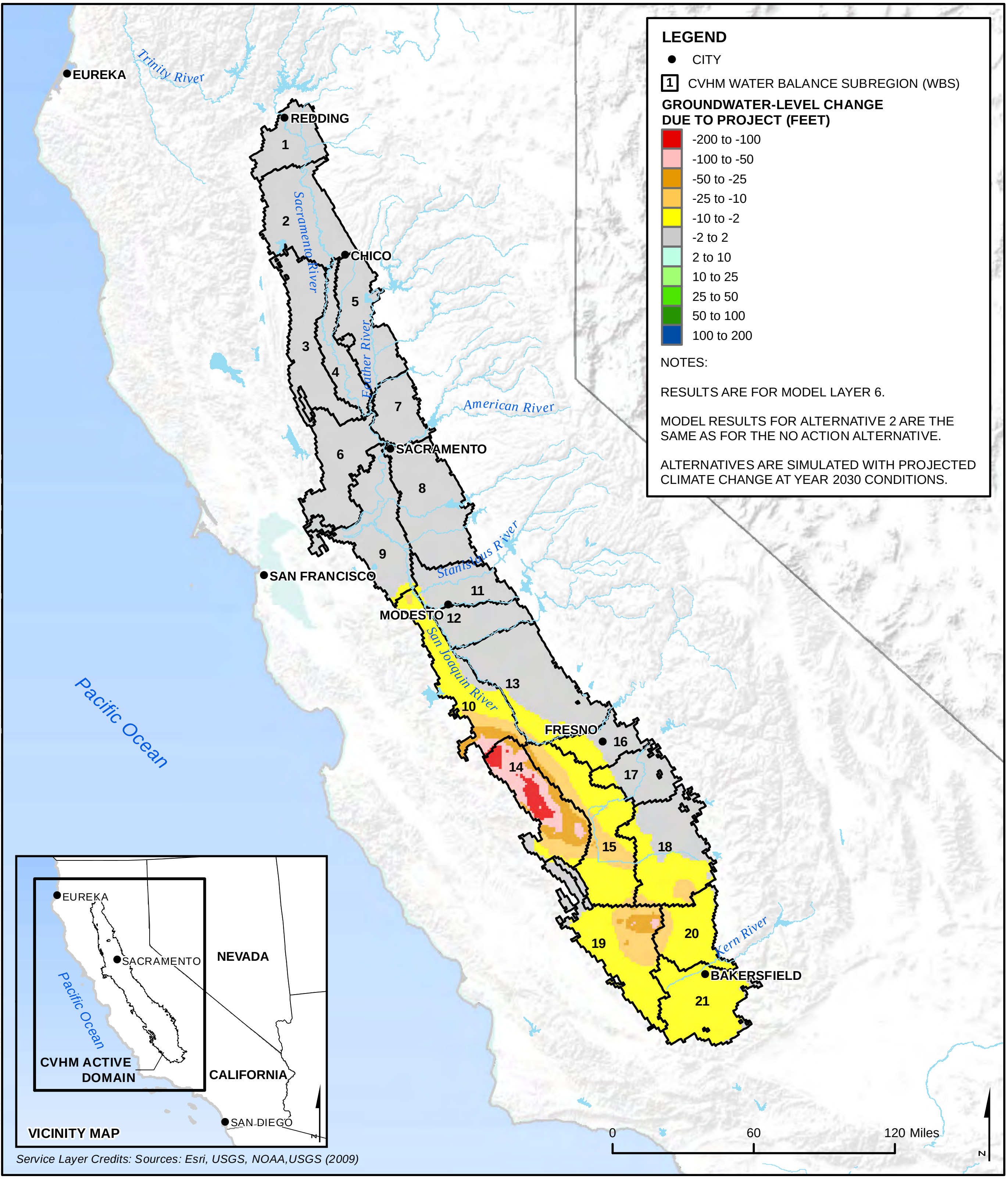
Figure 7.15 Forecast Groundwater-Level Changes for Alternative 2 and No Action Alternative Compared to Second Basis of Comparison for Average July in a Future Wet Year



NOTES:

RESULTS ARE FOR MODEL LAYER 6.

MODEL RESULTS FOR ALTERNATIVE 2 ARE THE SAME AS FOR THE NO ACTION ALTERNATIVE.

ALTERNATIVES ARE SIMULATED WITH PROJECTED CLIMATE CHANGE AT YEAR 2030 CONDITIONS.

Service Layer Credits: Sources: Esri, USGS, NOAA,USGS (2009)

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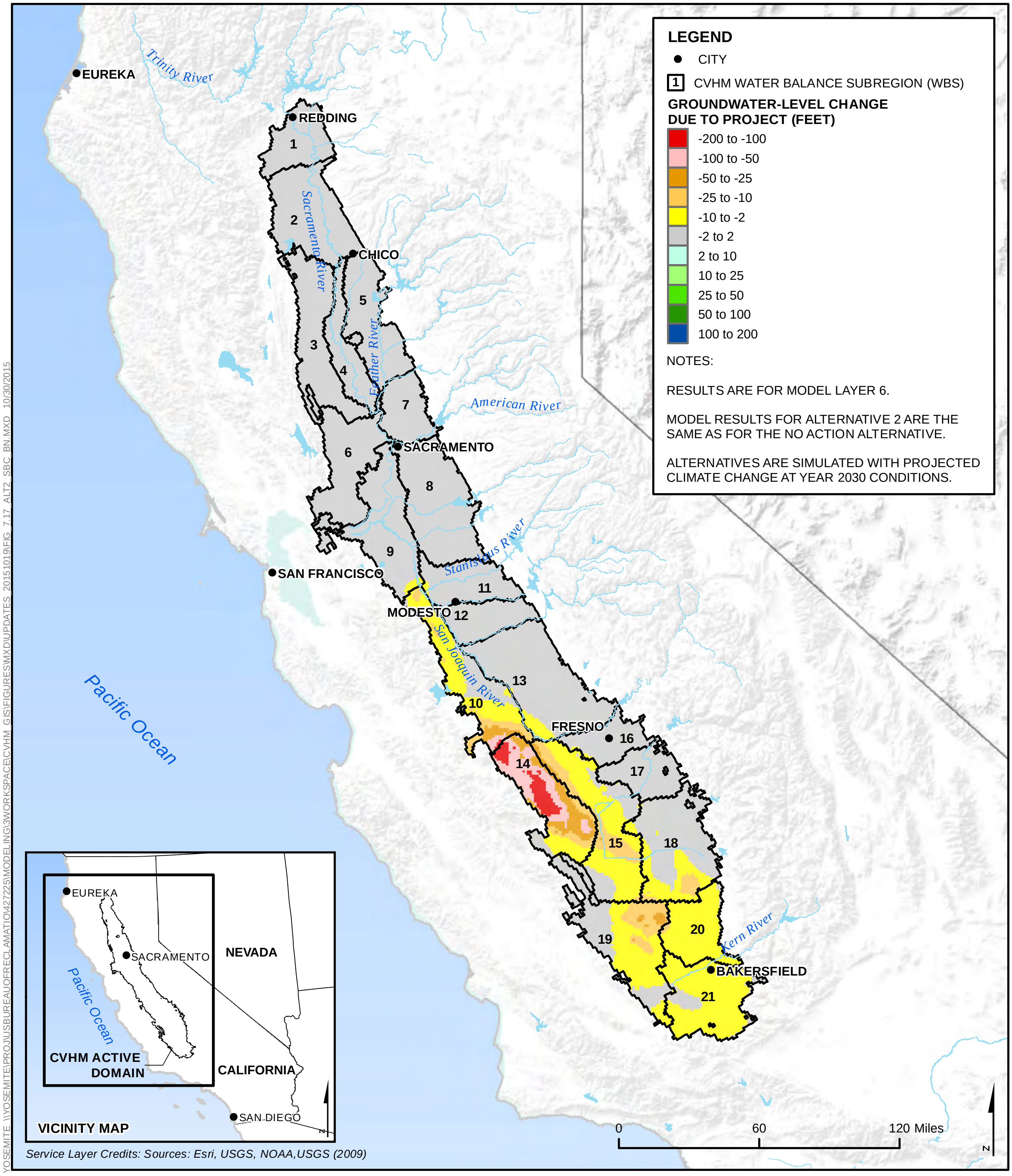
Figure 7.16 Forecast Groundwater-Level Changes for Alternative 2 and No Action Alternative Compared to Second Basis of Comparison for Average July in a Future Above-Normal Year



NOTES:

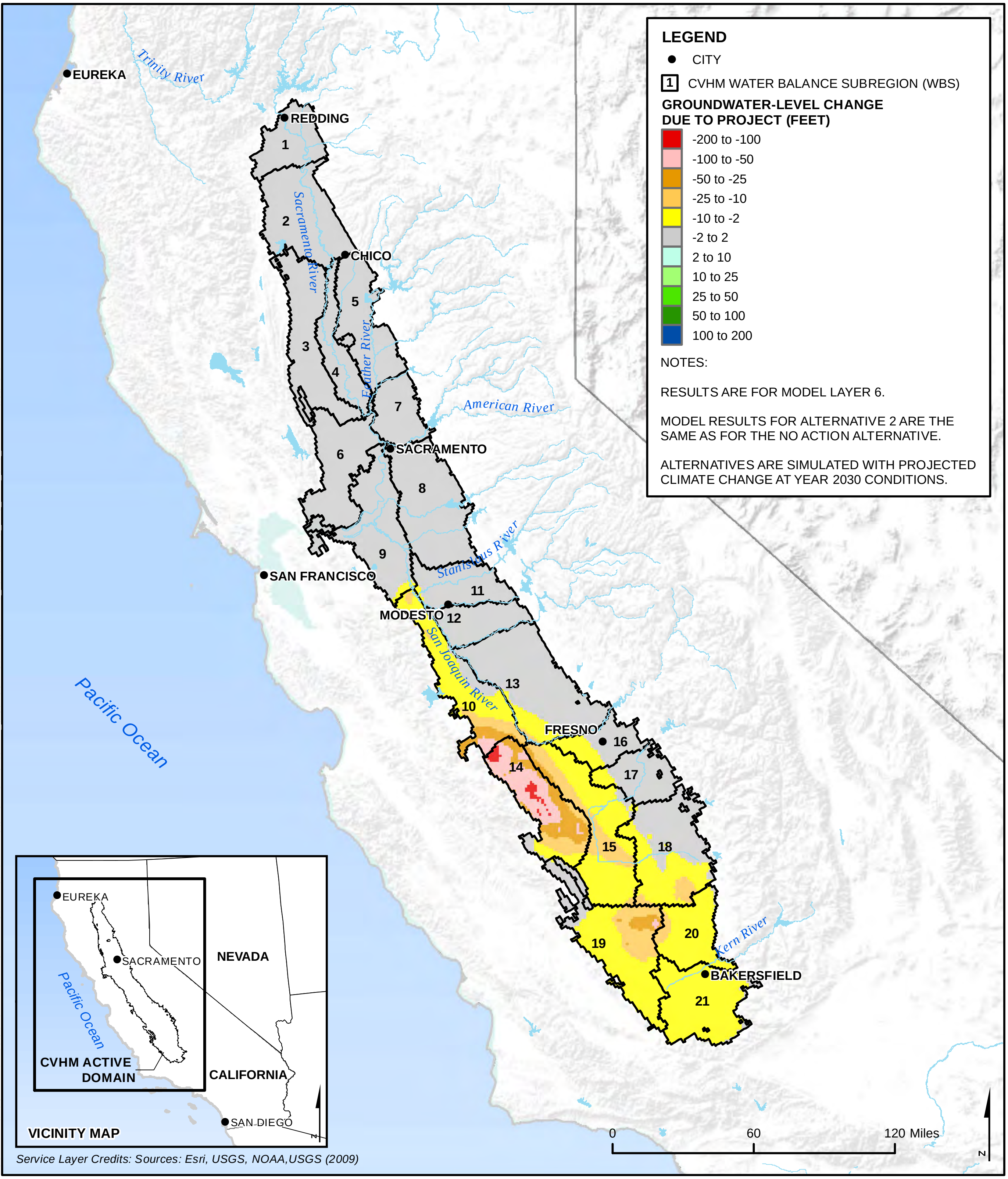
RESULTS ARE FOR MODEL LAYER 6.

MODEL RESULTS FOR ALTERNATIVE 2 ARE THE SAME AS FOR THE NO ACTION ALTERNATIVE.

ALTERNATIVES ARE SIMULATED WITH PROJECTED CLIMATE CHANGE AT YEAR 2030 CONDITIONS.

Service Layer Credits: Sources: Esri, USGS, NOAA,USGS (2009)

Figure 7.17 Forecast Groundwater-Level Changes for Alternative 2 and No Action Alternative Compared to Second Basis of Comparison for Average July in a Future Below-Normal Year



NOTES:

RESULTS ARE FOR MODEL LAYER 6.

MODEL RESULTS FOR ALTERNATIVE 2 ARE THE SAME AS FOR THE NO ACTION ALTERNATIVE.

ALTERNATIVES ARE SIMULATED WITH PROJECTED CLIMATE CHANGE AT YEAR 2030 CONDITIONS.

Service Layer Credits: Sources: Esri, USGS, NOAA,USGS (2009)

Figure 7.18 Forecast Groundwater-Level Changes for Alternative 2 and No Action Alternative Compared to Second Basis of Comparison for Average July in a Future Dry Year

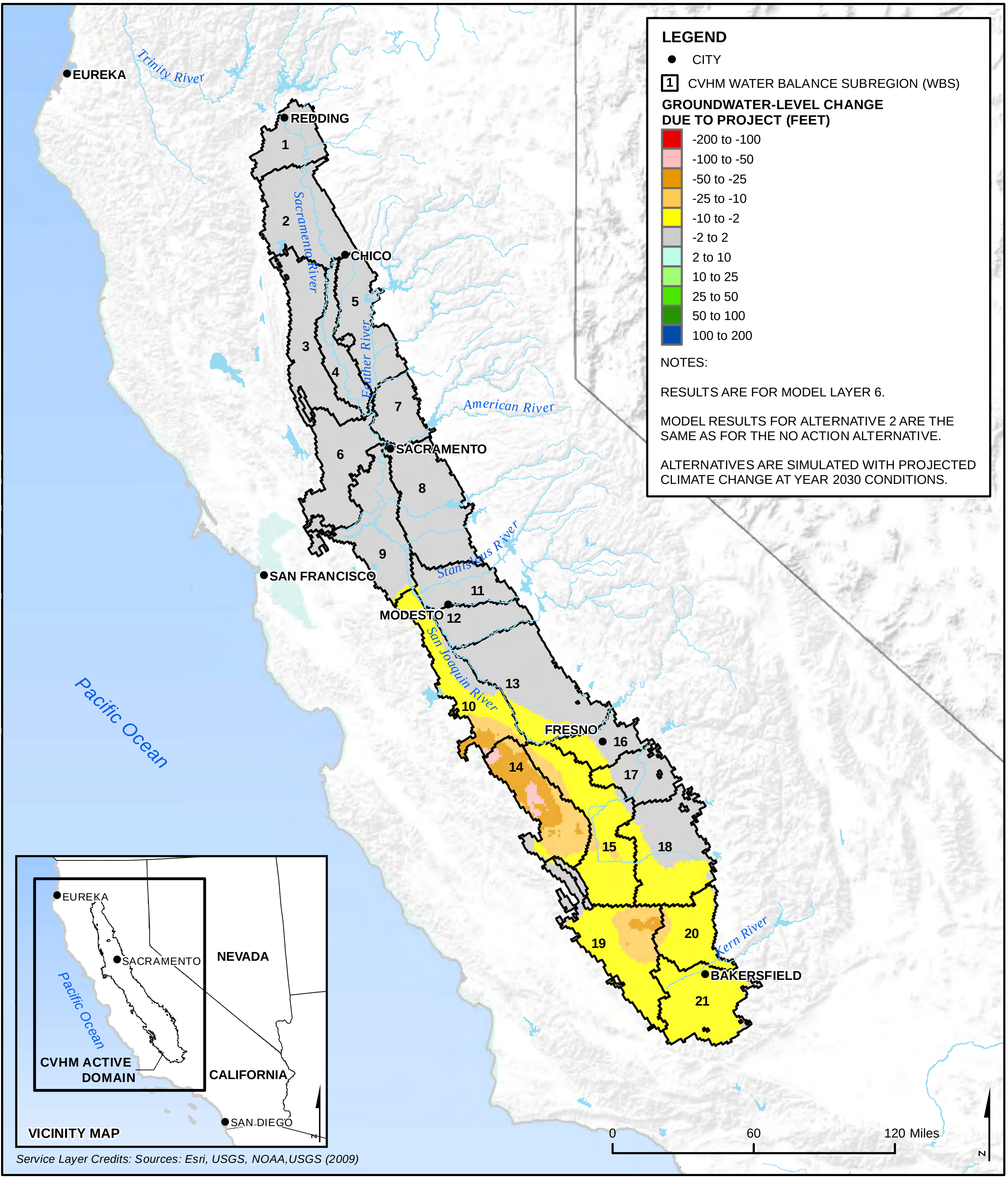


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Figure 7.19 Forecast Groundwater-Level Changes for Alternative 2 and No Action Alternative Compared to Second Basis of Comparison for Average July in a Future Critically-Dry Year

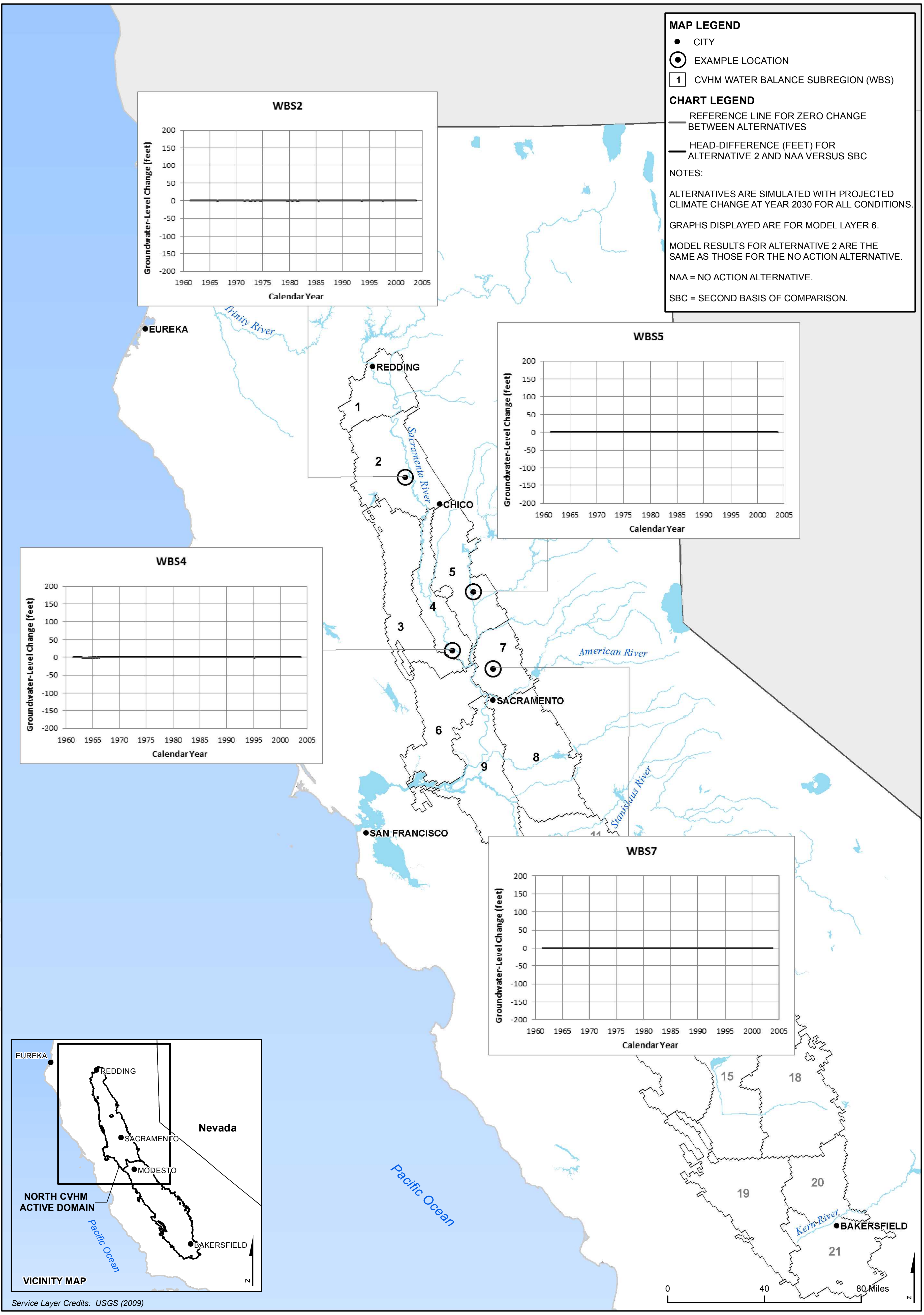

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Figure 7.20 Forecast Groundwater-Level Change Hydrographs for Alternative 2 and No Action Alternative Compared to Second Basis of Comparison at Example Locations in the Sacramento Valley

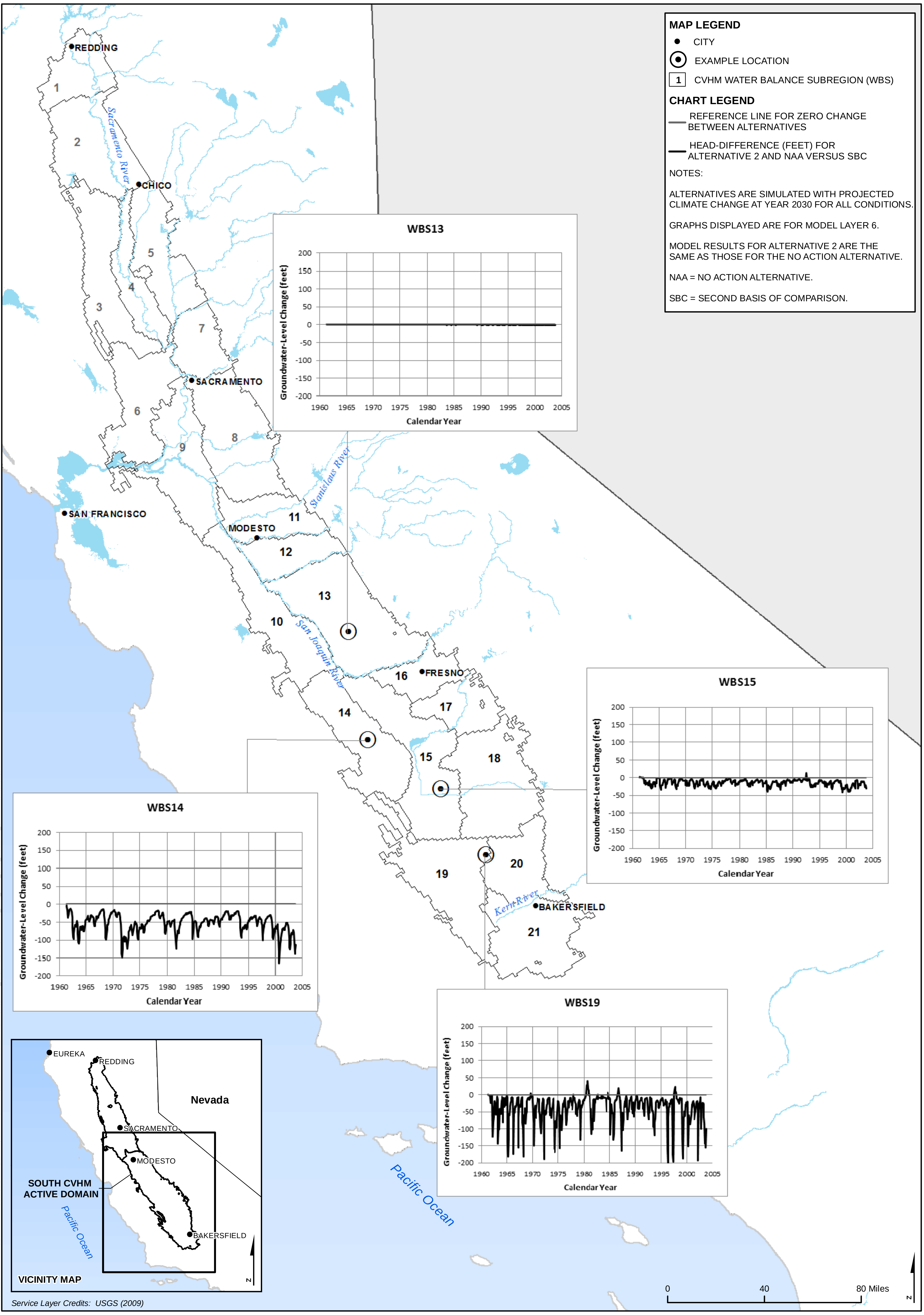

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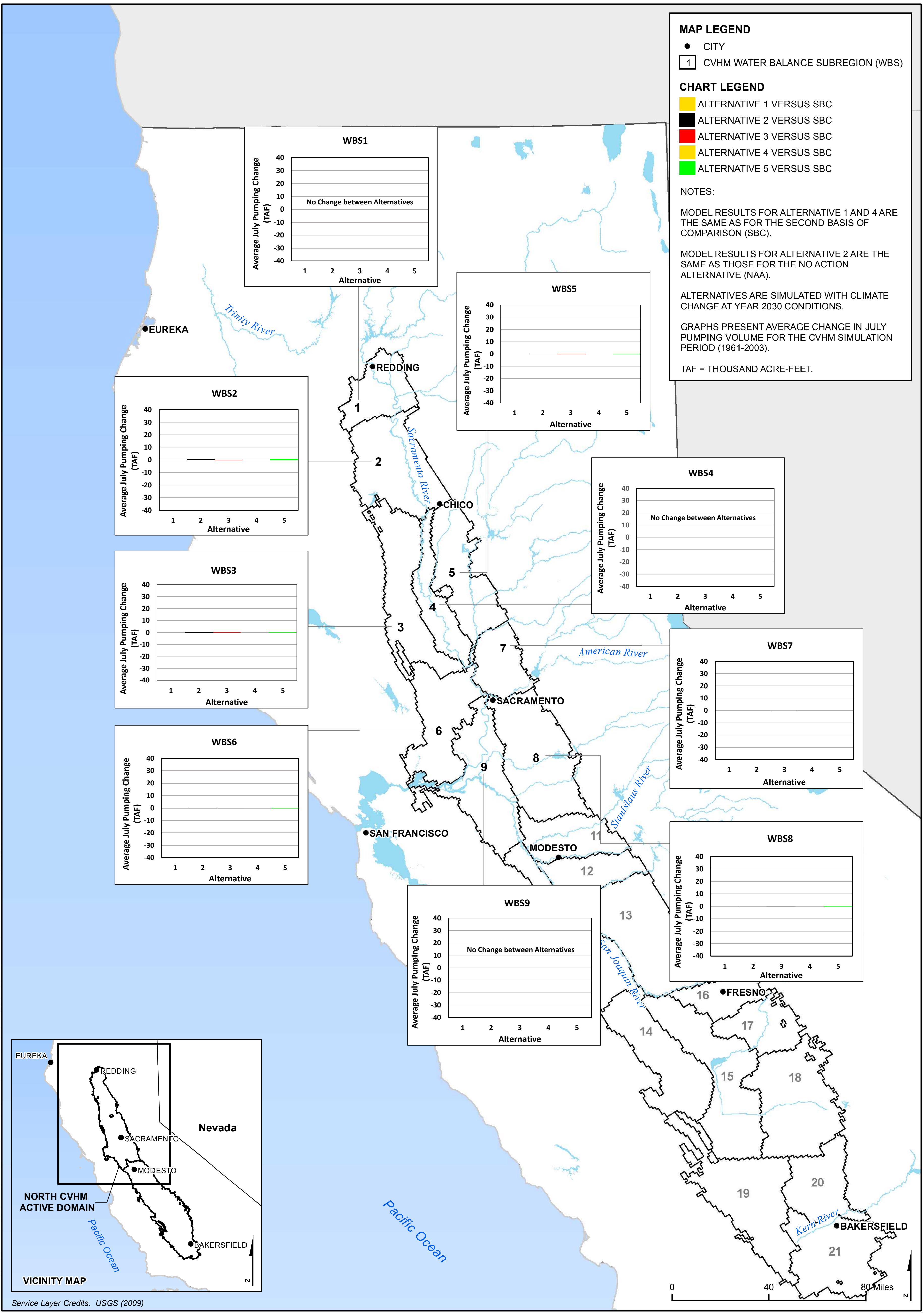
Figure 7.21 Forecast Groundwater-Level Change Hydrographs for Alternative 2 and No Action Alternative Compared to Second Basis of Comparison at Example Locations in the San Joaquin Valley



NOTES:

MODEL RESULTS FOR ALTERNATIVE 1 AND 4 ARE THE SAME AS FOR THE SECOND BASIS OF COMPARISON (SBC).

MODEL RESULTS FOR ALTERNATIVE 2 ARE THE SAME AS THOSE FOR THE NO ACTION ALTERNATIVE (NAA).

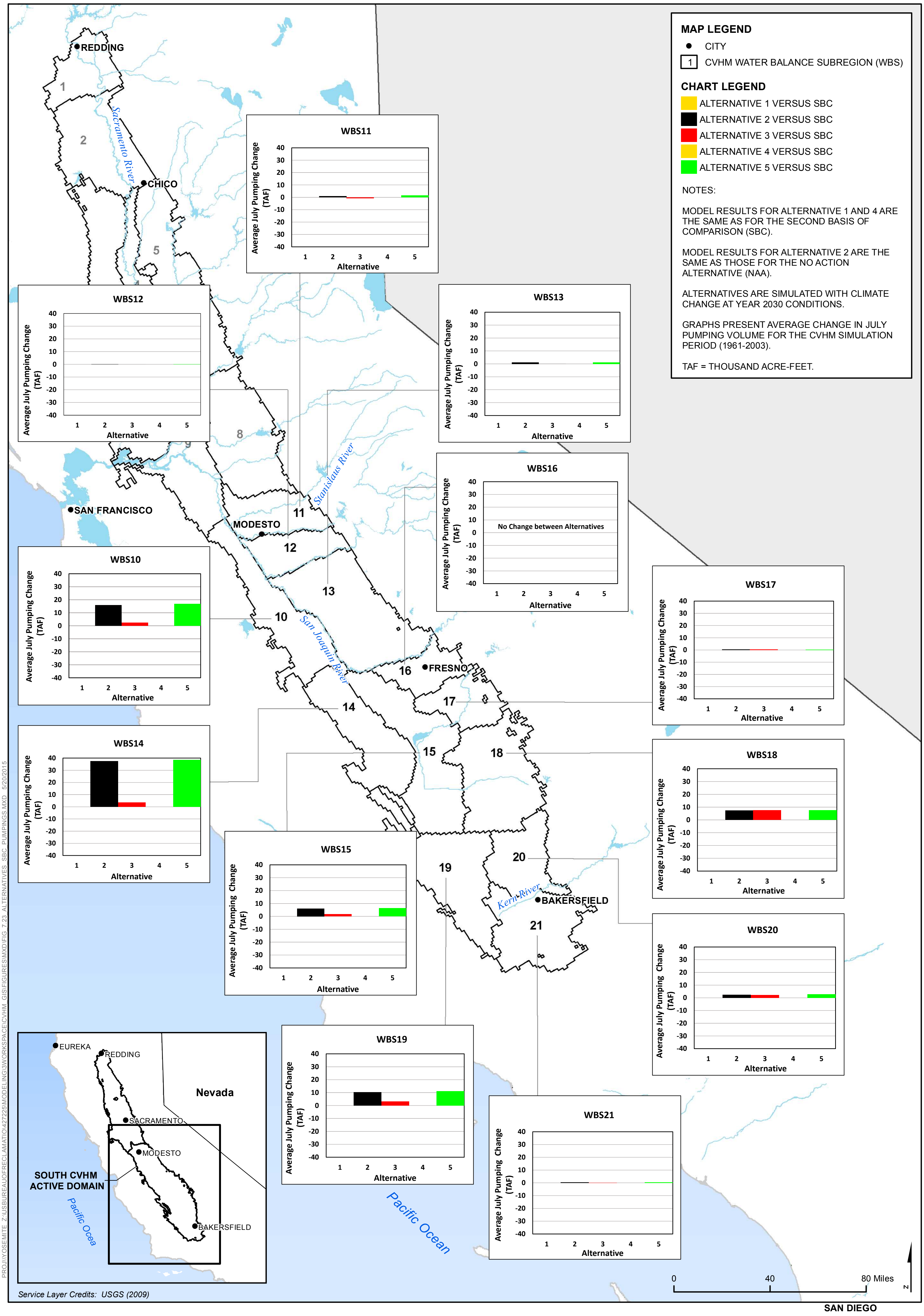
ALTERNATIVES ARE SIMULATED WITH CLIMATE CHANGE AT YEAR 2030 CONDITIONS.

GRAPHS PRESENT AVERAGE CHANGE IN JULY PUMPING VOLUME FOR THE CVHM SIMULATION PERIOD (1961-2003).

TAF = THOUSAND ACRE-FEET.

Service Layer Credits: USGS (2009)

Figure 7.22 Long-term Average Change in July Agricultural Groundwater Pumping for Alternatives Compared to the Second Basis of Comparison in the Sacramento Valley



NOTES:

MODEL RESULTS FOR ALTERNATIVE 1 AND 4 ARE THE SAME AS FOR THE SECOND BASIS OF COMPARISON (SBC).

MODEL RESULTS FOR ALTERNATIVE 2 ARE THE SAME AS THOSE FOR THE NO ACTION ALTERNATIVE (NAA).

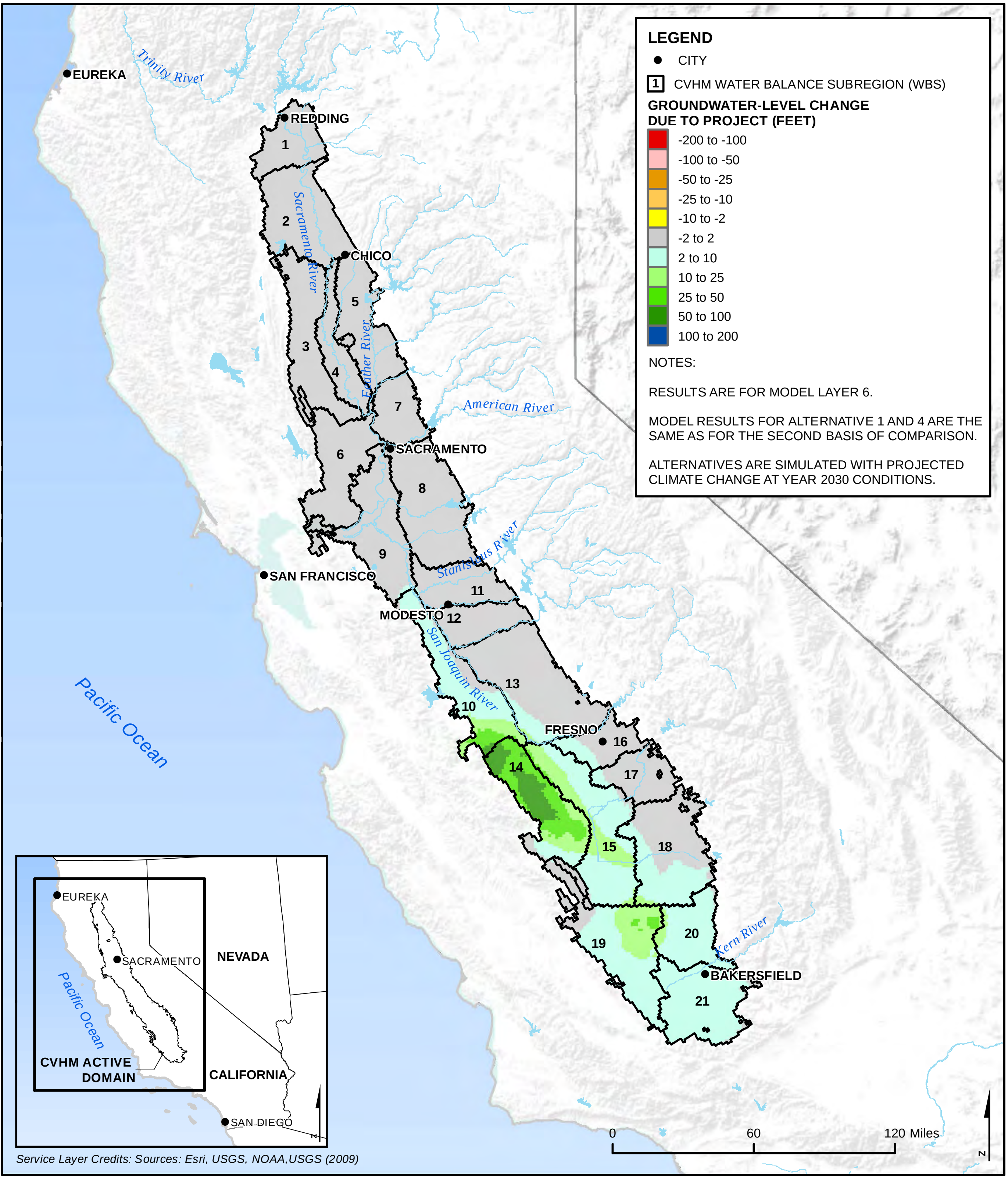
ALTERNATIVES ARE SIMULATED WITH CLIMATE CHANGE AT YEAR 2030 CONDITIONS.

GRAPHS PRESENT AVERAGE CHANGE IN JULY PUMPING VOLUME FOR THE CVHM SIMULATION PERIOD (1961-2003).

TAF = THOUSAND ACRE-FEET.

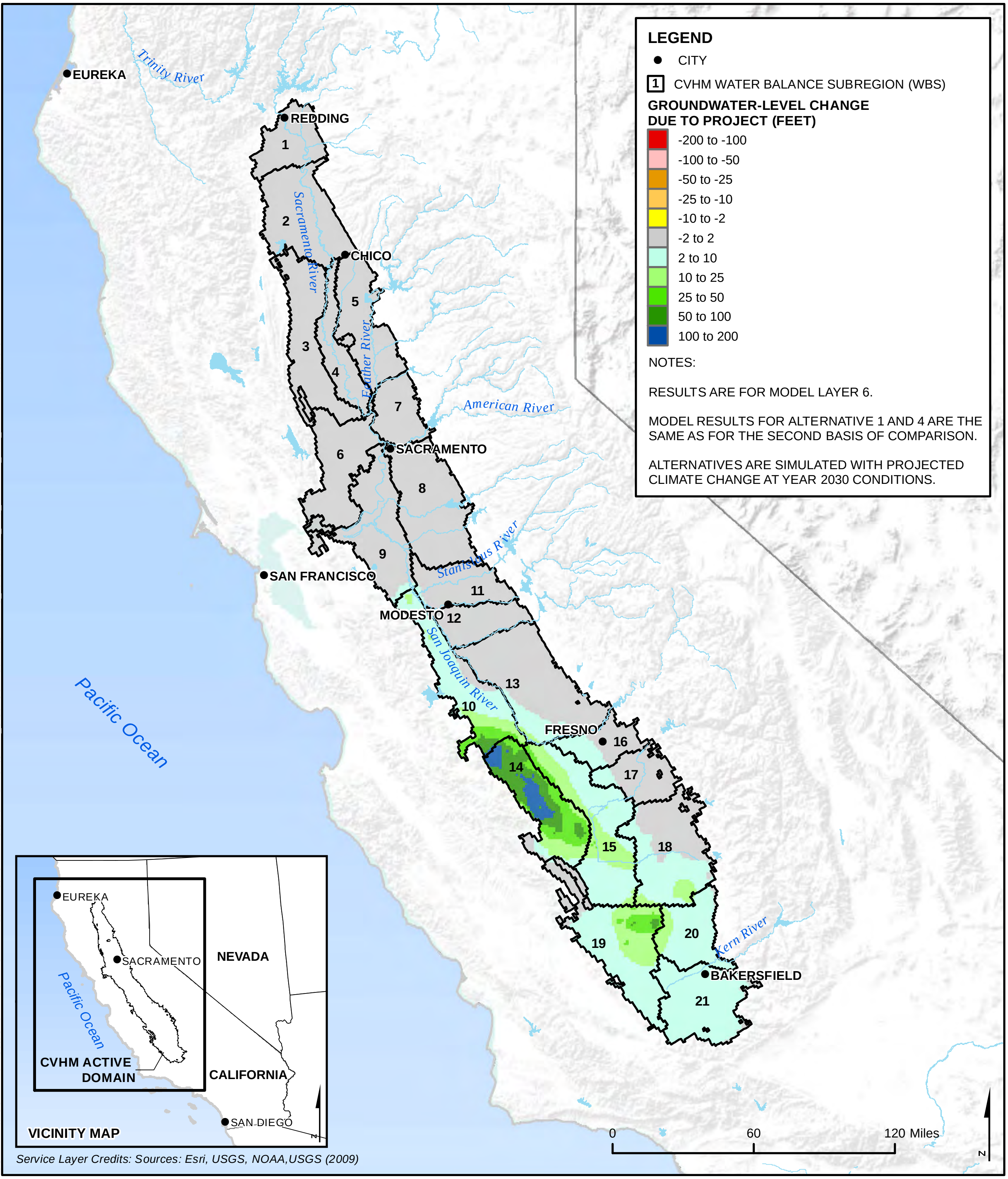
Service Layer Credits: USGS (2009)

Figure 7.23 Long-term Average Change in July Agricultural Groundwater Pumping for Alternatives Compared to the Second Basis of Comparison in the San Joaquin Valley



YOSEMITE \\YOSEMITE\PROJ\USBUREAUOFRECLAMATIO\427225\MODELING\3WORKSPACE\CVHM GIS\FIGURES\MXD\UPDATES 20151019\FIG 7.24 ALT1ALT4 NAA W.MXD 10/30/2015

Figure 7.24 Forecast Groundwater-Level Changes for Alternative 1, Alternative 4, and Second Basis of Comparison Compared to No Action Alternative For Average July in a Future Wet Year



NOTES:

RESULTS ARE FOR MODEL LAYER 6.

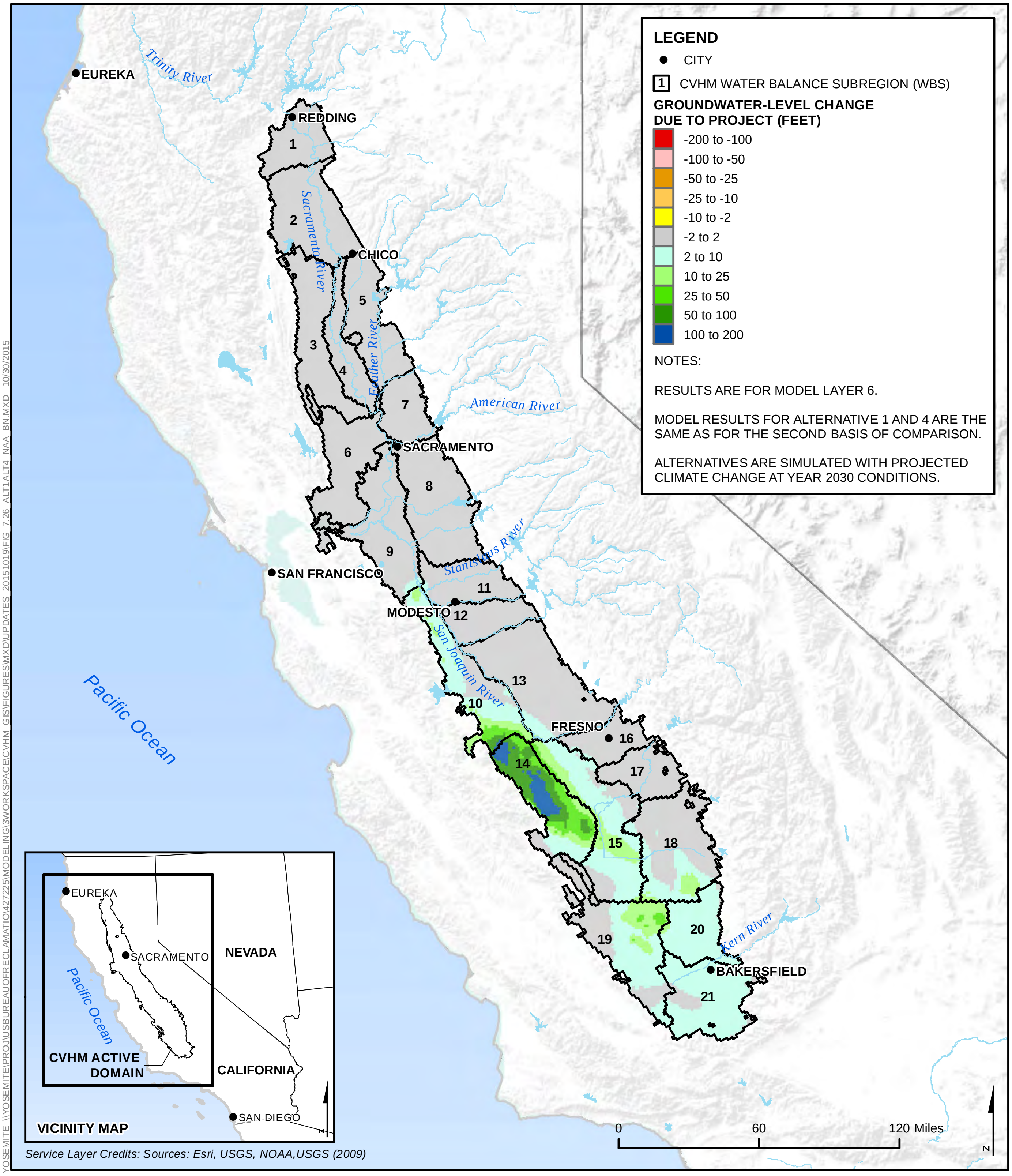
MODEL RESULTS FOR ALTERNATIVE 1 AND 4 ARE THE SAME AS FOR THE SECOND BASIS OF COMPARISON.

ALTERNATIVES ARE SIMULATED WITH PROJECTED CLIMATE CHANGE AT YEAR 2030 CONDITIONS.

Service Layer Credits: Sources: Esri, USGS, NOAA,USGS (2009)

YOSEMITE \\YOSEMITE\PROJ\USBUREAUOFRECLAMATION\427225\MODELING\3WORKSPACE\CVHM GIS\FIGURES\MXD\UPDATES 20151019\FIG 7.25 ALT1ALT4 NAA AN.MXD 10/30/2015

Figure 7.25 Forecast Groundwater-Level Changes for Alternative 1, Alternative 4, and Second Basis of Comparison Compared to No Action Alternative for Average July in a Future Above-Normal Year



NOTES:

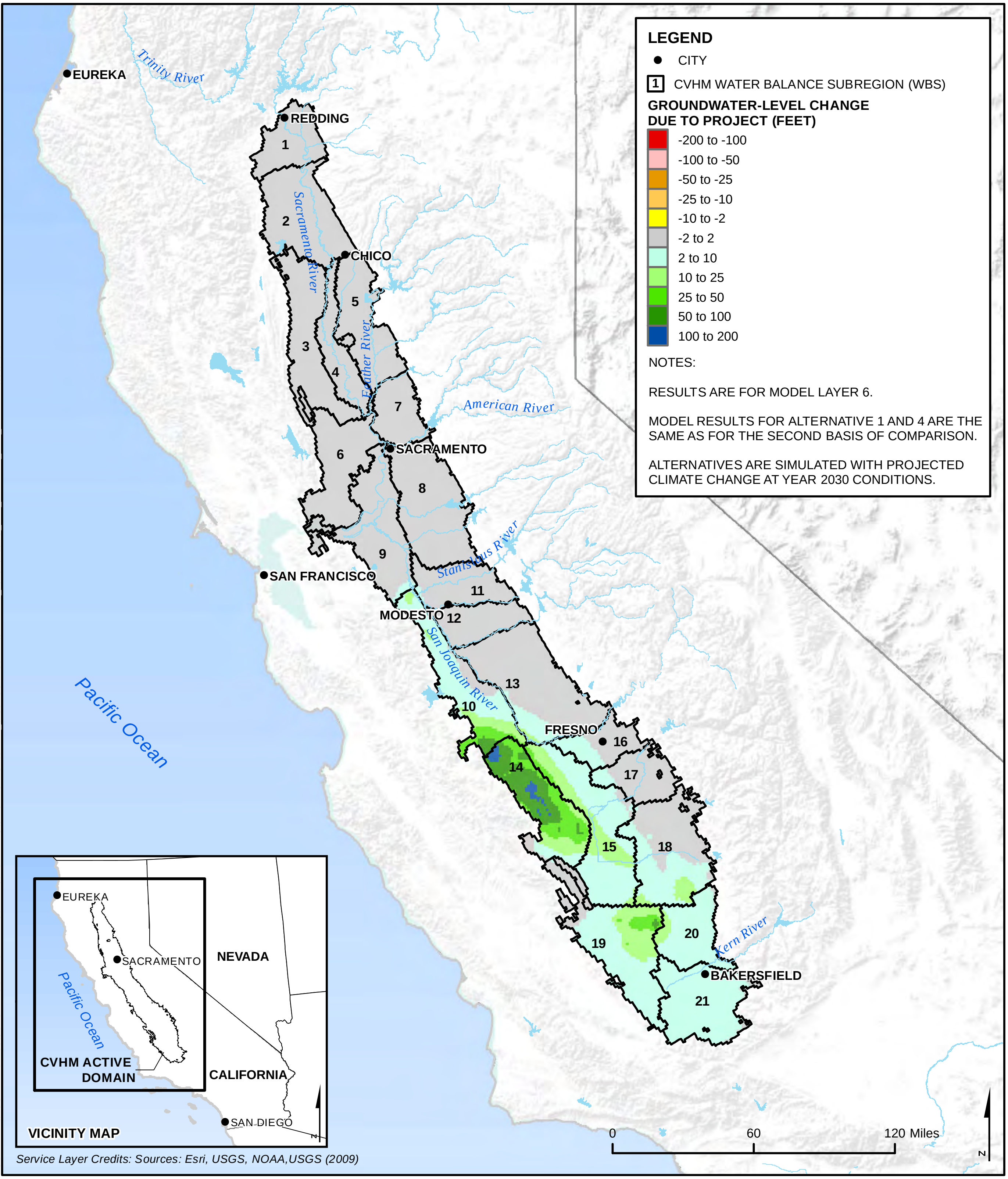
RESULTS ARE FOR MODEL LAYER 6.

MODEL RESULTS FOR ALTERNATIVE 1 AND 4 ARE THE SAME AS FOR THE SECOND BASIS OF COMPARISON.

ALTERNATIVES ARE SIMULATED WITH PROJECTED CLIMATE CHANGE AT YEAR 2030 CONDITIONS.

Service Layer Credits: Sources: Esri, USGS, NOAA,USGS (2009)

Figure 7.26 Forecast Groundwater-Level Changes for Alternative 1, Alternative 4, and Second Basis of Comparison Compared to No Action Alternative For Average July in a Future Below-Normal Year



NOTES:

RESULTS ARE FOR MODEL LAYER 6.

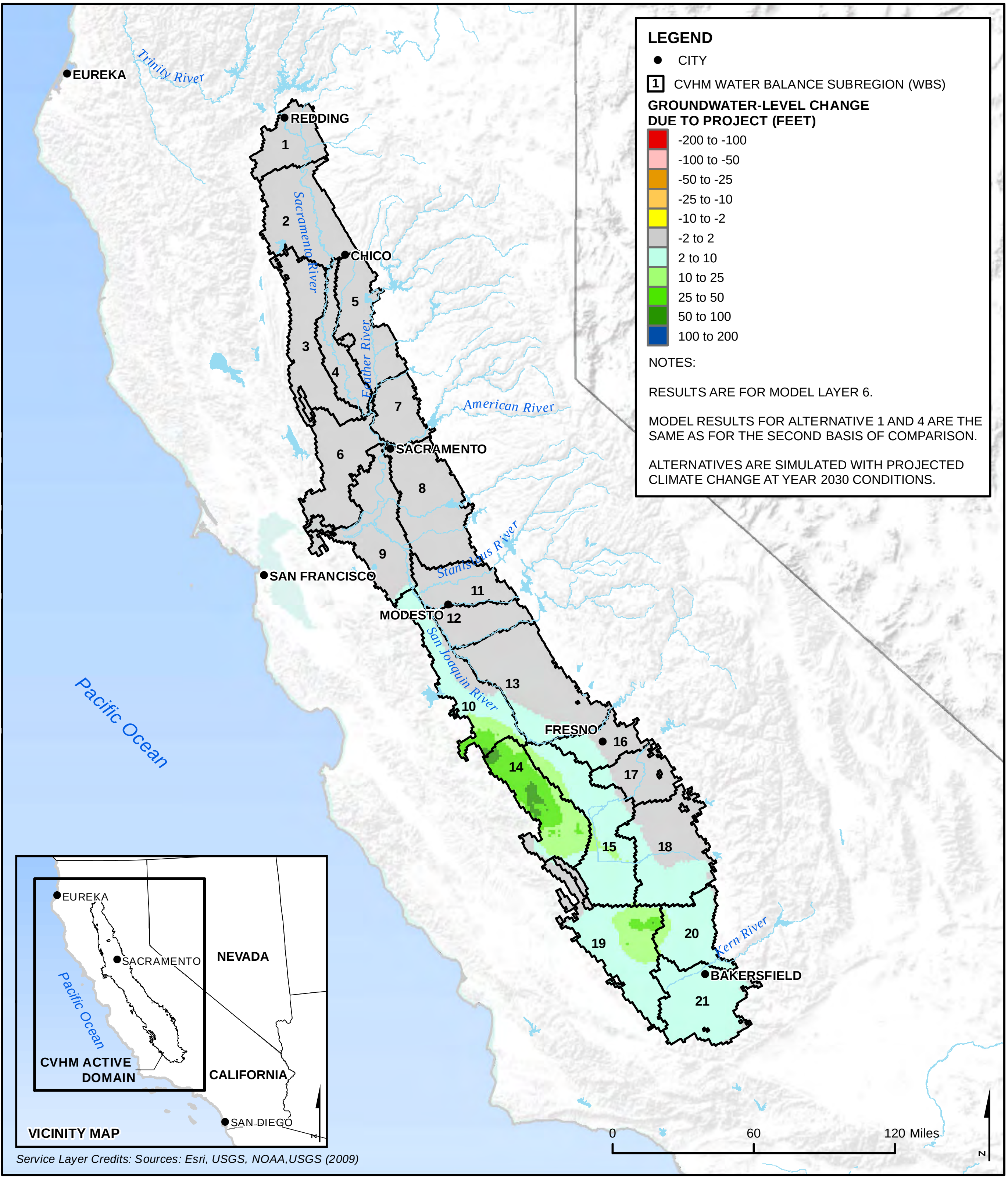
MODEL RESULTS FOR ALTERNATIVE 1 AND 4 ARE THE SAME AS FOR THE SECOND BASIS OF COMPARISON.

ALTERNATIVES ARE SIMULATED WITH PROJECTED CLIMATE CHANGE AT YEAR 2030 CONDITIONS.

Service Layer Credits: Sources: Esri, USGS, NOAA,USGS (2009)

YOSEMITE \\YOSEMITE\PROJ\USBUREAUOFRECLAMATIO\427225\MODELING\3WORKSPACE\CVHM GIS\FIGURES\MXD\UPDATES 20151019\FIG 7.27 ALT1ALT4 NAA D.MXD 10/30/2015

Figure 7.27 Forecast Groundwater-Level Changes for Alternative 1, Alternative 4, and Second Basis of Comparison Compared to No Action Alternative For Average July in a Future Dry Year



Service Layer Credits: Sources: Esri, USGS, NOAA,USGS (2009)

Figure 7.28 Forecast Groundwater-Level Changes for Alternative 1, Alternative 4, and Second Basis of Comparison Compared to No Action Alternative For Average July in a Future Critically-Dry Year

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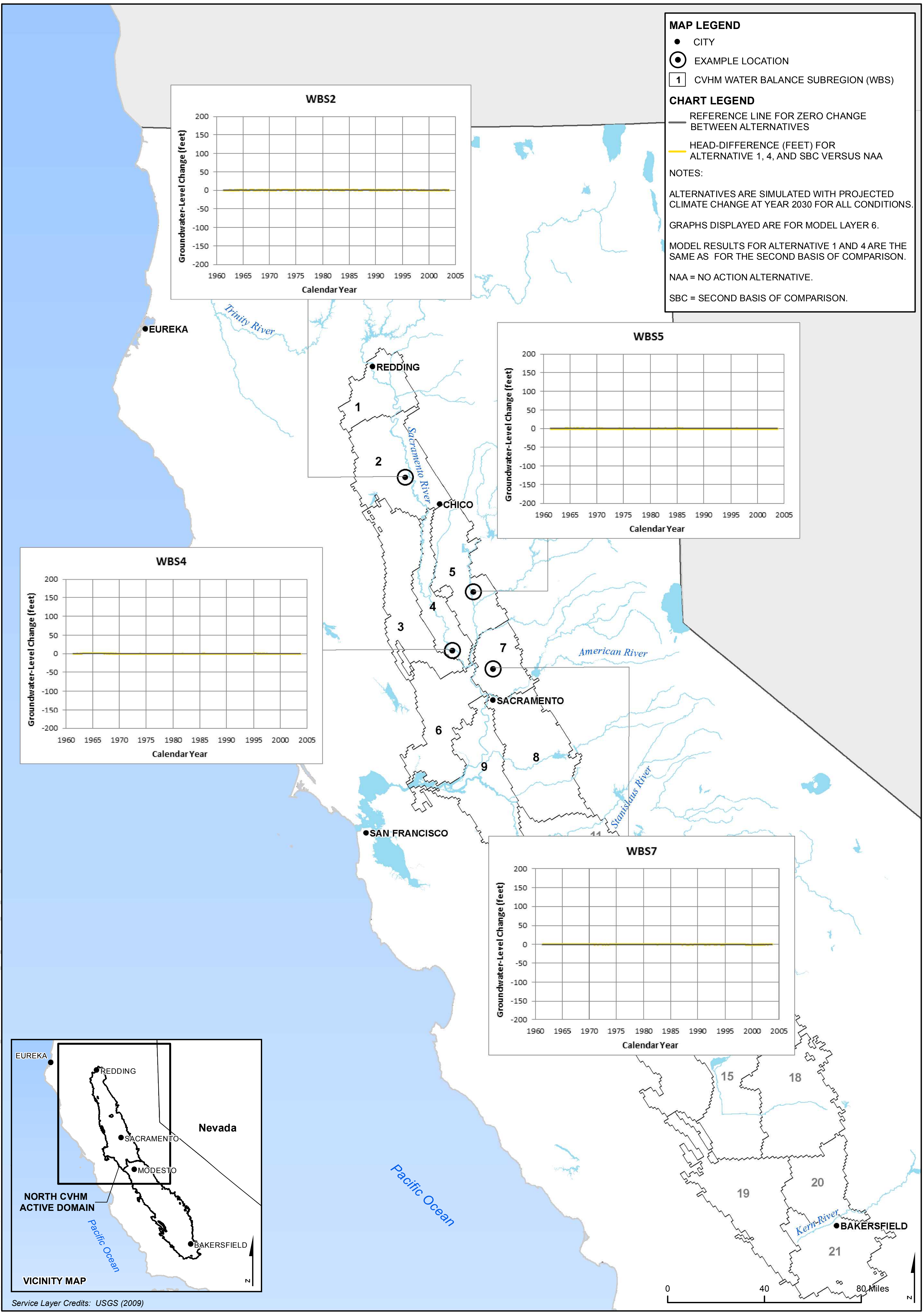
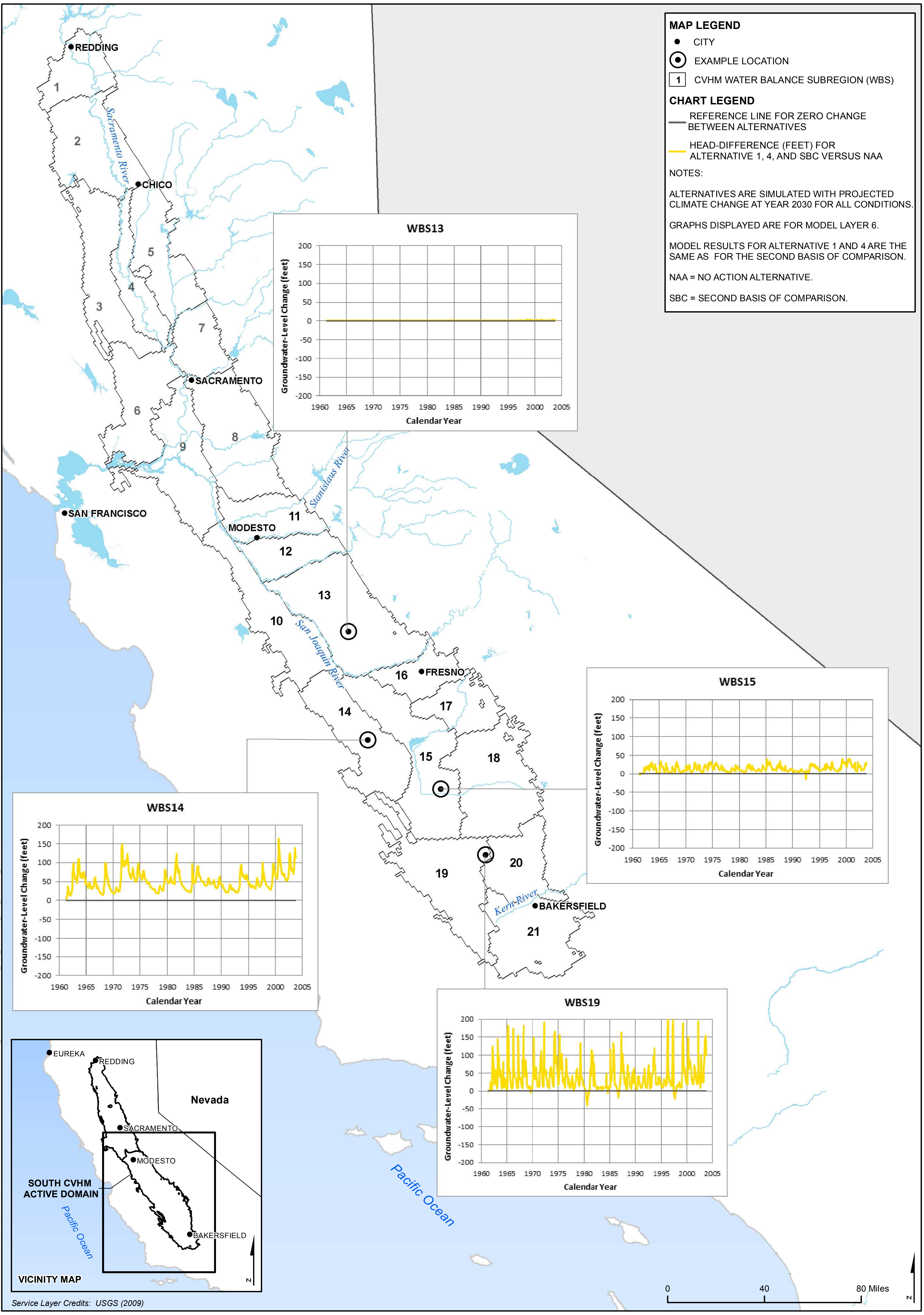


PROJ\YOSEMITE Z:\USBUREAUOFRECLAMATION\427225MODELING\3WORKSPACE\CVHM_GIS\FIGURES\MXD\FIG_7.29_ALT1ALT4_NAA_HGRAPH_N.MXD 5/21/2015

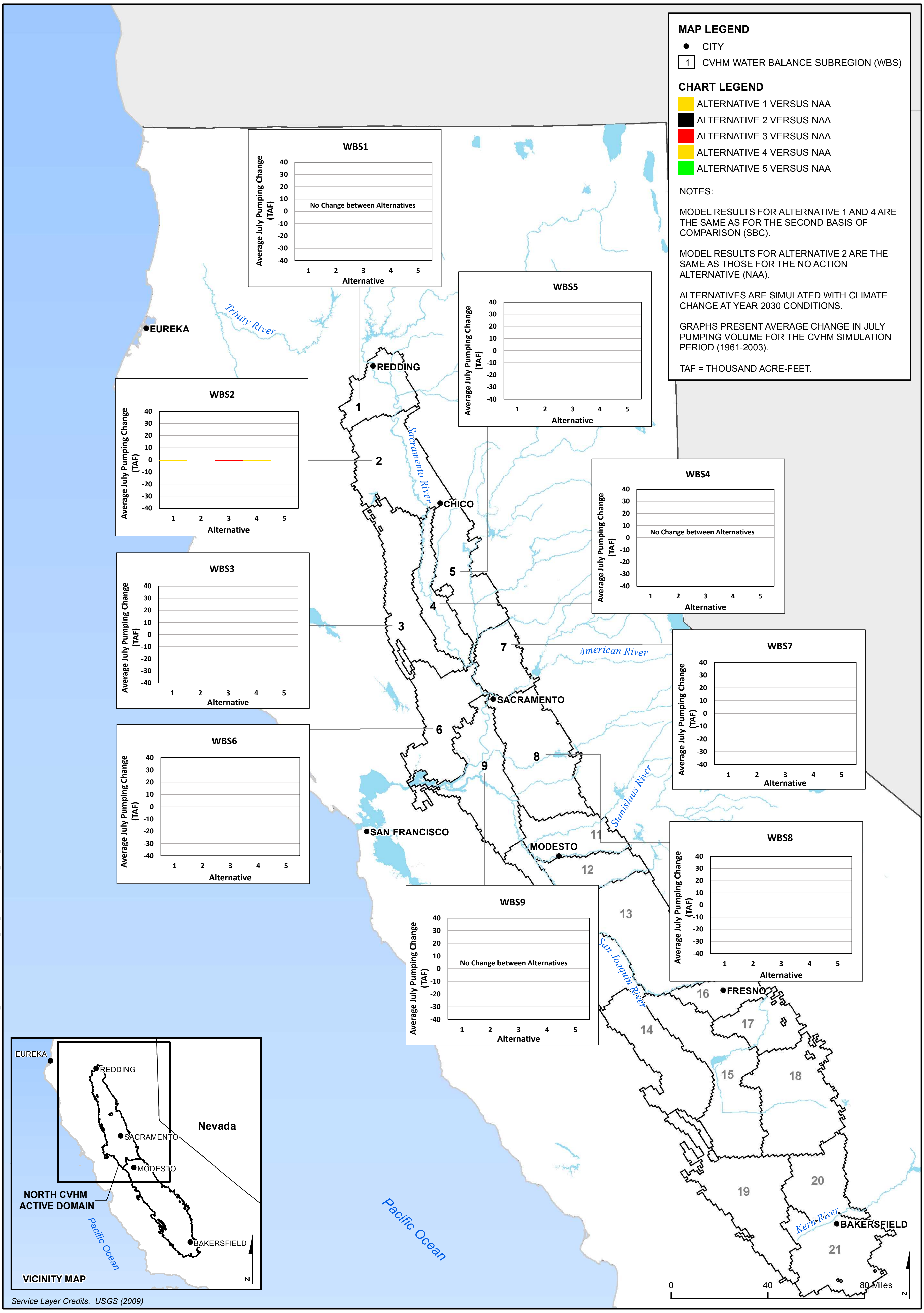
Figure 7.29 Forecast Groundwater-Level Change Hydrographs for Alternative 1, Alternative 4, and Second Basis of Comparison Compared to No Action Alternative at Example Locations in the Sacramento Valley



Service Layer Credits: USGS (2009)

PROJ\YOSEMITE Z:\USBUREAUOFRECLAMATIO\427225\MODELING\3WORKSPACE\CVHM_GIS\FIGURES\MXD\FIG_7.30_ALT1ALT4_NAA_HGRAPH_S.MXD 5/21/2015

Figure 7.30 Forecast Groundwater-Level Change Hydrographs for Alternative 1, Alternative 4, and Second Basis of Comparison Compared to No Action Alternative at Example Locations in the San Joaquin Valley



NOTES:

MODEL RESULTS FOR ALTERNATIVE 1 AND 4 ARE THE SAME AS FOR THE SECOND BASIS OF COMPARISON (SBC).

MODEL RESULTS FOR ALTERNATIVE 2 ARE THE SAME AS THOSE FOR THE NO ACTION ALTERNATIVE (NAA).

ALTERNATIVES ARE SIMULATED WITH CLIMATE CHANGE AT YEAR 2030 CONDITIONS.

GRAPHS PRESENT AVERAGE CHANGE IN JULY PUMPING VOLUME FOR THE CVHM SIMULATION PERIOD (1961-2003).

TAF = THOUSAND ACRE-FEET.

Service Layer Credits: USGS (2009)

PROJ\\YOSEMITE Z:\USBUREAUOFRECLAMATIO\427225\MODELING\3WORKSPACE\CVHM_GIS\FIGURES\MXD\FIG_7.31_ALTERNATIVES_NAA_PUMPINGN.MXD 5/20/2015

Figure 7.31 Long-term Average Change in July Agricultural Groundwater Pumping for Alternatives Compared to the No Action Alternative in the Sacramento Valley

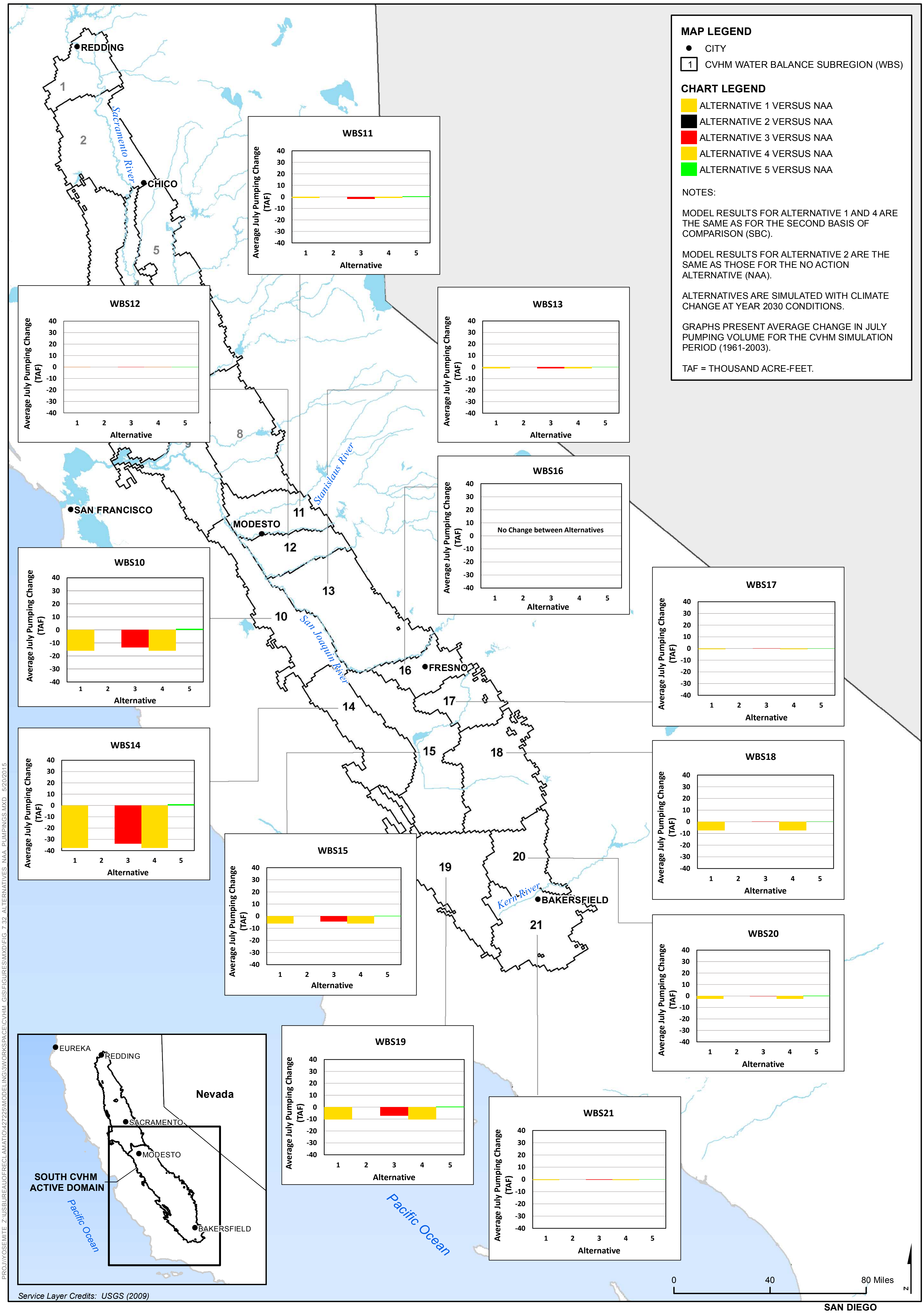
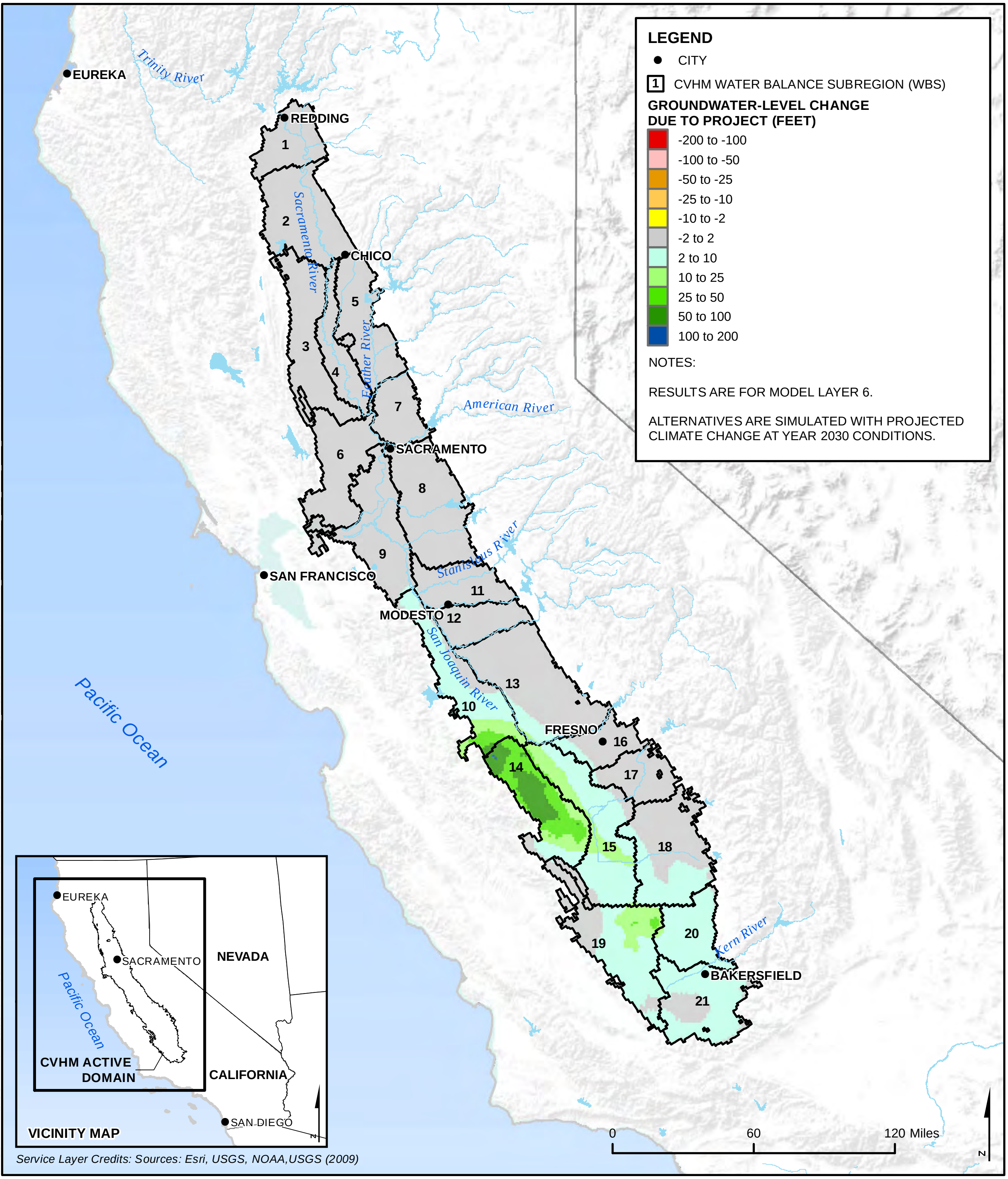


Figure 7.32 Long-term Average Change in July Agricultural Groundwater Pumping for Alternatives Compared to the No Action Alternative in the San Joaquin Valley



Service Layer Credits: Sources: Esri, USGS, NOAA,USGS (2009)

YOSEMITE \\YOSEMITE\PROJ\USBUREAUOFRECLAMATIO\427225\MODELING\3WORKSPACE\CVHM GIS\FIGURES\MXD\UPDATES 20151019\FIG 7.33 ALT3 NAA W.MXD 10/30/2015

Figure 7.33 Forecast Groundwater-Level Changes for Alternative 3 Compared to No Action Alternative for Average July in a Future Wet Year

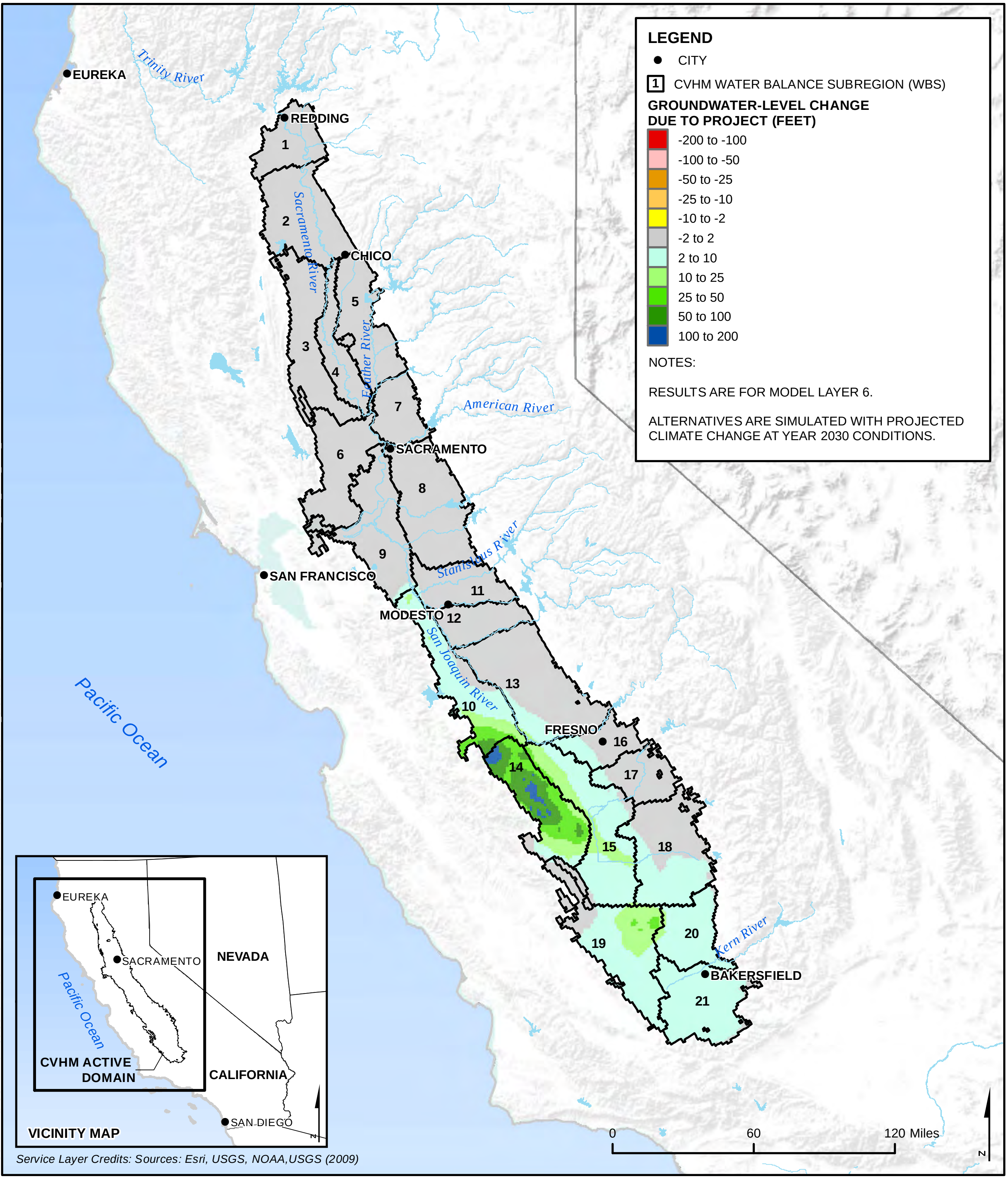


Figure 7.34 Forecast Groundwater-Level Changes for Alternative 3 Compared to No Action Alternative for Average July in a Future Above-Normal Year

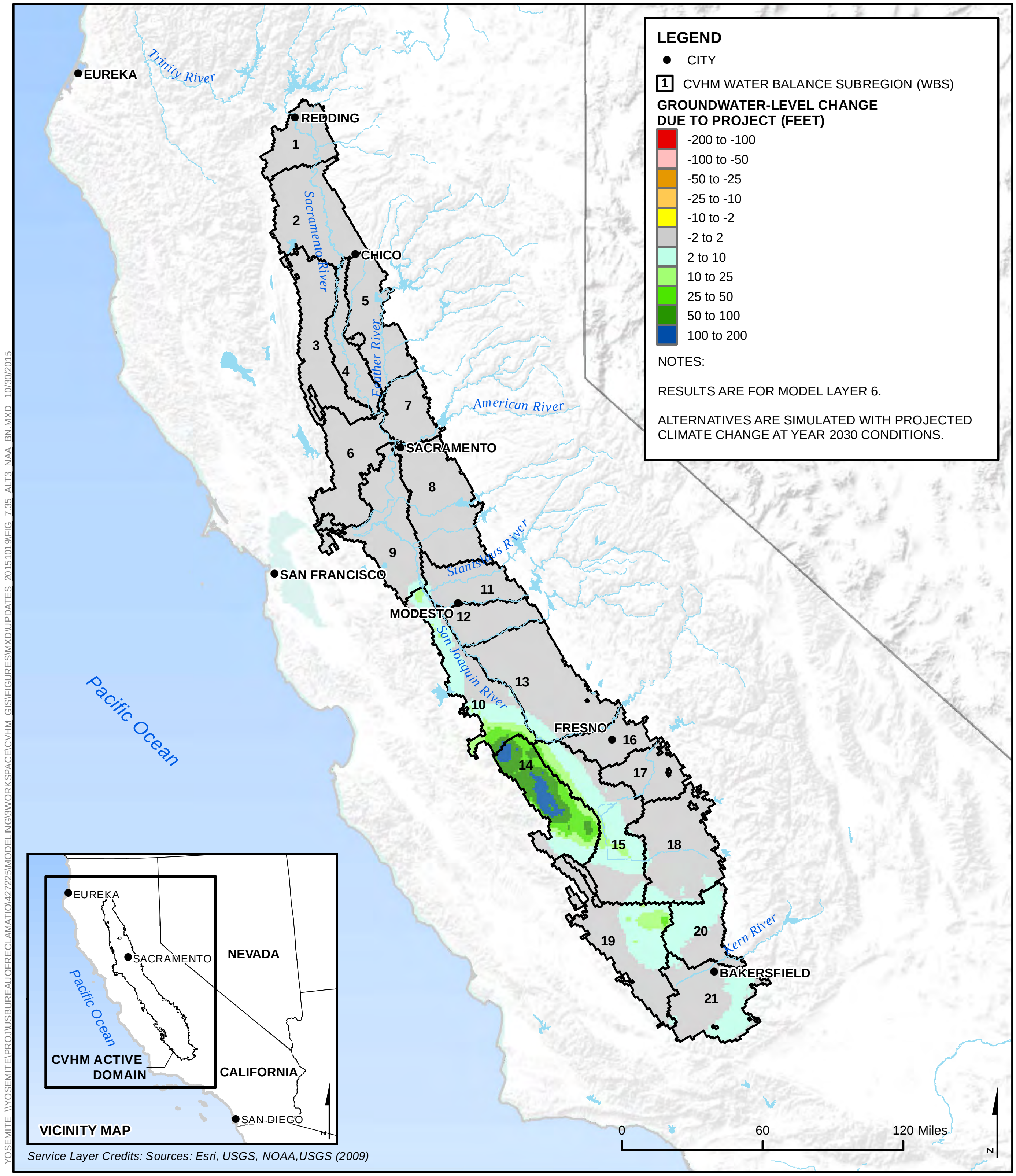
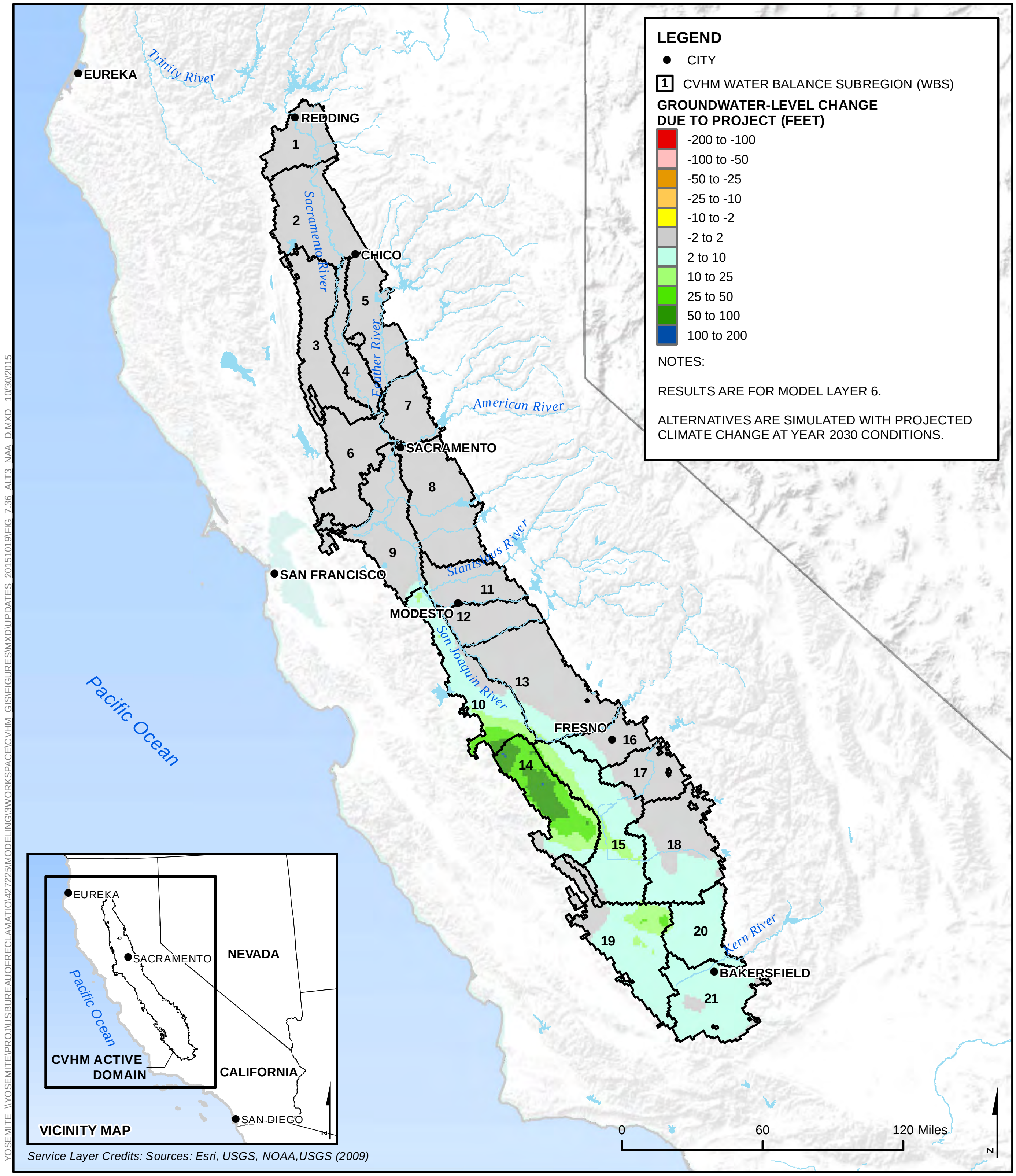
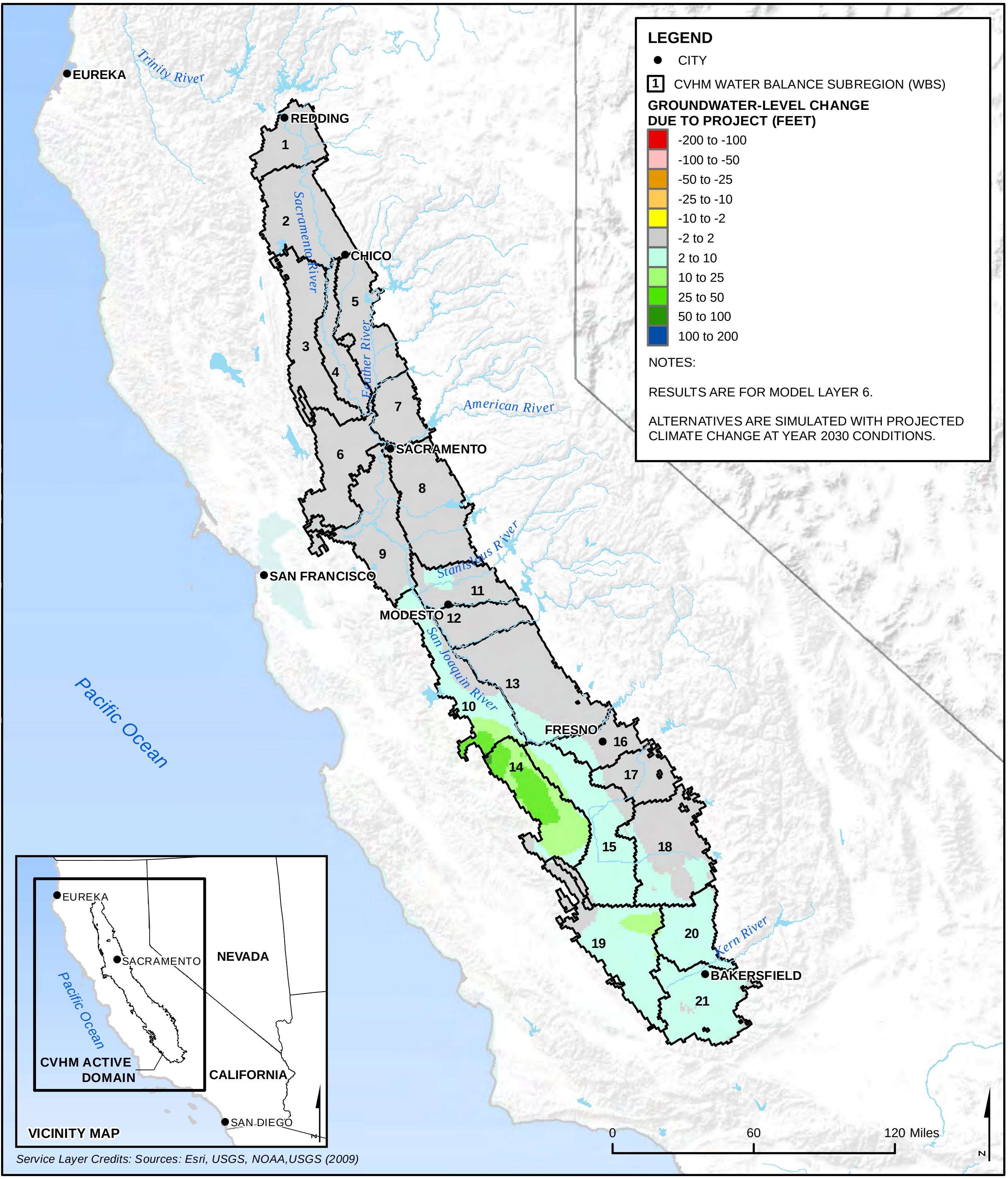


Figure 7.35 Forecast Groundwater-Level Changes for Alternative 3 Compared to No Action Alternative for Average July in a Future Below-Normal Year



Service Layer Credits: Sources: Esri, USGS, NOAA,USGS (2009)

Figure 7.36 Forecast Groundwater-Level Changes for Alternative 3 Compared to No Action Alternative for Average July in a Future Dry Year



YOSEMITE \\YOSEMITE\PROJ\US\BUREAUOFRECLAMATIO\427225\MODELING\3WORKSPACE\CVHM GIS\FIGURES\MXD\UPDATES 20151019\FIG 7.37 ALT3 NAA CD.MXD 10/30/2015

Figure 7.37 Forecast Groundwater-Level Changes for Alternative 3 Compared to No Action Alternative for Average July in a Future Critically-Dry Year

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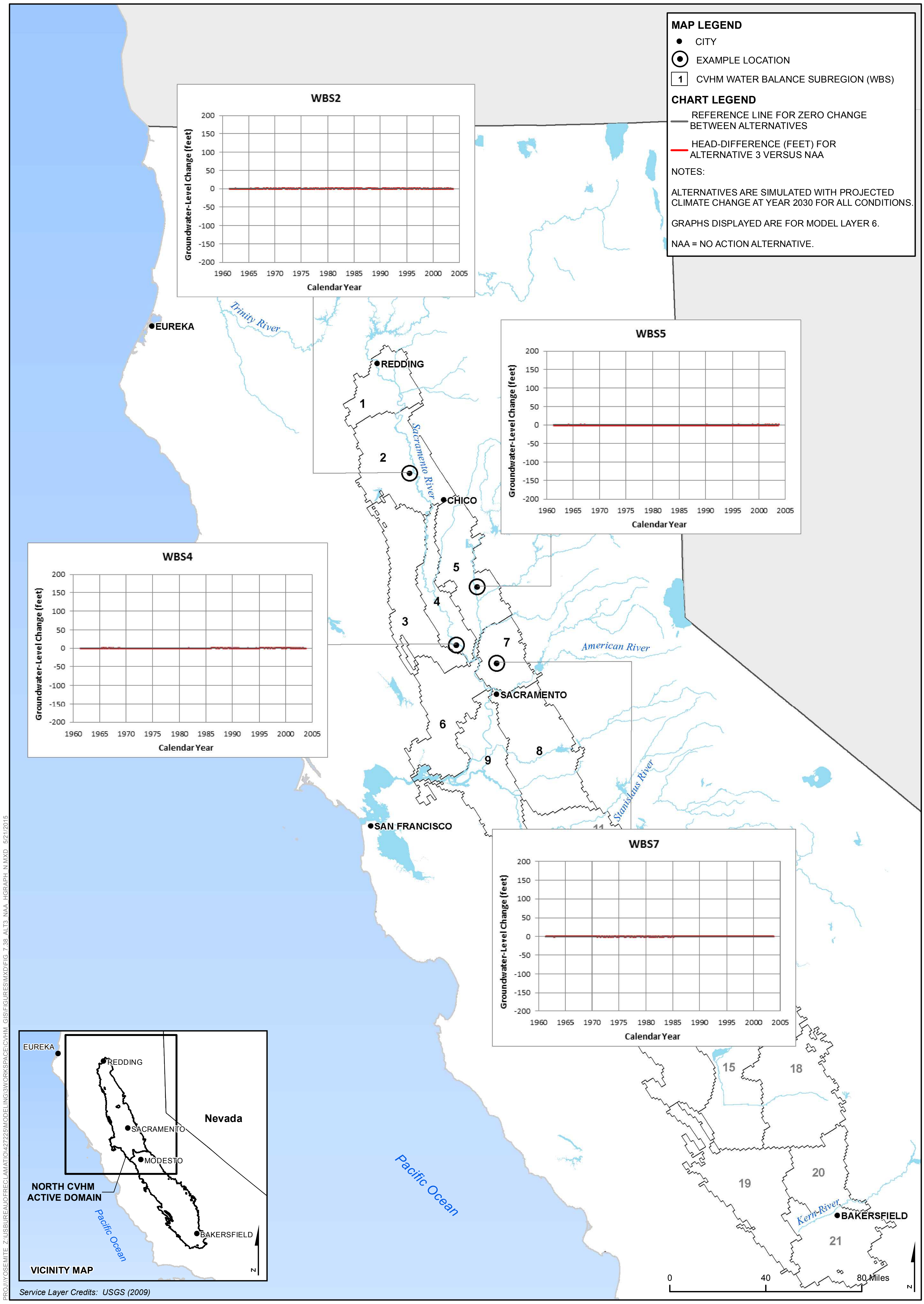


Service Layer Credits: USGS (2009)

Figure 7.38 Forecast Groundwater-Level Change Hydrographs for Alternative 3 Compared to No Action Alternative at Example Locations in the Sacramento Valley

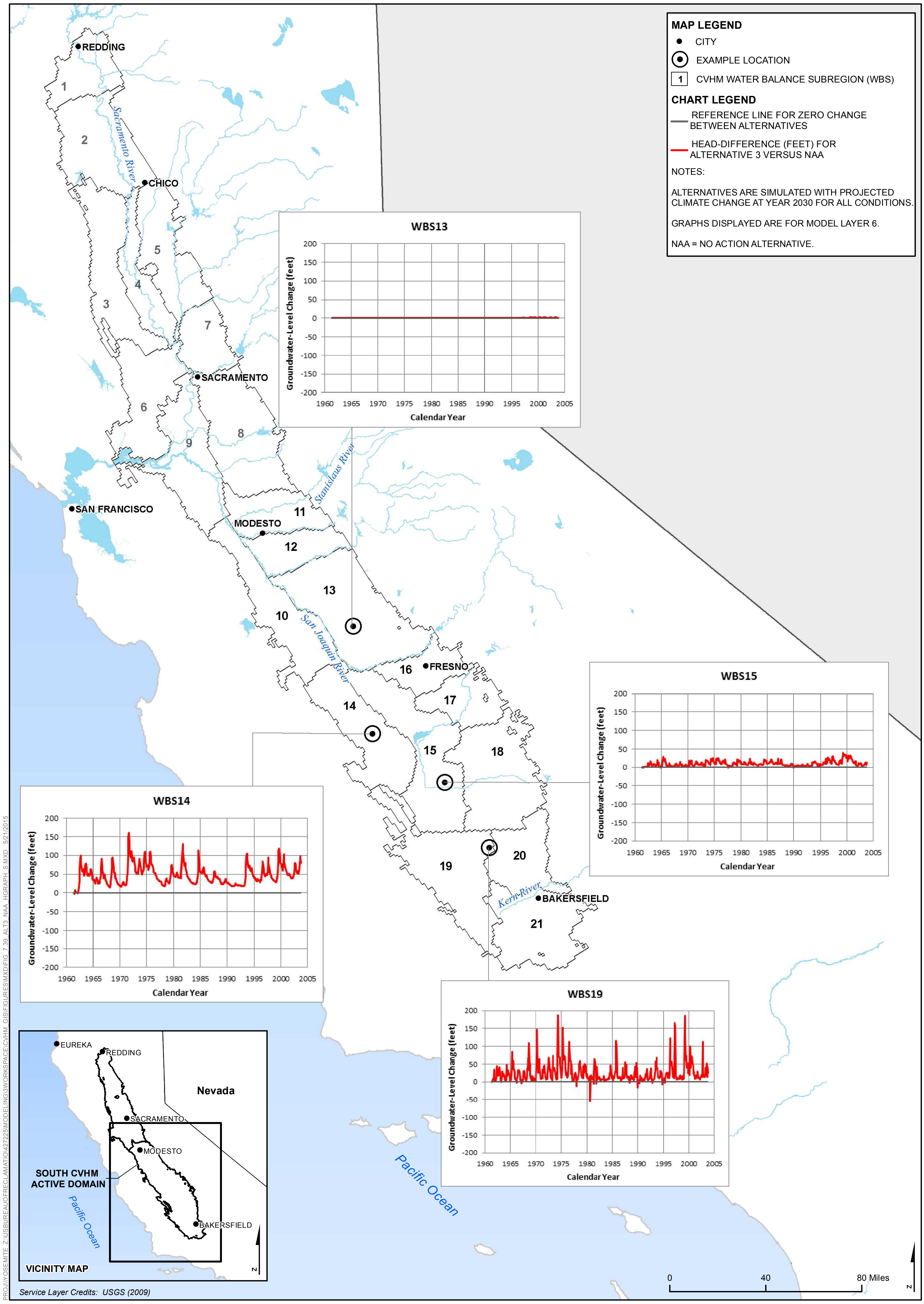
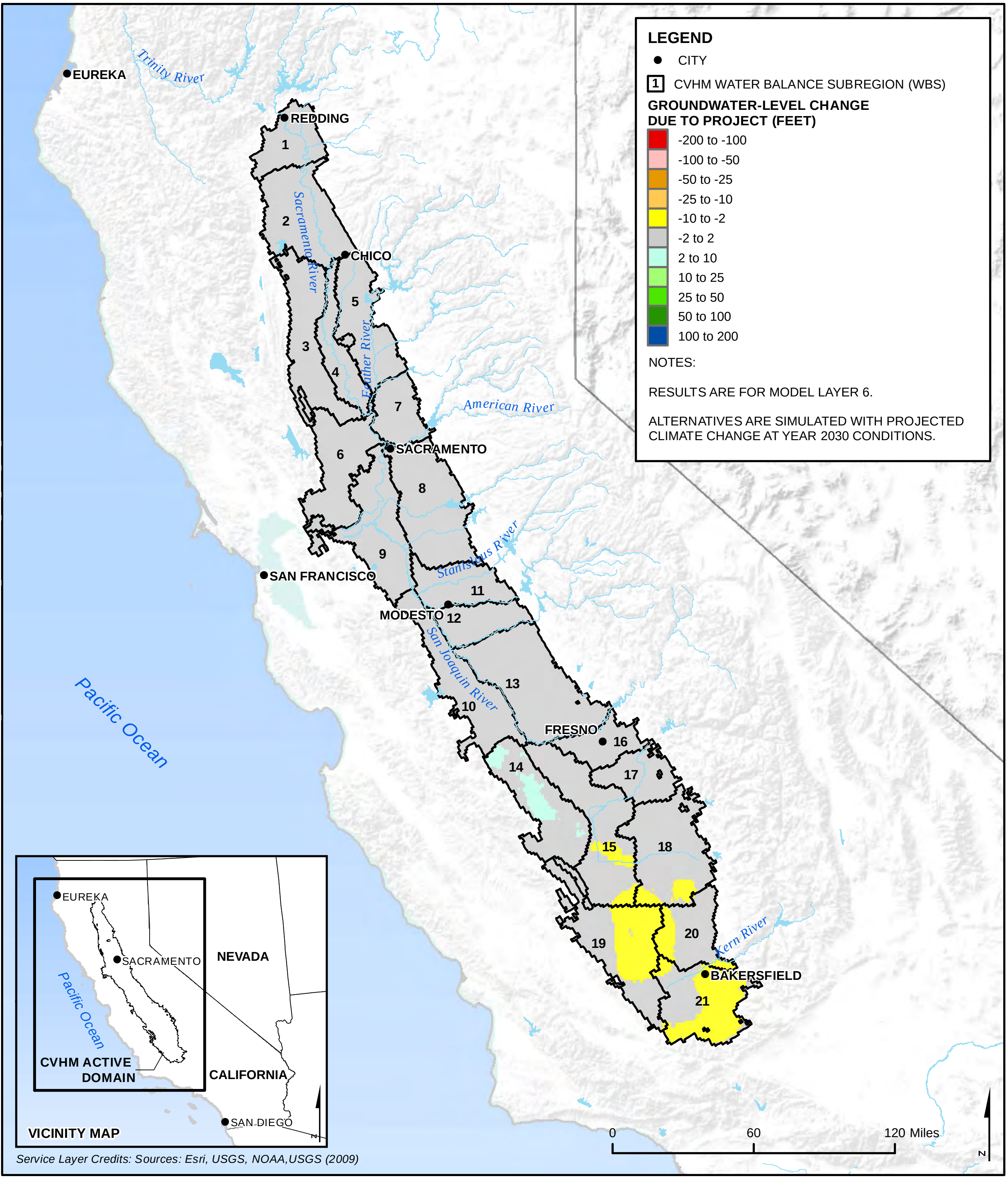


Figure 7.39 Forecast Groundwater-Level Change Hydrographs for Alternative 3 Compared to No Action Alternative at Example Locations in the San Joaquin Valley



Service Layer Credits: Sources: Esri, USGS, NOAA,USGS (2009)

YOSEMITE \\YOSEMITE\PROJ\USBUREAUOFRECLAMATIO\427225\MODELING\3WORKSPACE\CVHM_GIS\FIGURES\MXD\UPDATES_20151019\FIG_7.40_ALT3_SBC_W.MXD 10/30/2015

Figure 7.40 Forecast Groundwater-Level Changes for Alternative 3 Compared to Second Basis of Comparison for Average July in a Future Wet Year

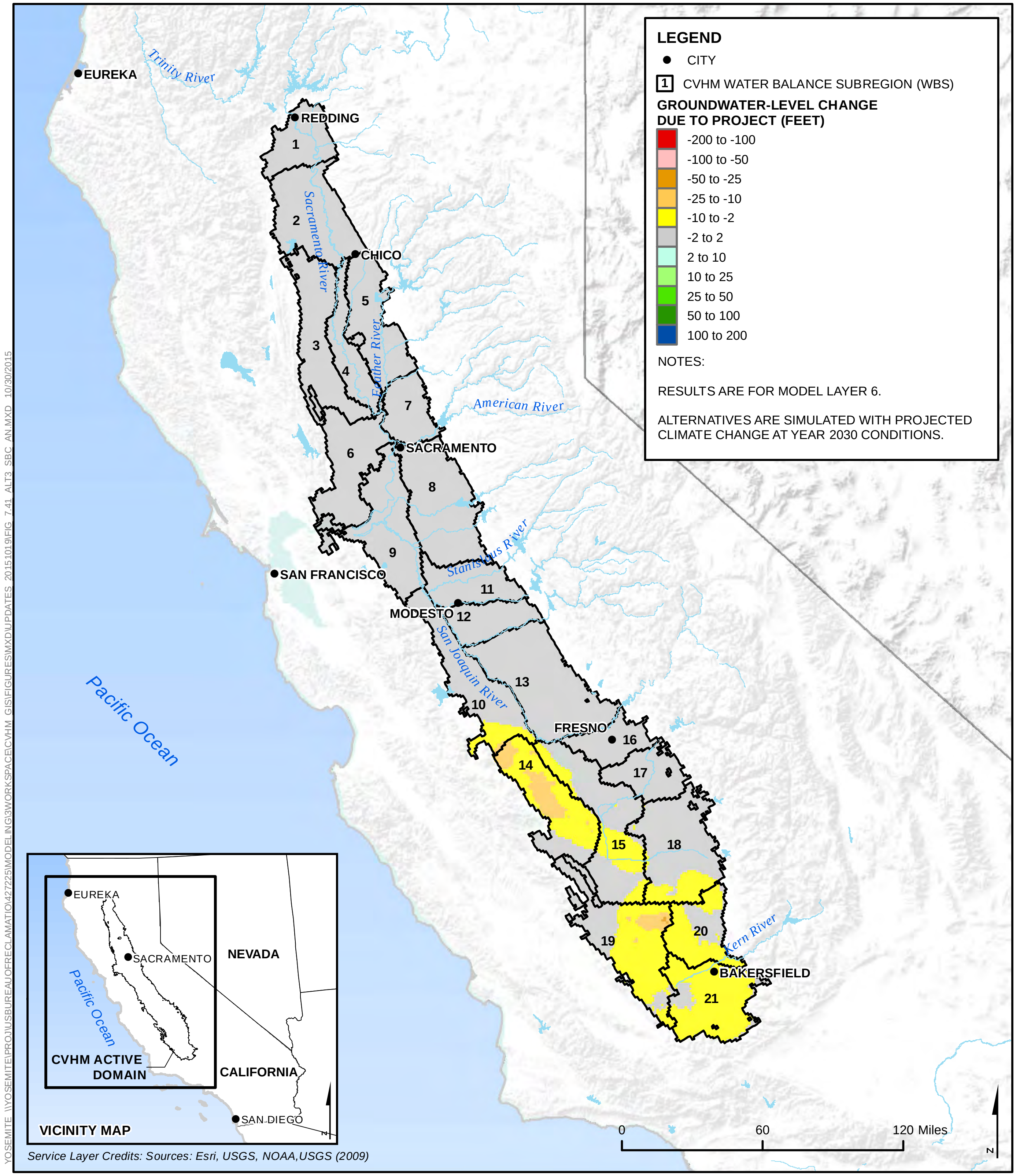
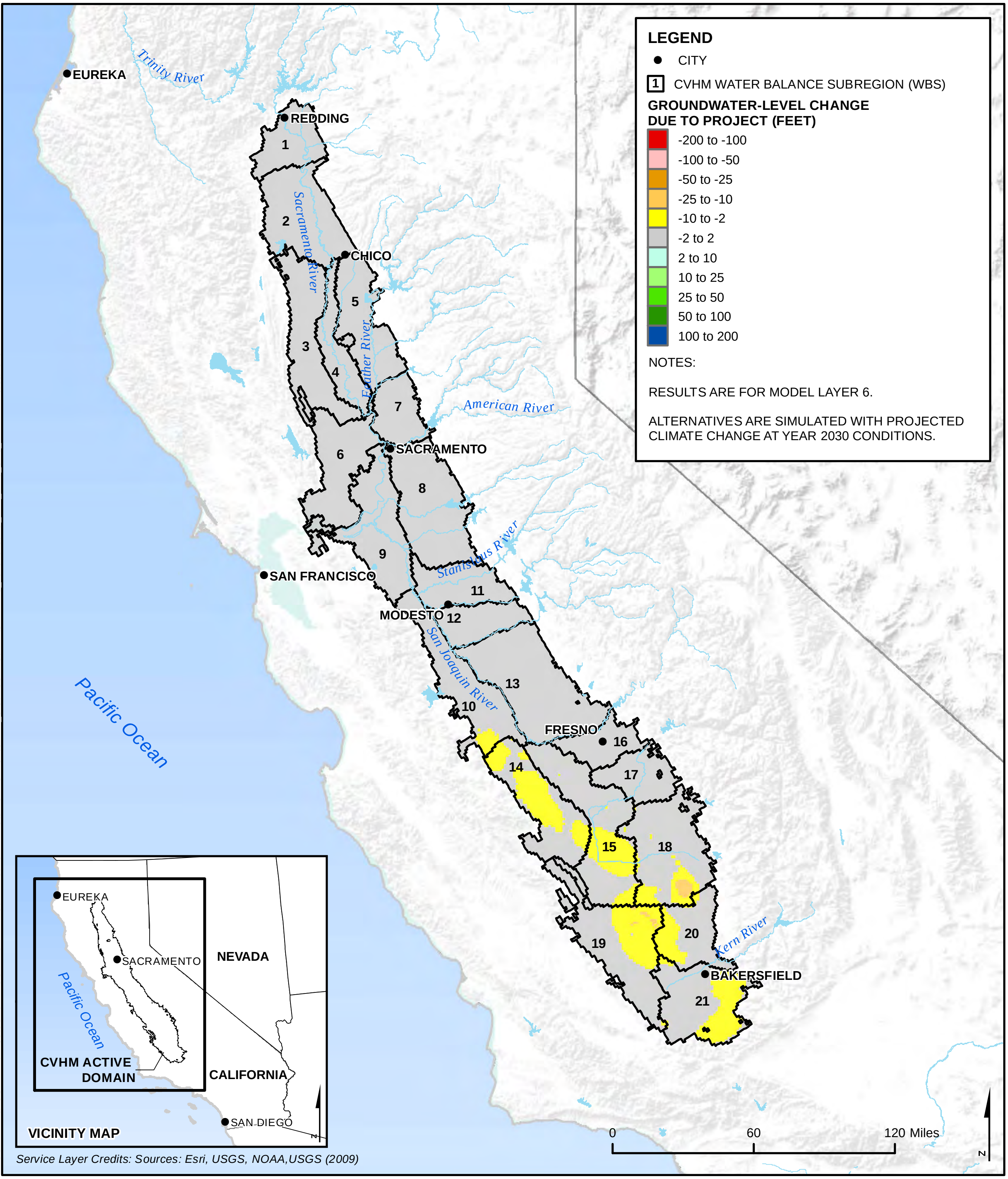


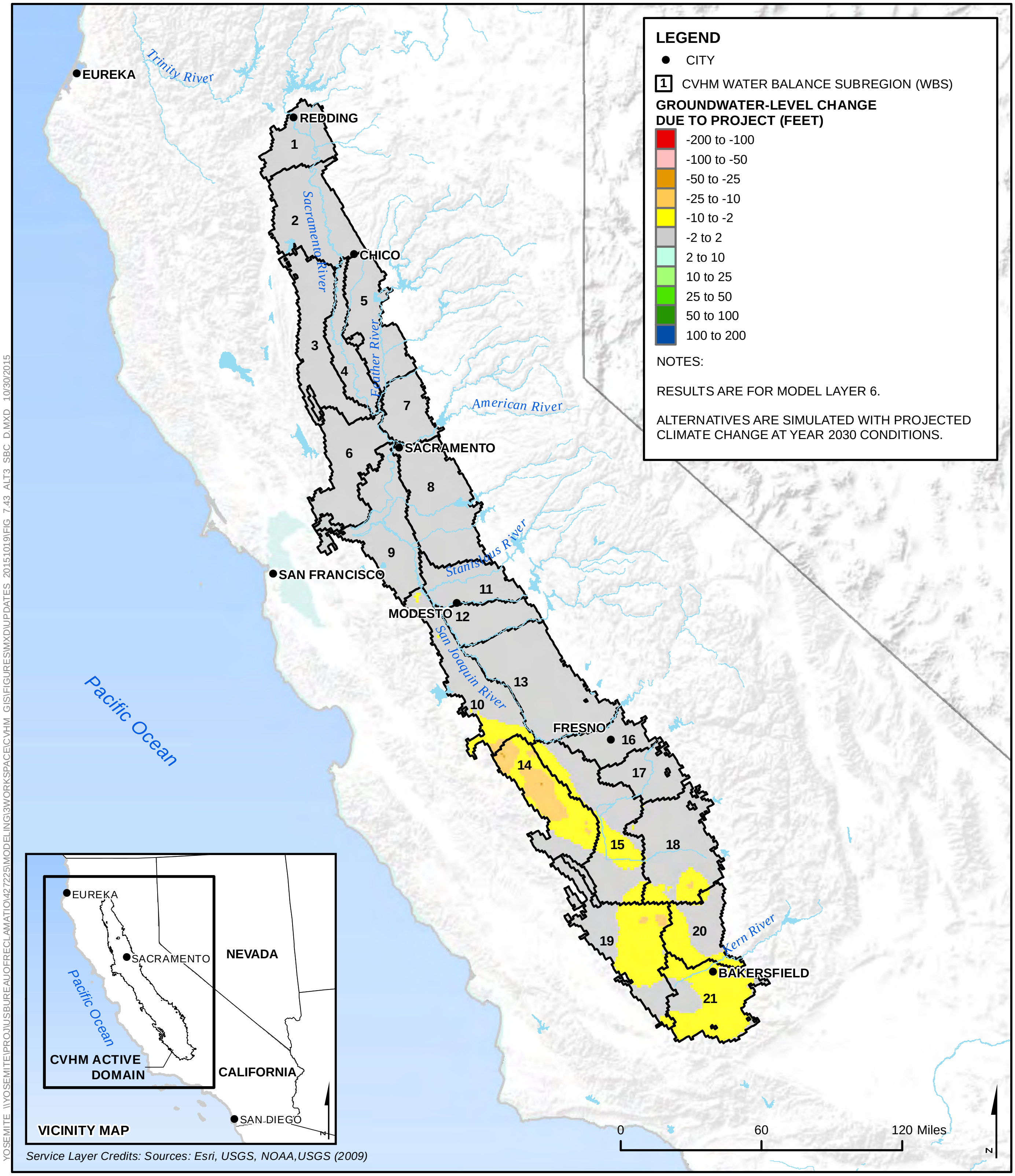
Figure 7.41 Forecast Groundwater-Level Changes for Alternative 3 Compared to Second Basis of Comparison for Average July in a Future Above-Normal Year



Service Layer Credits: Sources: Esri, USGS, NOAA,USGS (2009)

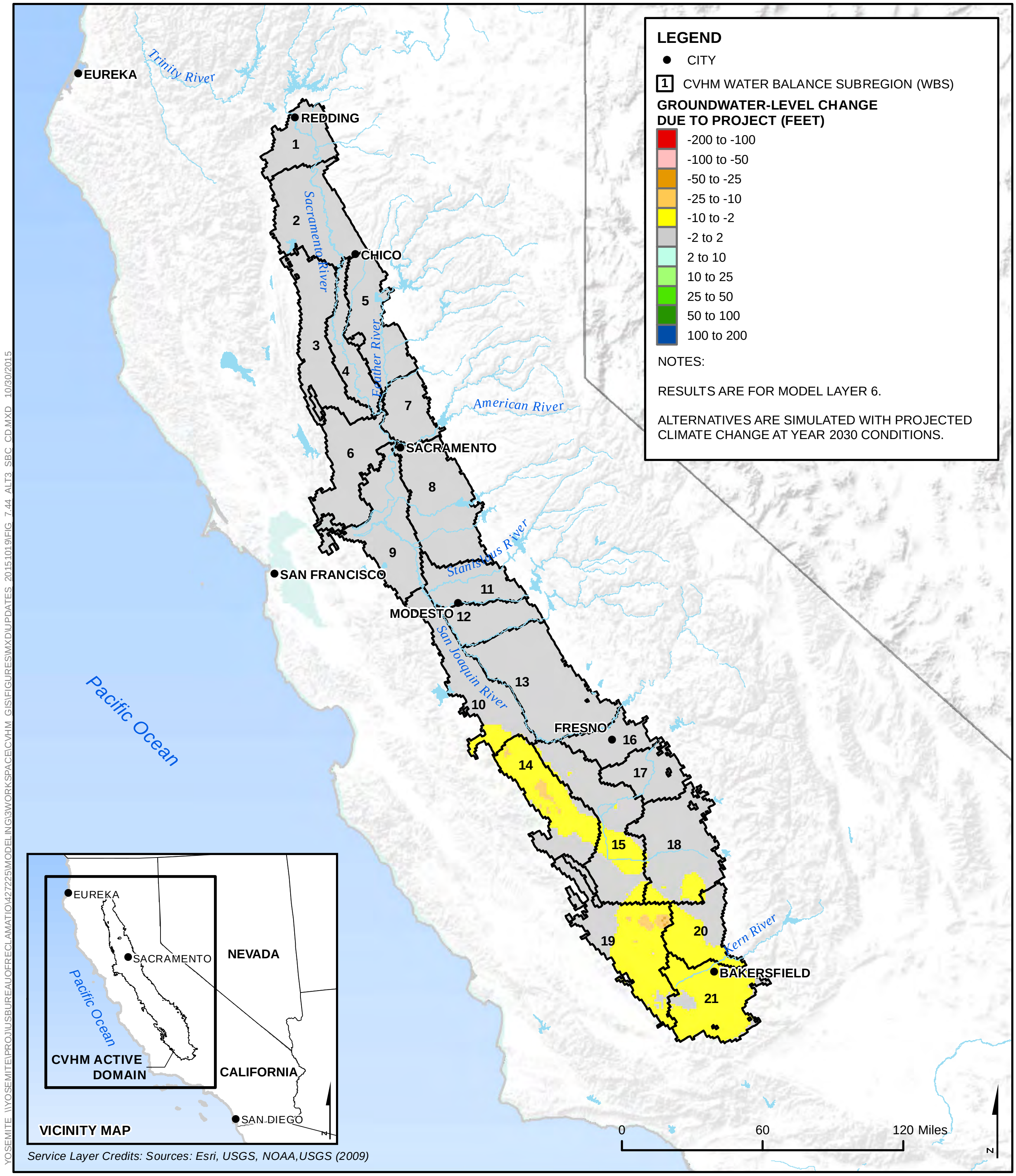
YOSEMITE \\YOSEMITE\PROJ\USBUREAUOFRECLAMATIO\427225\MODELING\3\WORKSPACE\CVHM_GIS\FIGURES\MXD\UPDATES_20151019\FIG_7.42_ALT3_SBC_BN.MXD 10/30/2015

Figure 7.42 Forecast Groundwater-Level Changes for Alternative 3 Compared to Second Basis of Comparison for Average July in a Future Below-Normal Year



Service Layer Credits: Sources: Esri, USGS, NOAA,USGS (2009)

Figure 7.43 Forecast Groundwater-Level Changes for Alternative 3 Compared to Second Basis of Comparison for Average July in a Future Dry Year



Service Layer Credits: Sources: Esri, USGS, NOAA,USGS (2009)

Figure 7.44 Forecast Groundwater-Level Changes for Alternative 3 Compared to Second Basis of Comparison for Average July in a Future Critically-Dry Year

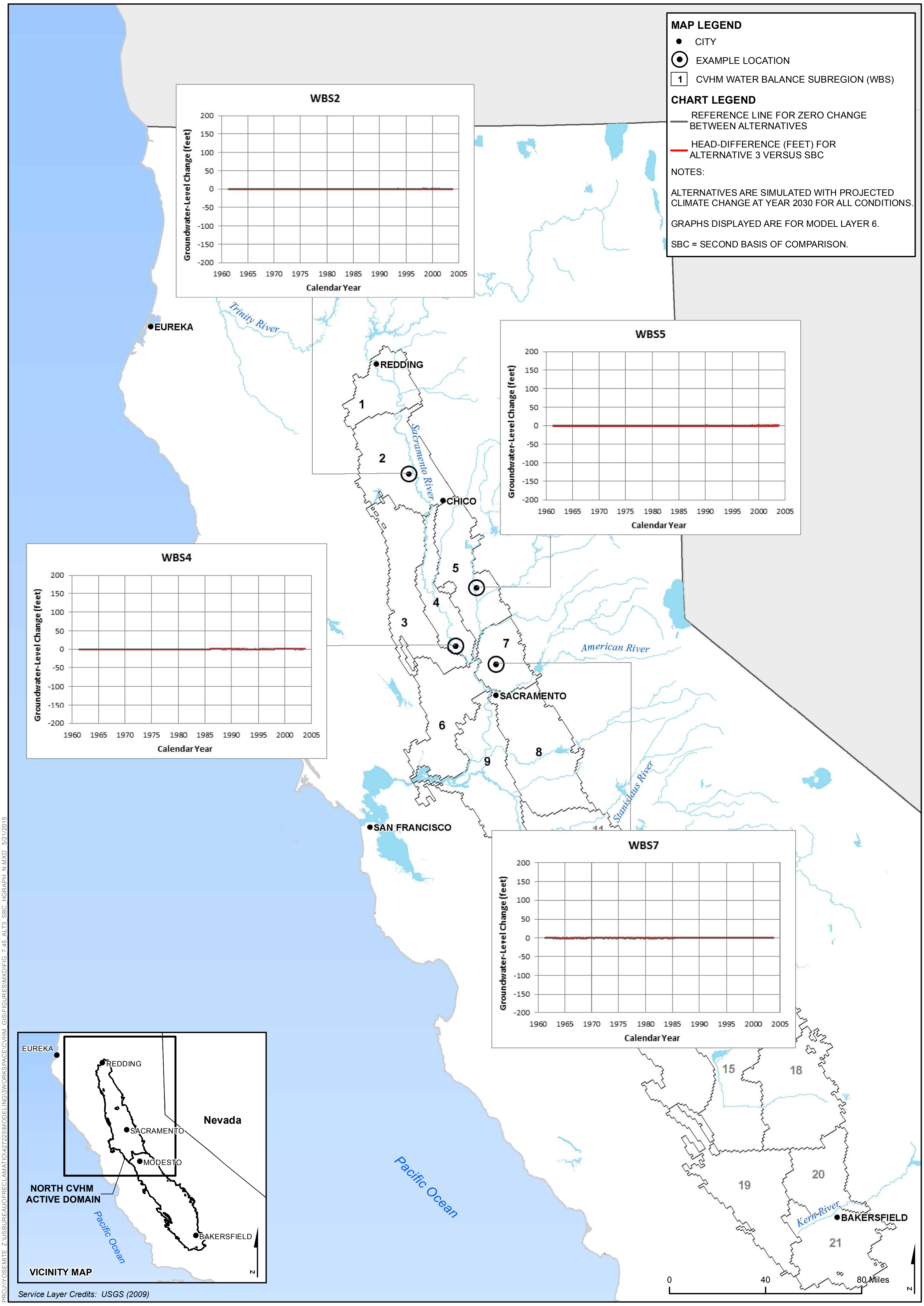
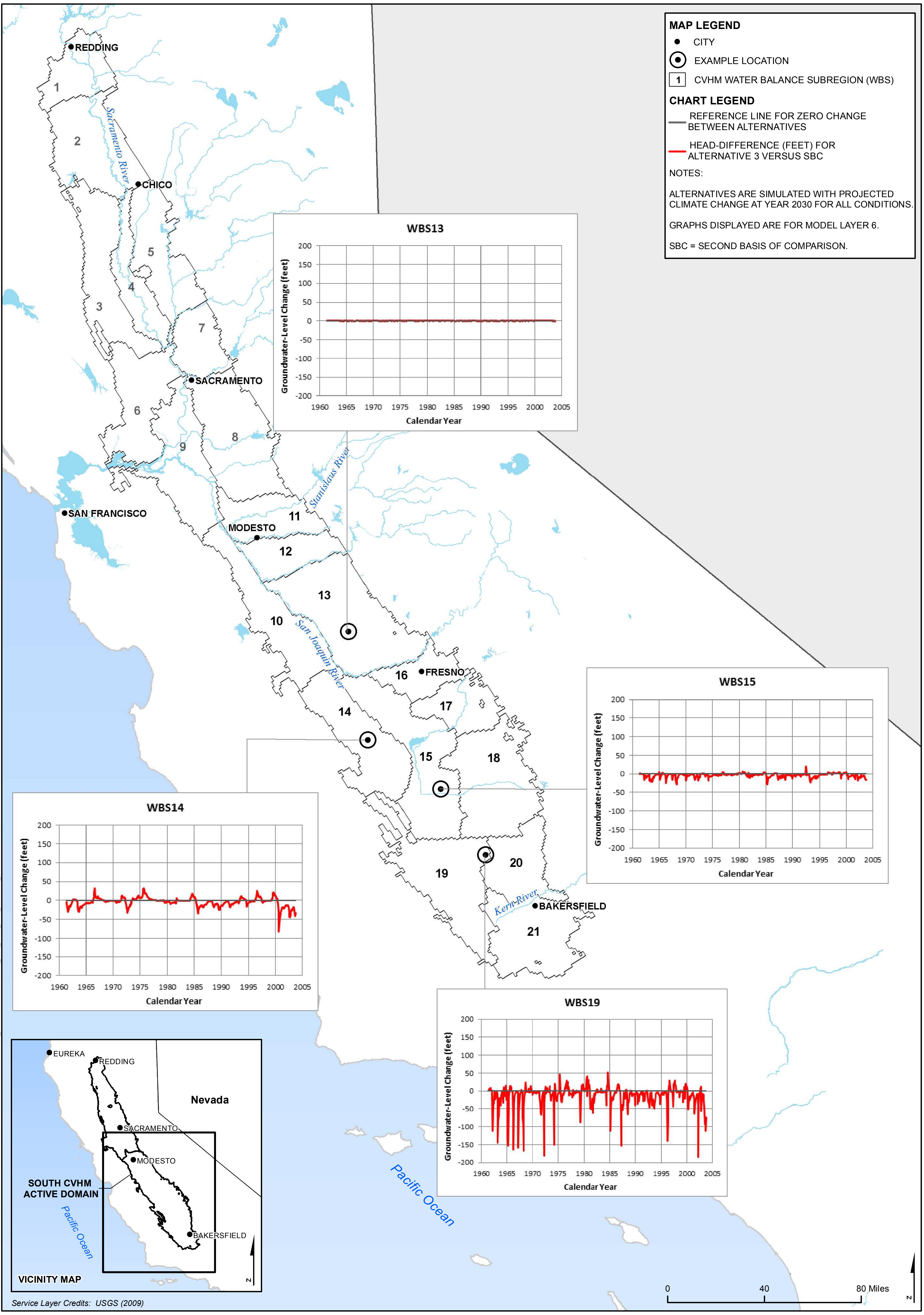
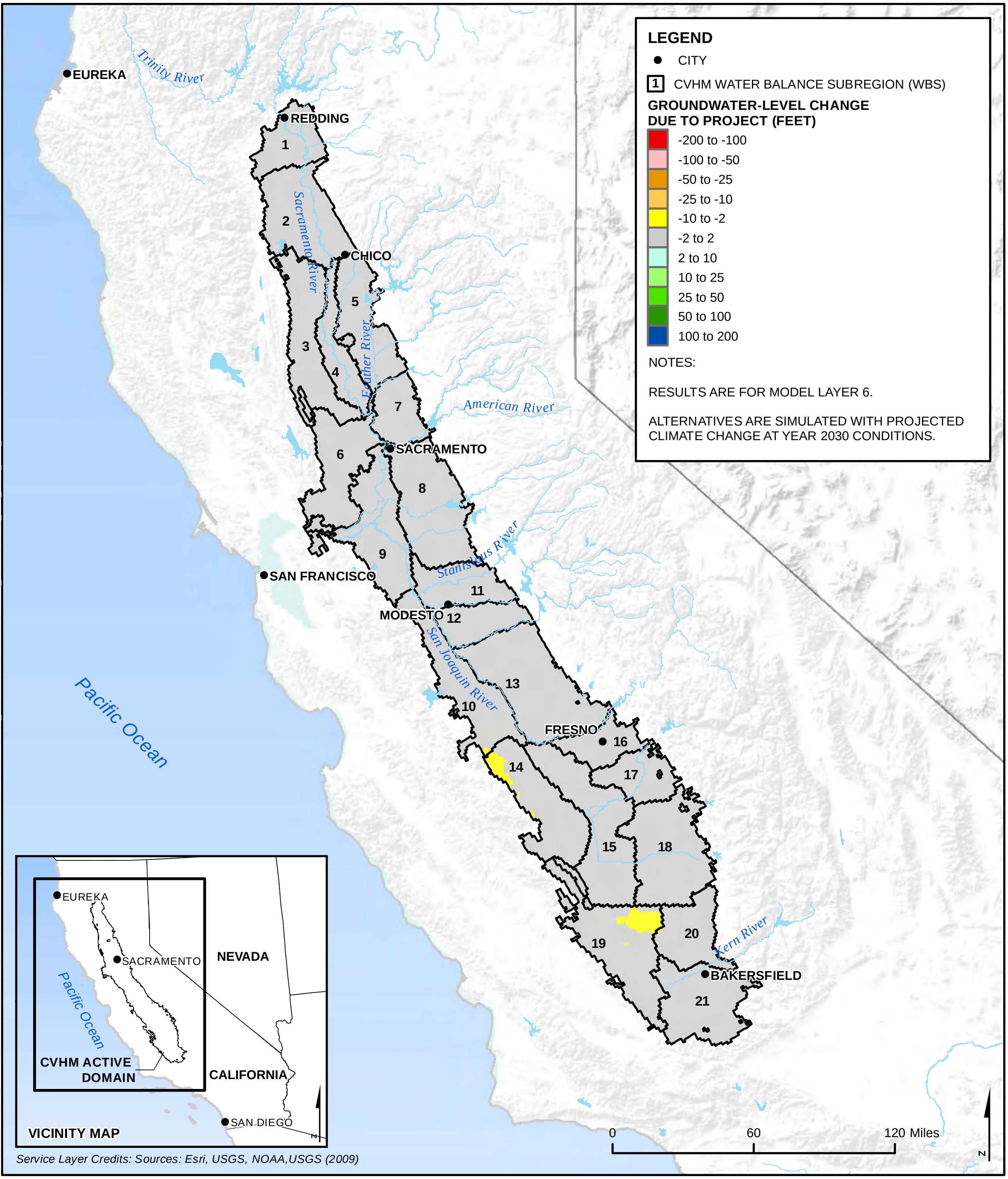


Figure 7.45 Forecast Groundwater-Level Change Hydrographs for Alternative 3 Compared to Second Basis of Comparison at Example Locations in the Sacramento Valley



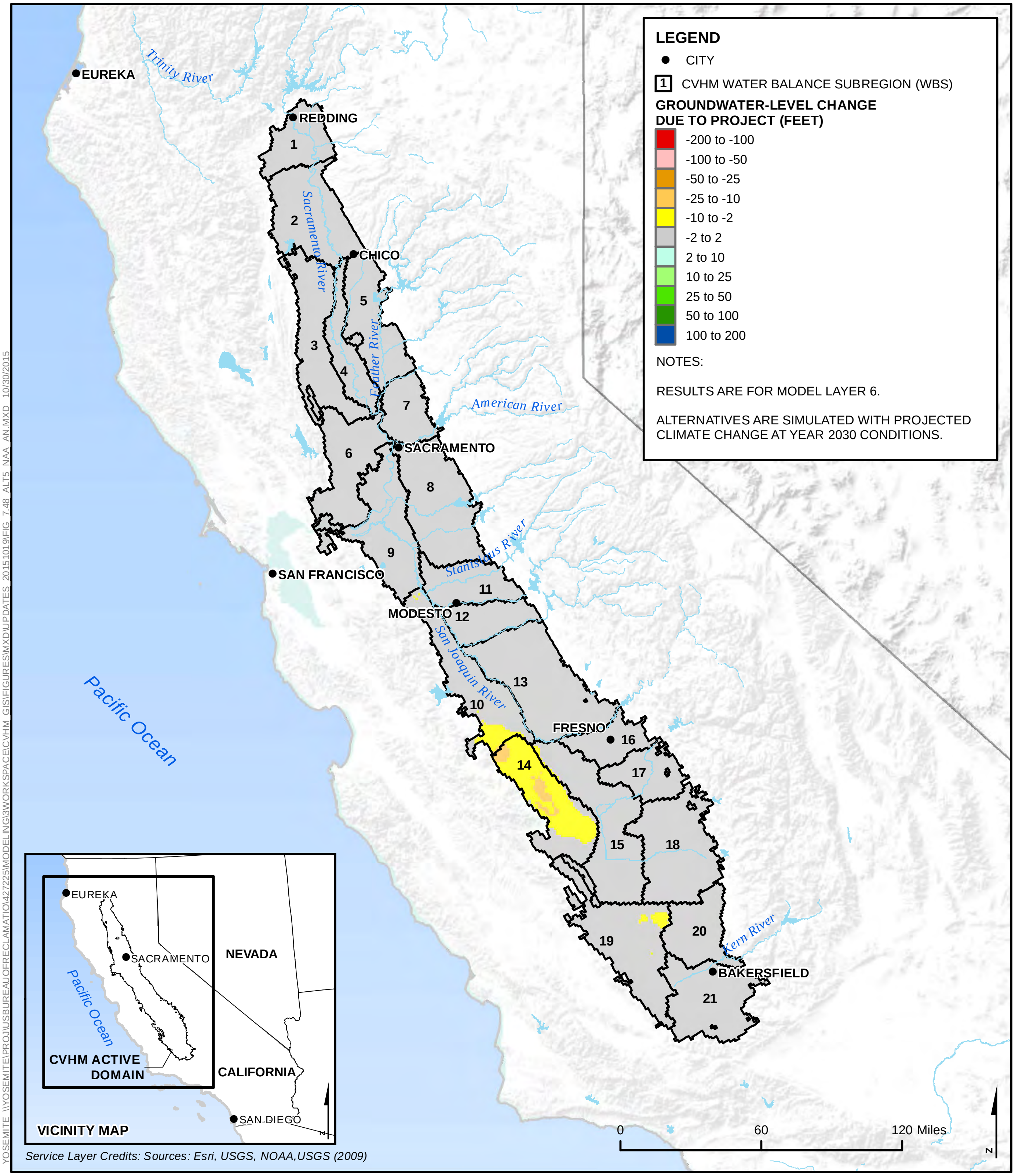
PROJ\YOSEMITE Z:\USBUREAUOFRECLAMATION\427225\MODELING3\WORKSPACE\CVHM_GIS\FIGURES\MXD\FIG_7.46_ALT3_SBC_HGRAPH_S.MXD 5/21/2015

Figure 7.46 Forecast Groundwater-Level Change Hydrographs for Alternative 3 Compared to Second Basis of Comparison at Example Locations in the San Joaquin Valley



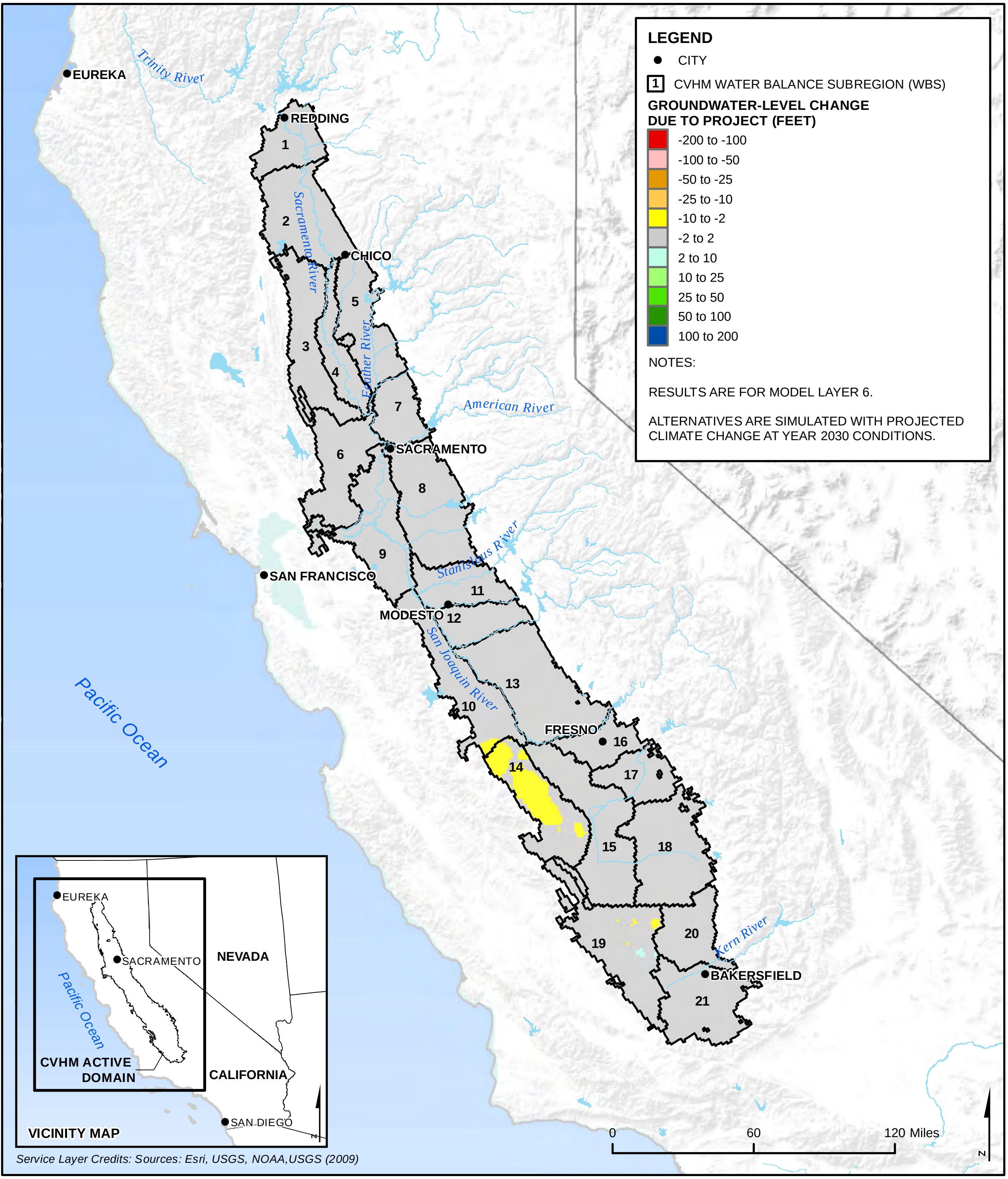
YOSEMITE \\YOSEMITE\PROJ\USBUREAUOFRECLAMATIO\427225\MODELING\3WORKSPACE\CVHM GIS\FIGURES\MXD\UPDATES 20151019\FIG 7.47 ALT5 NAA W.MXD 10/30/2015

Figure 7.47 Forecast Groundwater-Level Changes for Alternative 5 Compared to No Action Alternative For Average July in a Future Wet Year



Service Layer Credits: Sources: Esri, USGS, NOAA,USGS (2009)

Figure 7.48 Forecast Groundwater-Level Changes for Alternative 5 Compared to No Action Alternative For Average July in a Future Above-Normal Year



Service Layer Credits: Sources: Esri, USGS, NOAA,USGS (2009)

YOSEMITE \\YOSEMITE\PROJ\USBUREAUOFRECLAMATIO\427225\MODELING\3WORKSPACE\CVHM GIS\FIGURES\MXD\UPDATES_20151019\FIG_7.49_ALT5_NAA_BN.MXD 10/30/2015

Figure 7.49 Forecast Groundwater-Level Changes for Alternative 5 Compared to No Action Alternative For Average July in a Future Below-Normal Year

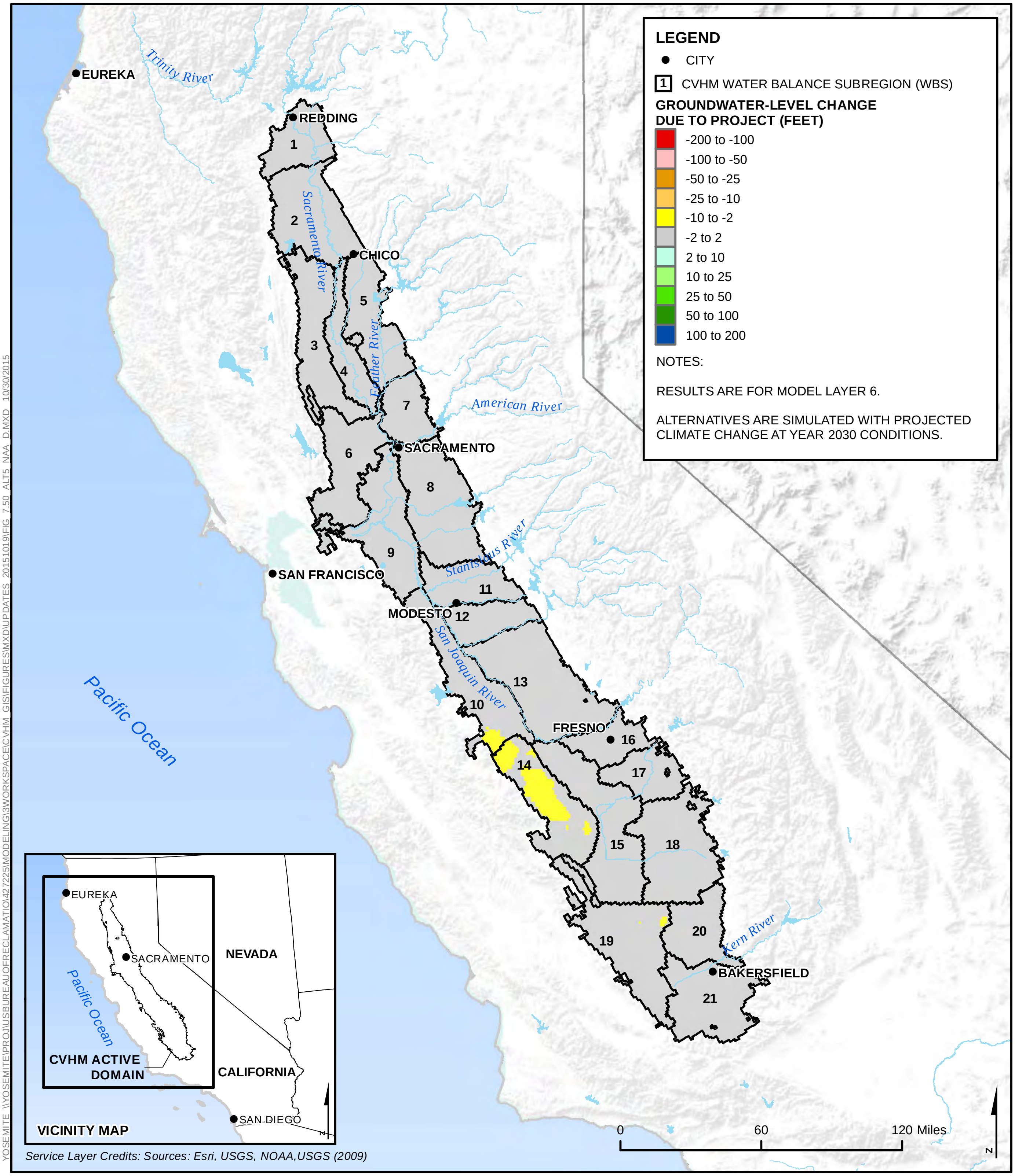
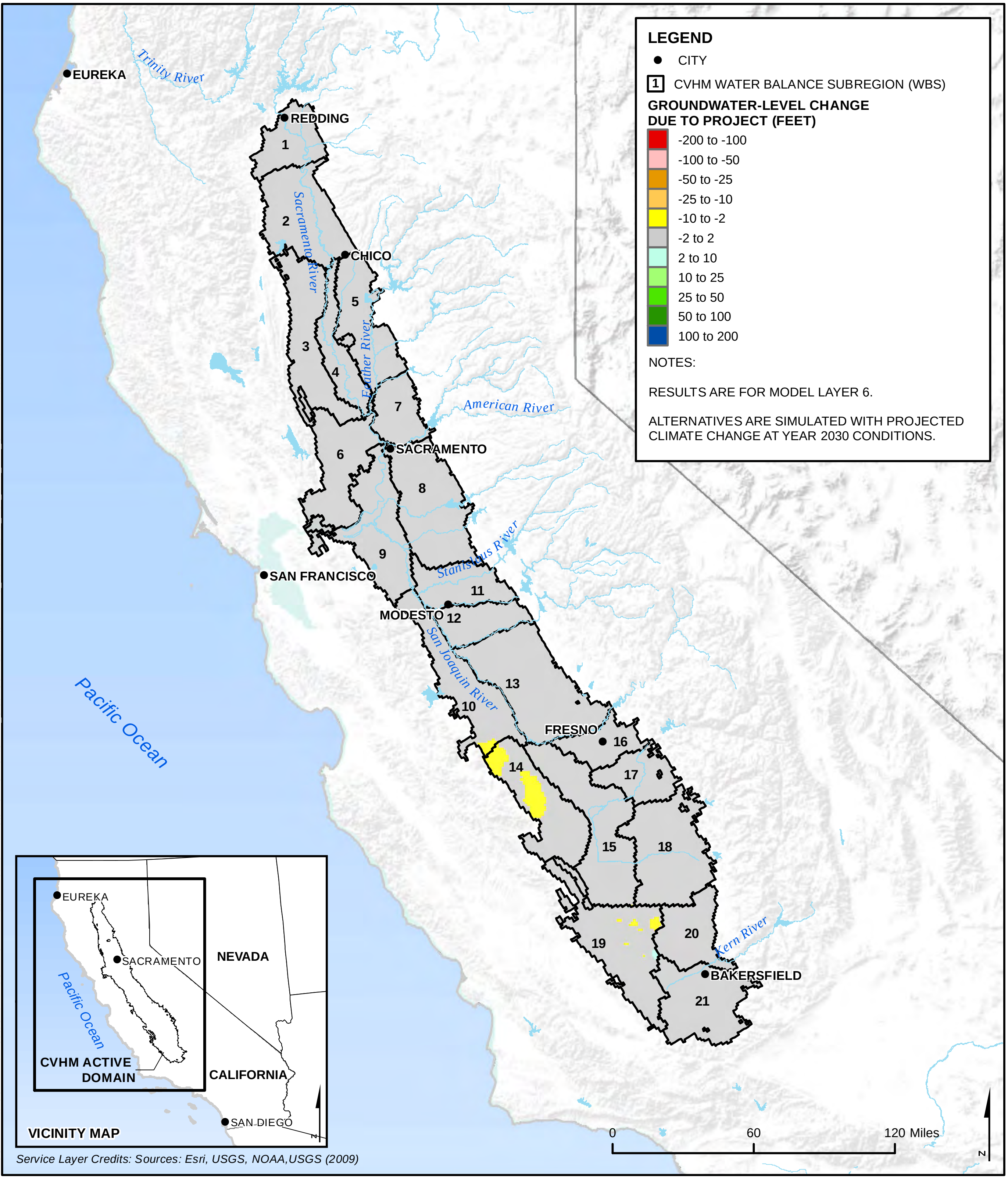


Figure 7.50 Forecast Groundwater-Level Changes for Alternative 5 Compared to No Action Alternative for Average July in a Future Dry Year



Service Layer Credits: Sources: Esri, USGS, NOAA,USGS (2009)

YOSEMITE \\YOSEMITE\PROJ\USBUREAUOFRECLAMATIO\427225\MODELING\3WORKSPACE\CVHM GIS\FIGURES\MXD\UPDATES 20151019\FIG 7.51 ALT5 NAA CD.MXD 10/30/2015

Figure 7.51 Forecast Groundwater-Level Changes for Alternative 5 Compared to No Action Alternative for Average July in a Future Critically-Dry Year

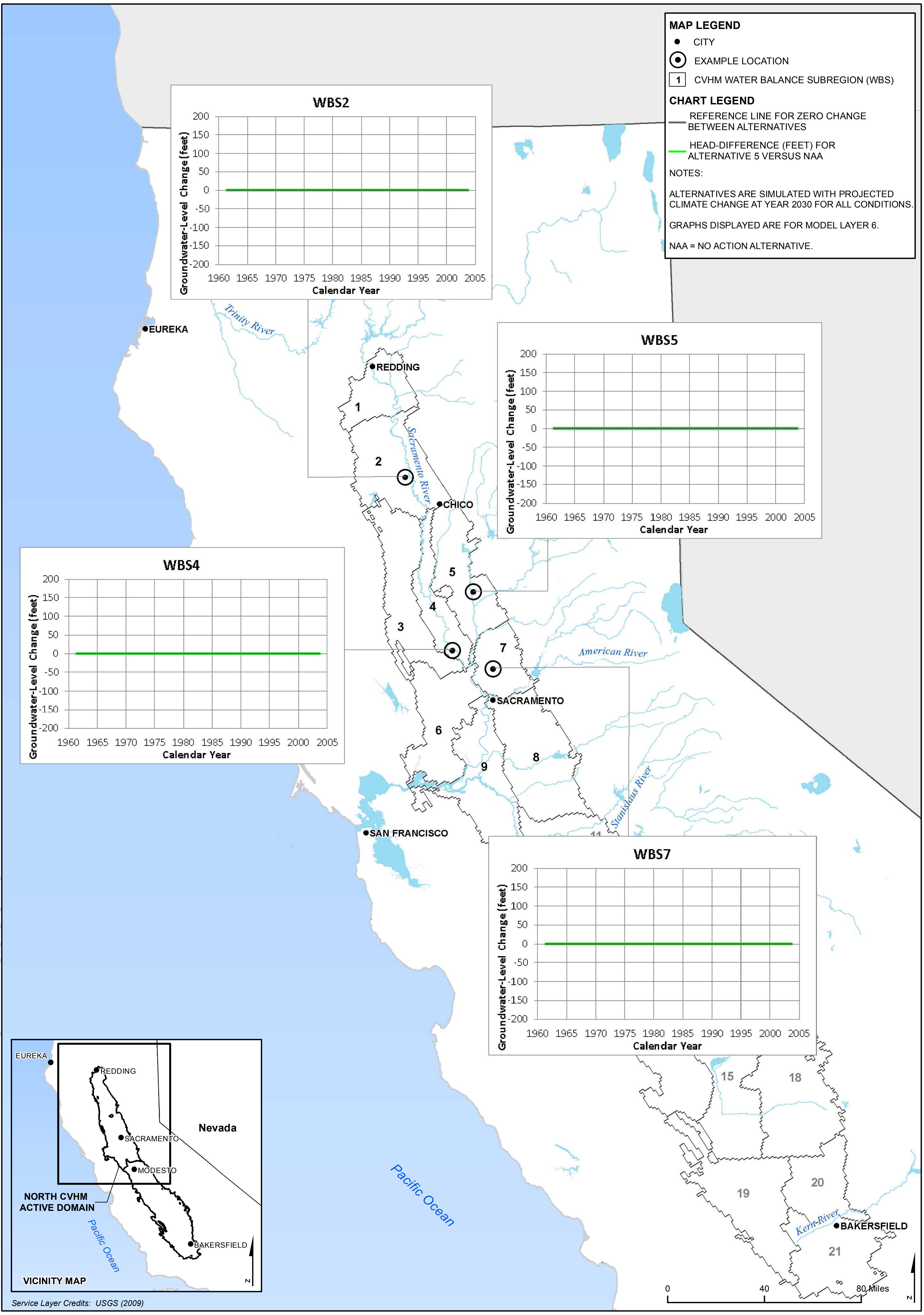


Figure 7.52 Forecast Groundwater-Level Change Hydrographs for Alternative 5 Compared to No Action Alternative at Example Locations in the Sacramento Valley

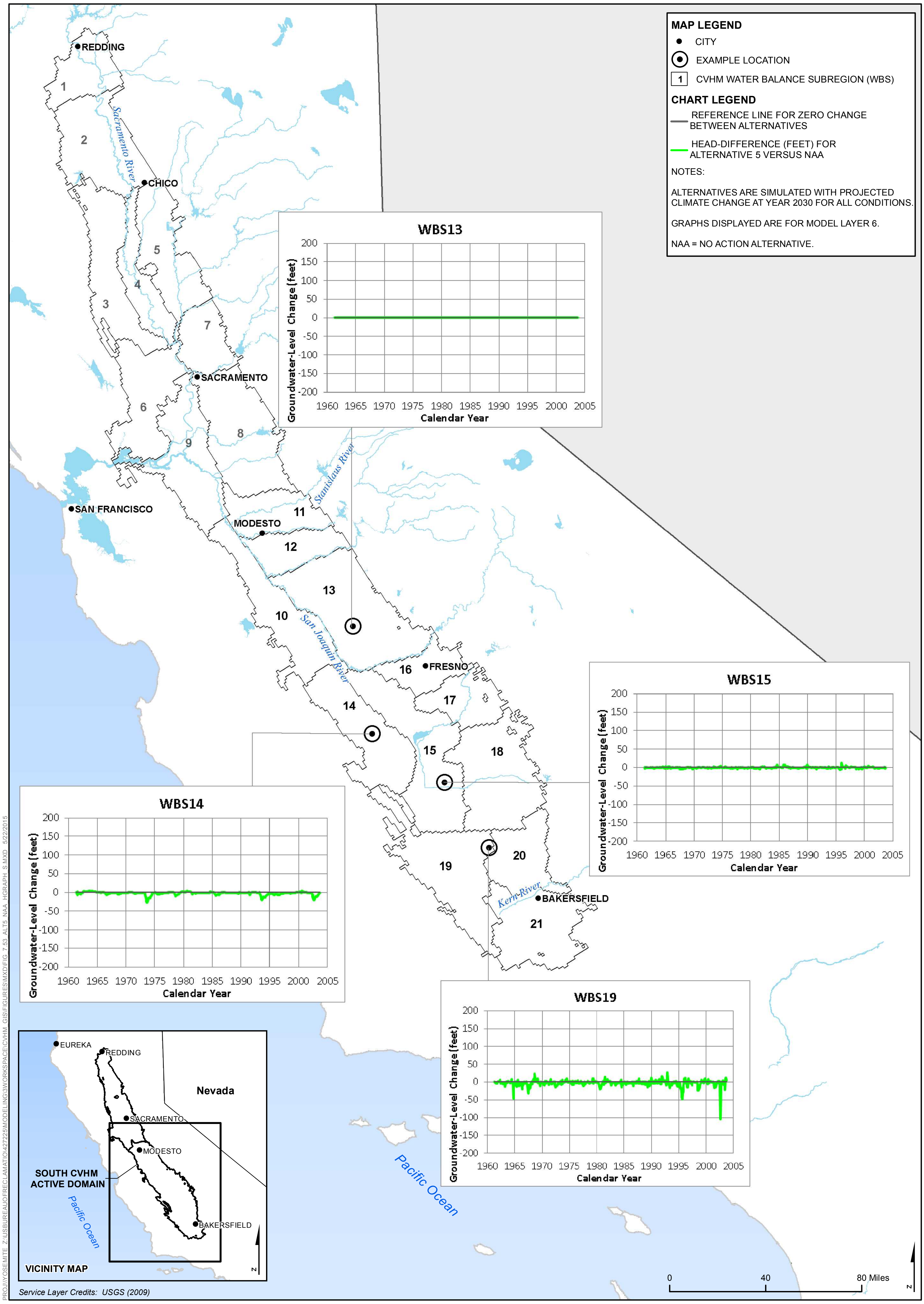
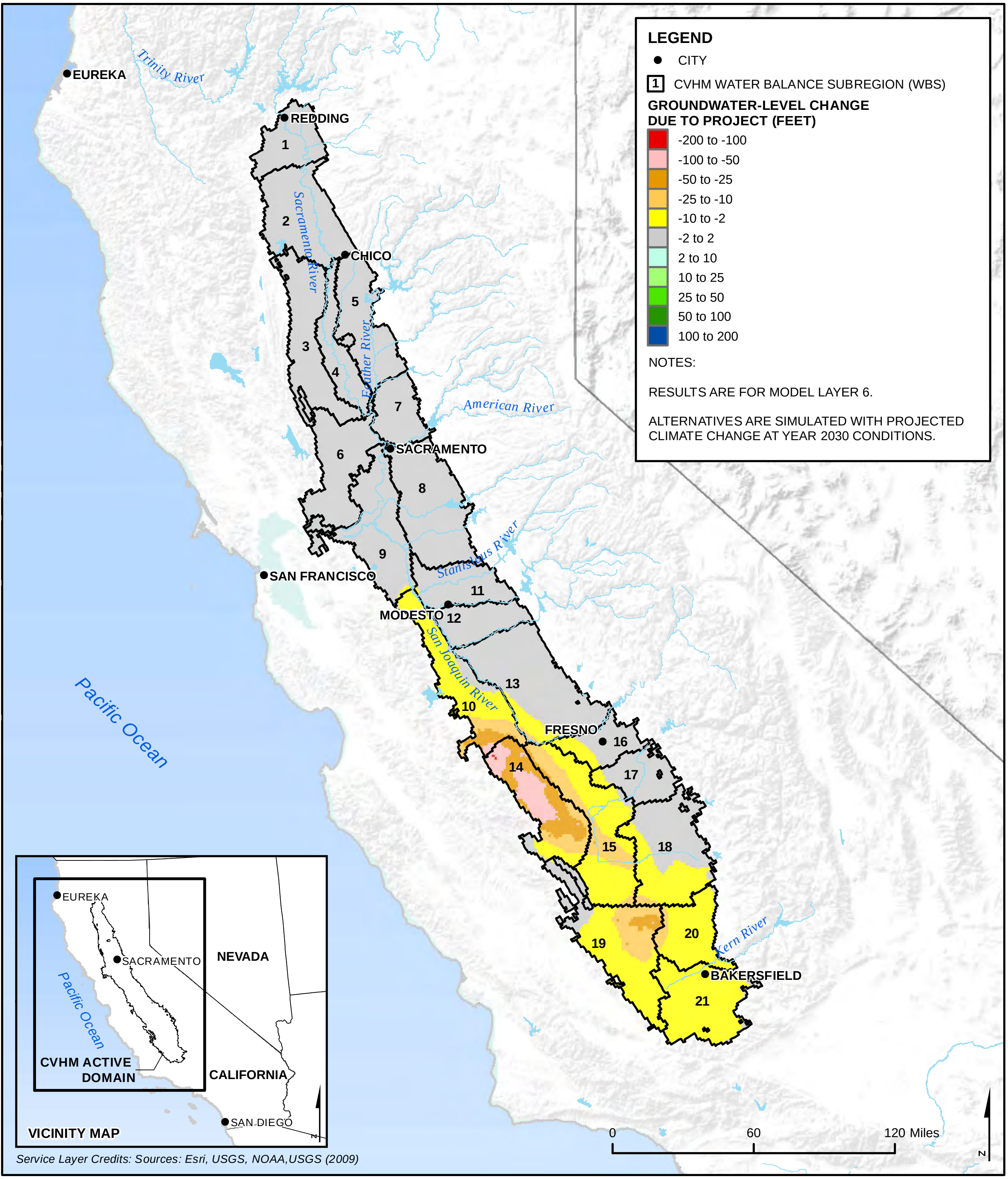


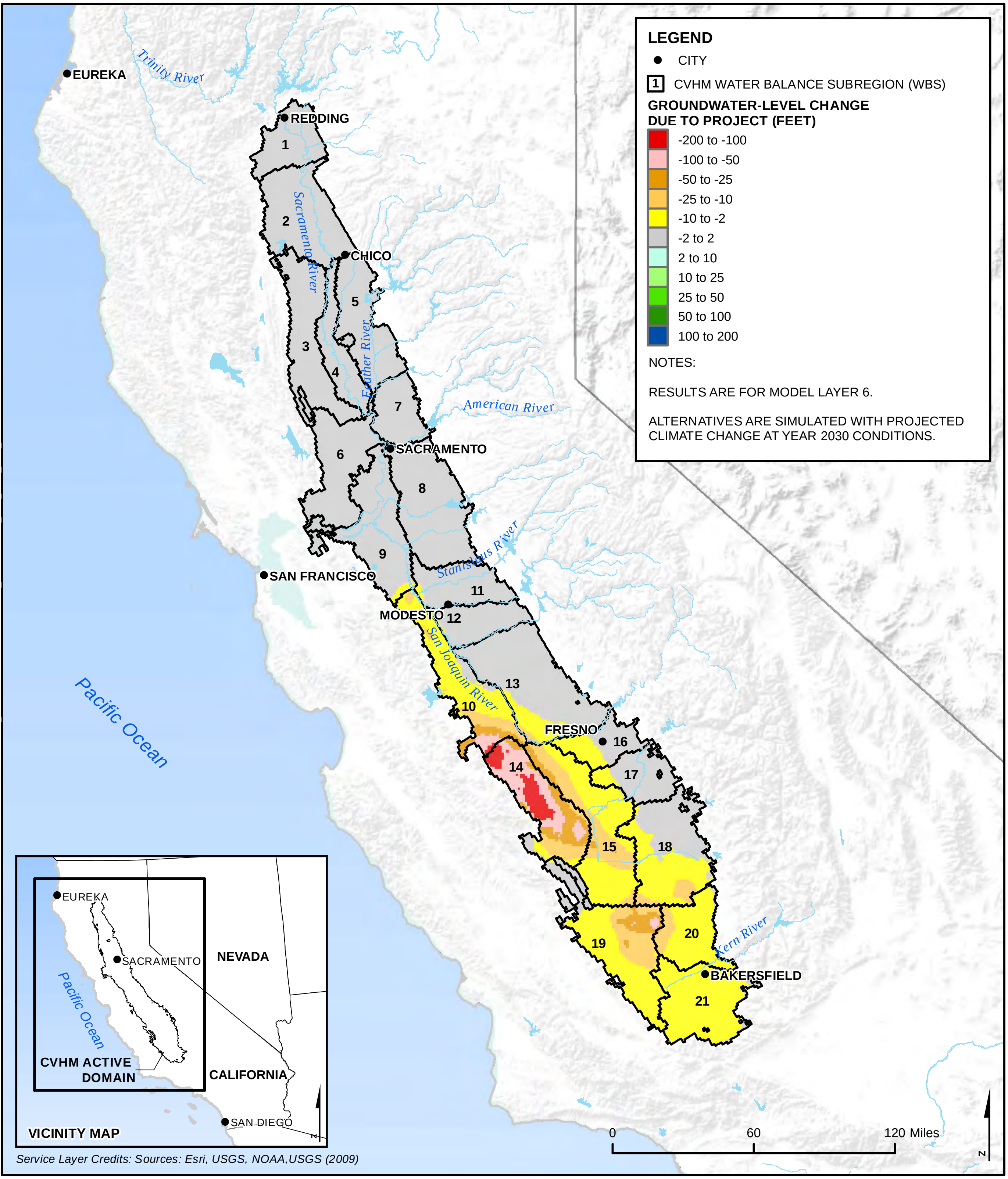
Figure 7.53 Forecast Groundwater-Level Change Hydrographs for Alternative 5 Compared to No Action Alternative at Example Locations in the San Joaquin Valley



YOSEMITE \\YOSEMITE\PROJ\USBUREAUOFRECLAMATIO\427225\MODELING\3WORKSPACE\CVHM_GIS\FIGURES\MXD\UPDATES_20151019\FIG_7.54_ALT5_SBC_W.MXD 10/30/2015

Service Layer Credits: Sources: Esri, USGS, NOAA,USGS (2009)

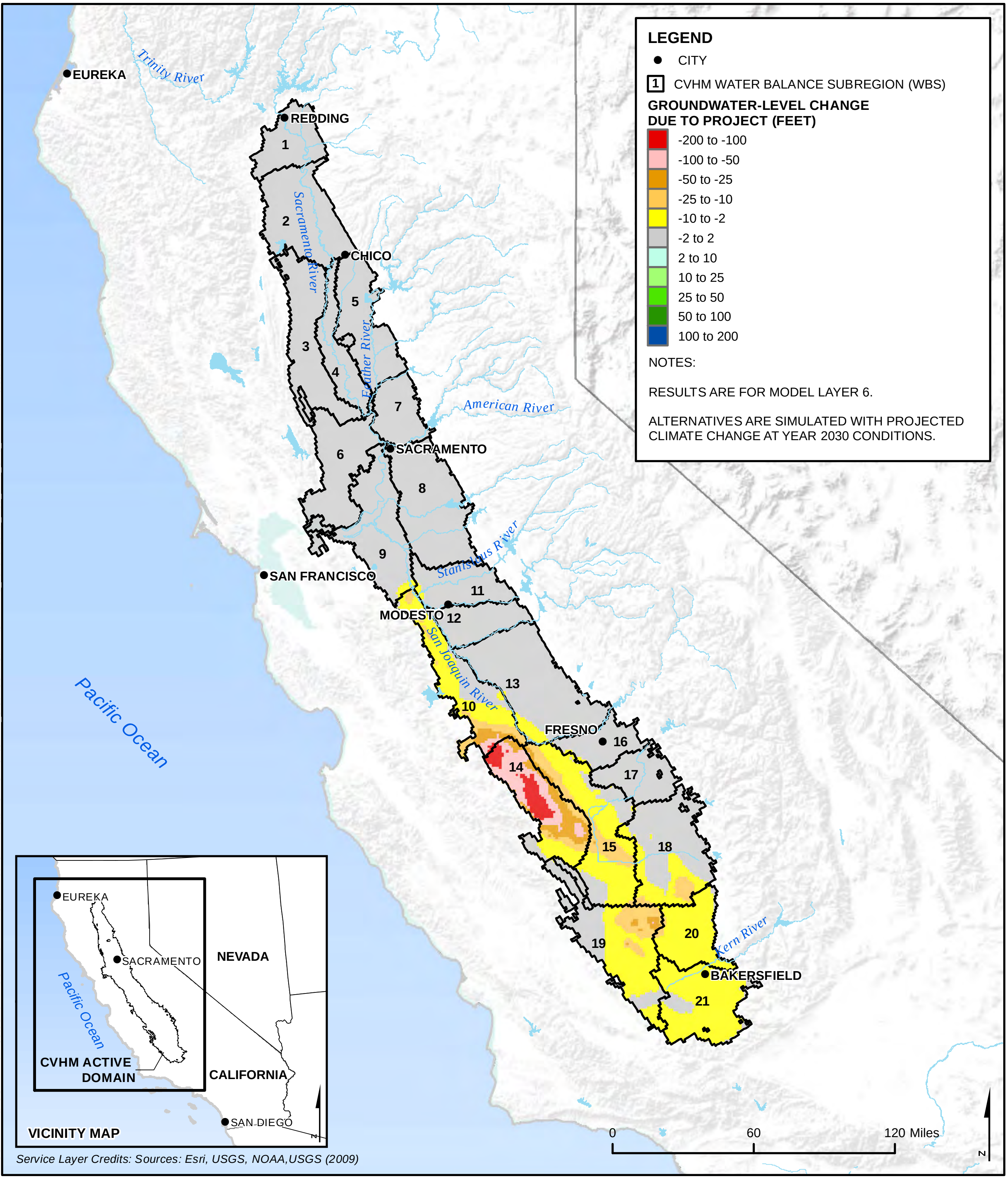
Figure 7.54 Forecast Groundwater-Level Changes for Alternative 5 Compared to Second Basis of Comparison for Average July in a Future Wet Year



Service Layer Credits: Sources: Esri, USGS, NOAA,USGS (2009)

YOSEMITE \\YOSEMITE\PROJ\USBUREAUOFRECLAMATIO\427225\MODELING\3WORKSPACE\CVHM GIS\FIGURES\MXD\UPDATES 20151019\FIG 7.55 ALT5 SBC AN.MXD 10/30/2015

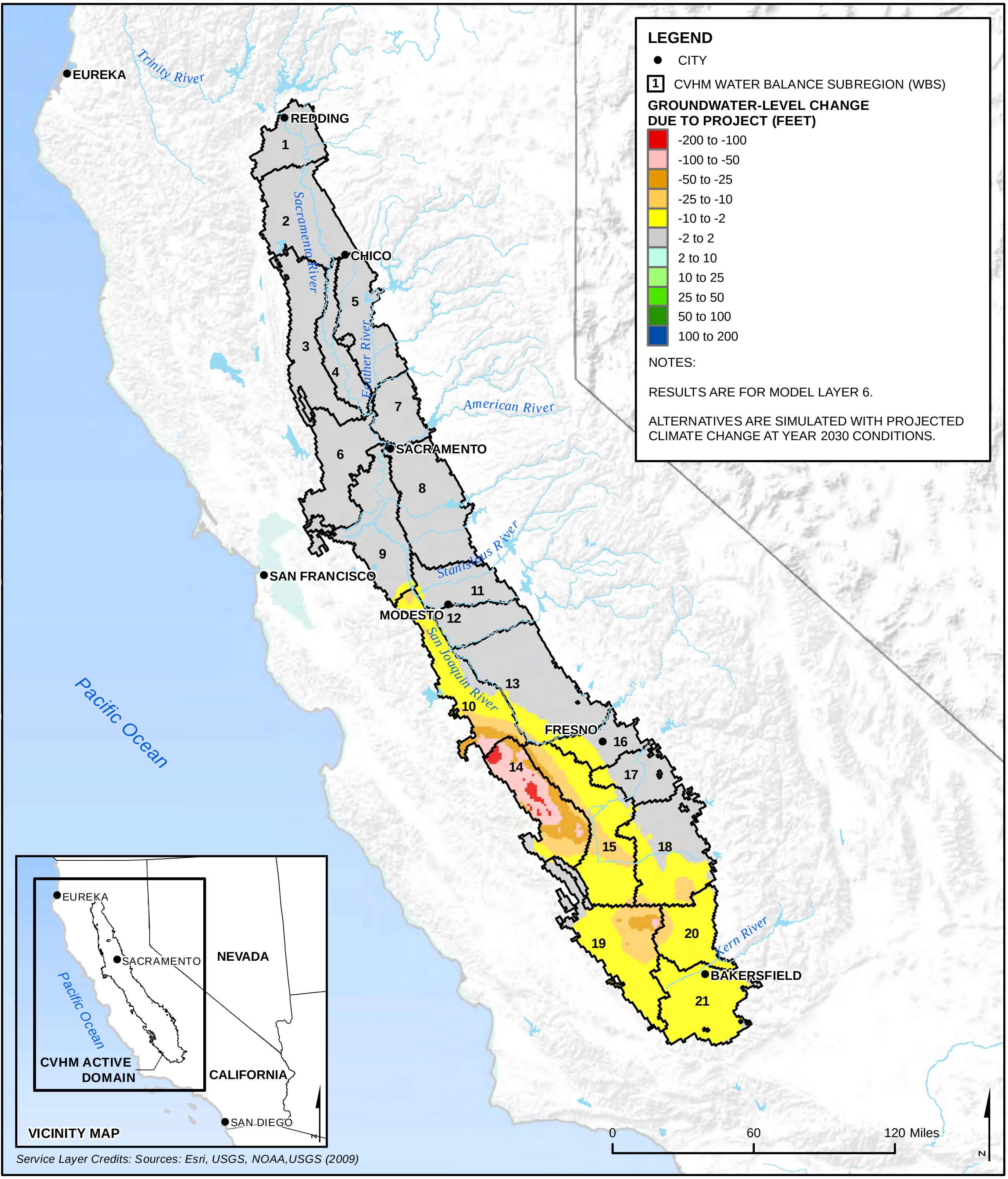
Figure 7.55 Forecast Groundwater-Level Changes for Alternative 5 Compared to Second Basis of Comparison For Average July in a Future Below-Normal Year



Service Layer Credits: Sources: Esri, USGS, NOAA,USGS (2009)

YOSEMITE \\YOSEMITE\PROJ\USBUREAUOFRECLAMATIO\427225\MODELING\3WORKSPACE\CVHM_GIS\FIGURES\MXD\UPDATES_20151019\FIG_7.56_ALT5_SBC_BN.MXD 10/30/2015

Figure 7.56 Forecast Groundwater-Level Changes for Alternative 5 Compared to Second Basis of Comparison for Average July in a Future Below-Normal Year



Service Layer Credits: Sources: Esri, USGS, NOAA,USGS (2009)

Figure 7.57 Forecast Groundwater-Level Changes for Alternative 5 Compared to Second Basis of Comparison for Average July in a Future Dry Year

YOSEMITE \\YOSEMITE\PROJ\USBUREAUOFRECLAMATIO\427225\MODELING\3WORKSPACE\CVHM_GIS\FIGURES\MXD\UPDATES_20151019\FIG_7.57_ALT5_SBC_D.MXD 10/30/2015

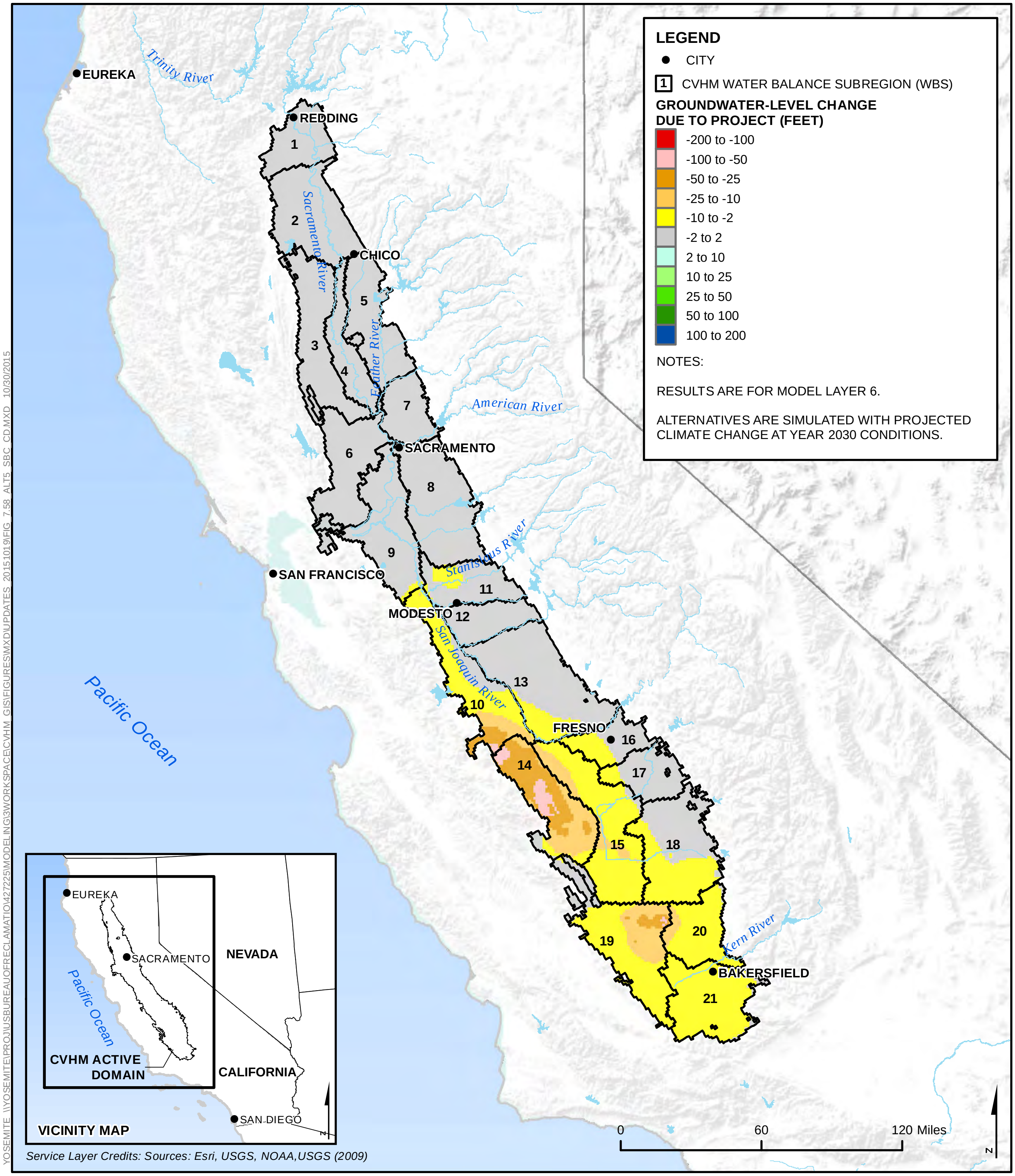


Figure 7.58 Forecast Groundwater-Level Changes for Alternative 5 Compared to Second Basis of Comparison for Average July in a Future Critically-Dry Year

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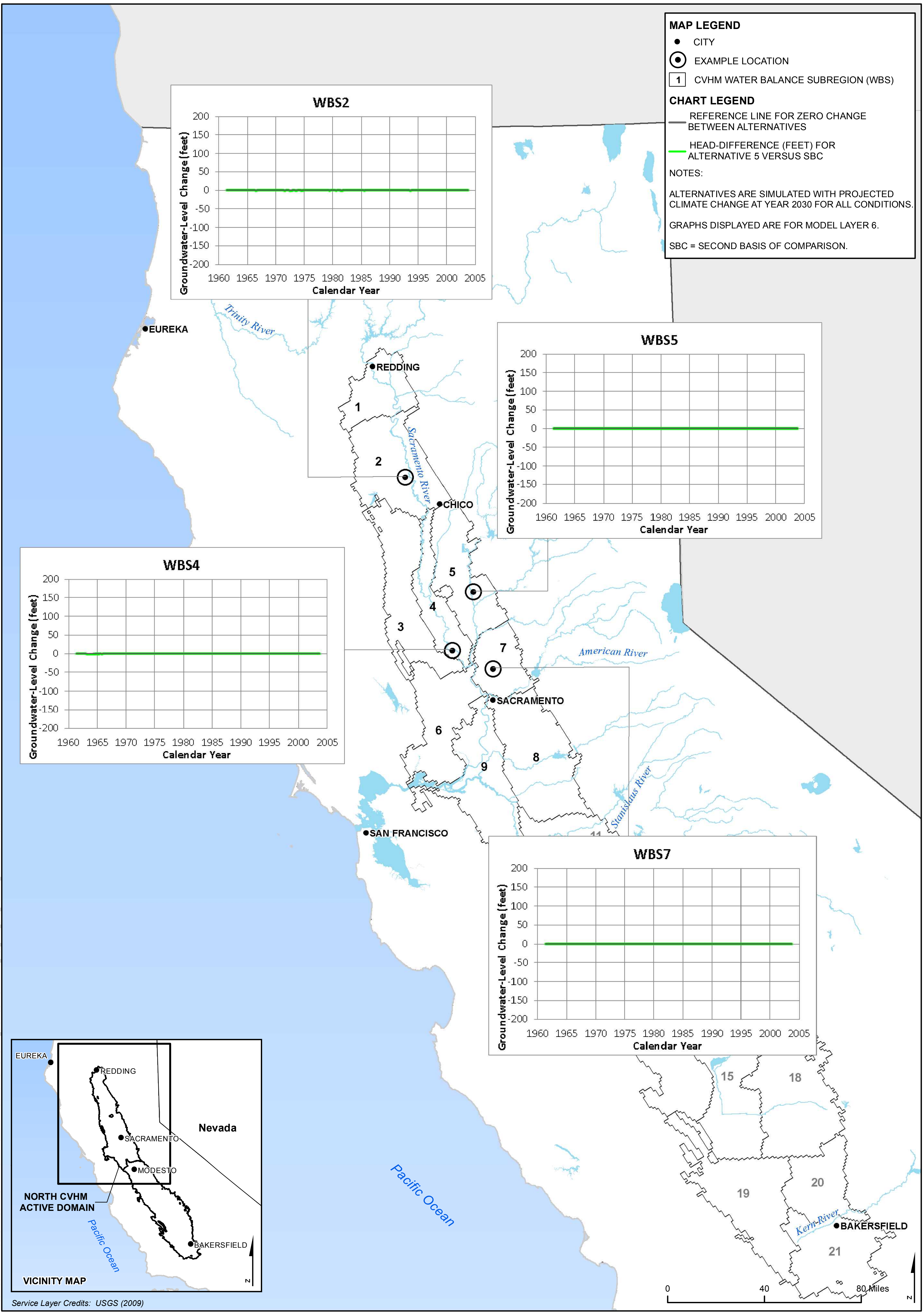
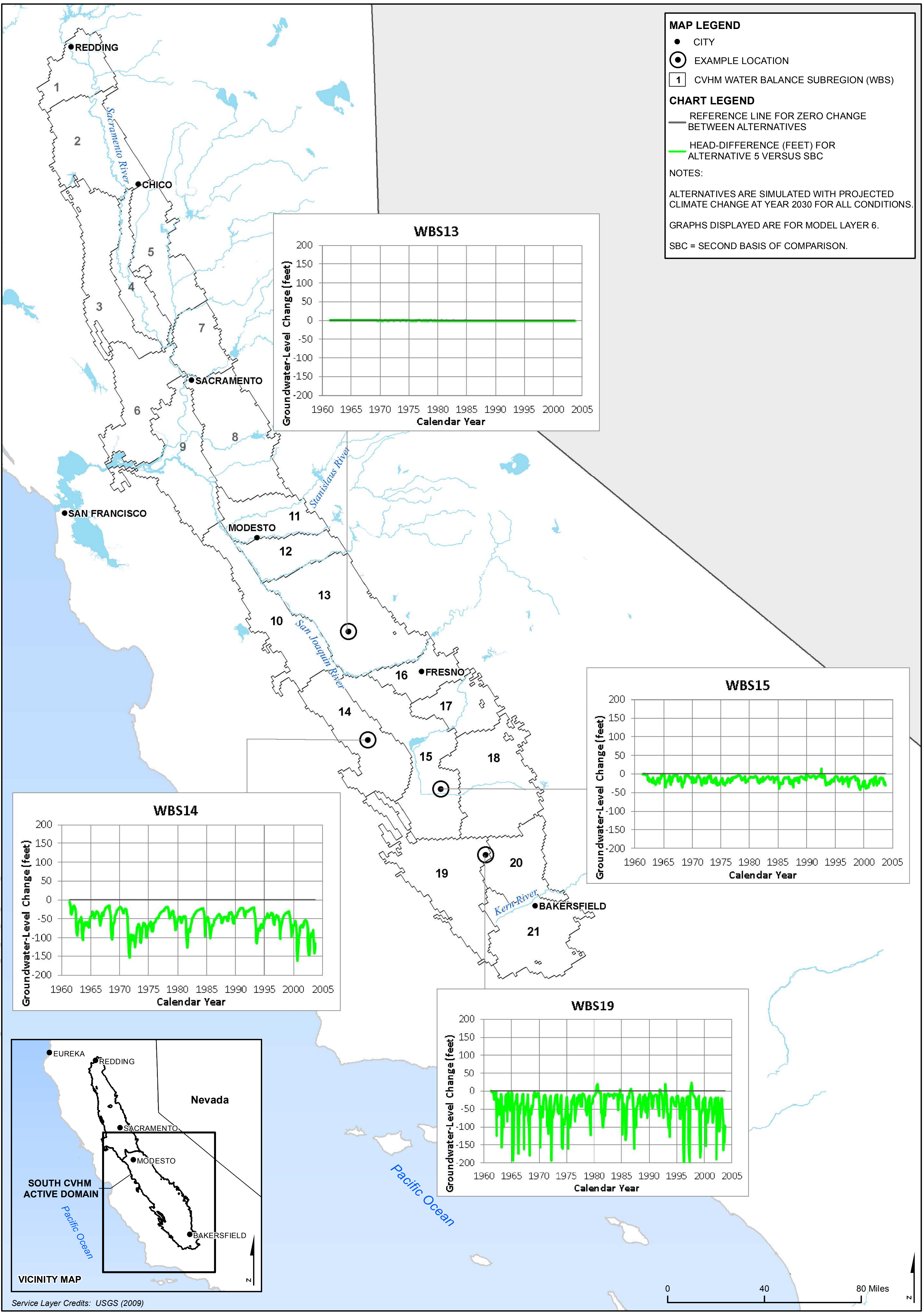


PROJ\YOSEMITE Z:\USBUREAUOFRECLAMATIO\427225\MODELING\3\WORKSPACE\CVHM_GIS\FIGURES\MXD\FIG_7.59_ALT5_SBC_HGRAPH_N.MXD 5/22/2015

Figure 7.59 Forecast Groundwater-Level Change Hydrographs for Alternative 5 Compared to Second Basis of Comparison at Example Locations in the Sacramento Valley



NOTES:

ALTERNATIVES ARE SIMULATED WITH PROJECTED CLIMATE CHANGE AT YEAR 2030 FOR ALL CONDITIONS.

GRAPHS DISPLAYED ARE FOR MODEL LAYER 6.

SBC = SECOND BASIS OF COMPARISON.

Service Layer Credits: USGS (2009)

PROJ\YOSEMITE Z:\USBUREAUOFRECLAMATIO\427225\MODELING3\WORKSPACE\CVHM_GIS\FIGURES\MXD\FIG_7.60_ALT5_SBC_HGRAPH_S.MXD 5/22/2015

Figure 7.60 Forecast Groundwater-Level Change Hydrographs for Alternative 5 Compared to Second Basis of Comparison at Example Locations in the San Joaquin Valley

Chapter 15

Recreation Resources

15.1 Introduction

This chapter describes recreational resources in the study area; and potential changes that could occur as a result of implementing the alternatives evaluated in this Environmental Impact Statement (EIS). Implementation of the alternatives could affect recreation resources through potential changes in operation of the Central Valley Project (CVP) and State Water Project (SWP) and ecosystem restoration.

15.2 Regulatory Environment and Compliance Requirements

Potential actions that could be implemented under the alternatives evaluated in this EIS could affect recreational resources at reservoirs and lands served by CVP and SWP water supplies. Actions located on public agency lands; or implemented, funded, or approved by Federal and state agencies would need to be compliant with appropriate Federal and state agency policies and regulations, as summarized in Chapter 4, Approach to Environmental Analyses.

15.3 Affected Environment

This section describes recreational resources that could be potentially affected by the implementation of the alternatives considered in this EIS. Changes in recreation opportunities due to changes in CVP and SWP operations may occur in the Trinity River, Central Valley, San Francisco Bay Area, Central Coast, and Southern California regions. Recreational fishing in San Francisco Bay and along the Pacific Coast also may be affected by changes in CVP and SWP operations.

There are extensive recreational opportunities within this study area. However, the recreational opportunities that could be directly or indirectly affected through implementation of the alternatives analyzed in this EIS are related to water-related recreation activities at CVP and SWP reservoirs and in the rivers downstream of those reservoir, fishing opportunities in the Delta and the Pacific Ocean that are affected by the water flows managed by CVP and SWP operations, and bird watching, wildlife viewing, and hunting activities at wildlife refuges that use CVP water supplies. Therefore, the following description of the affected environment is limited to these recreational aspects. The wildlife refuges identified to receive CVP water supplies are shown on Figure 15.1.

15.3.1 Trinity River Region

The Trinity River Region includes the area along the Trinity River from Trinity Lake to the confluence with the Klamath River; and along the lower Klamath River from the confluence with the Trinity River to the Pacific Ocean. Major recreational opportunities occur at Trinity Lake, Lewiston Reservoir, along the Trinity River between Lewiston Reservoir and the confluence with the Klamath River, and along the lower Klamath River.

15.3.1.1 Trinity Lake

Trinity Lake is a CVP facility on the Trinity River that is located approximately 50 miles northwest of Redding, as described in Chapter 5, Surface Water Resources and Water Supplies. Trinity Lake is part of the Whiskeytown-Shasta-Trinity National Recreation Area and part of the Shasta-Trinity National Forest. Recreational facilities and activities at Trinity Lake are administered by the U.S. Forest Service (USFS). When the water storage in the reservoir is at full capacity (water elevation at 2370 feet mean sea level (msl), Trinity Lake has a surface area of 17,222 acres and 147 miles of shoreline (USFS 2014).

Boating, windsurfing, and fishing primarily occur in the northern part of the lake near Trinity Center. Houseboats, motorboats, water skiing primarily occur in the southern part of the lake. There are six public boat ramps on Trinity Lake as summarized in Table 15.1.

Table 15.1 Trinity Lake Boat Ramps

Location	Boat Ramp	Comments	Useable Elevations (feet, msl)
Trinity Lake	Bowerman	–	2,370 to 2,323
Trinity Lake	Clark Spring	–	2,370 to 2,313
Trinity Lake	Fairview	–	2,370 to 2,313
Trinity Lake	Minersville	–	2,305 to 2,170
Trinity Lake	Stuart Fork	–	2,370 to 2,338
Trinity Lake	Trinity Center	–	2,370 to 2,300

Source: USFS 2014

Three major marinas are located at Trinity Lake, as summarized in Table 15.2. The USFS can permit up to 1,000 boat slips at the Trinity Lake marinas (USFS 2014). Many commercial houseboats are available for rent at the marinas. Trinity Lake shoreline includes approximately 32 miles of prime houseboating areas and 18.5 miles of secondary houseboating areas. The USFS issues permits for houseboats and privately-owned recreational occupancy vehicles that use the water overnight. At Trinity Lake, up to 99 permits for privately-owned vessels and 85 permits for commercially-owned vessels may be issued each year.

Table 15.2 Trinity Lake Marinas and Moorage Facilities

Location	Marina and Moorage Facility	Number
Trinity Lake	Cedar Stock Resort & Marina	31 Commercial and 220 Private Slips, including 10 Commercial Houseboats
Trinity Lake	KOA Campground	15 Commercial and 110 Private Slips
Trinity Lake	Pinewood Cove Docks	52 Private Slips
Trinity Lake	Trinity Alps Marina	31 Commercial and 63 Private Slips, including 25 Commercial Houseboats
Trinity Lake	Trinity Center Marina	80 Private Slips

Source: USFS 2014

The Trinity Unit of the Whiskeytown-Shasta-Trinity National Recreation Area includes many campground sites, including campgrounds for group camping opportunities (USFS 2014), as summarized in Table 15.3. There are other campgrounds within the upper elevations of the Trinity Lake watershed that are not directly or indirectly affected by changes in surface water elevations.

Table 15.3 Trinity Lake Major Campgrounds

Location	Campground	Comments	Number of Campsites
Trinity Lake	Alpine View	–	53
Trinity Lake	Bushytail	–	11
Trinity Lake	Captain’s Point	Boat-In Campground	3
Trinity Lake	Clark Springs	–	21
Trinity Lake	Fawn	Group Campground	60
Trinity Lake	Hayward Flat	–	98
Trinity Lake	Jackass Springs	–	10
Trinity Lake	Mariner’s Roost	Boat-In Campground	7
Trinity Lake	Minersville	–	14
Trinity Lake	Ridgeville	Boat-In Campground	10
Trinity Lake	Ridgeville Island	Boat-In Campground	3
Trinity Lake	Stoney Creek	Group Campground	10
Trinity Lake	Stoney Point	–	15
Trinity Lake	Tannery Gulch	–	82

Source: USFS 2014

Trinity Lake recreational areas also include day use areas for picnicking, swimming, and other recreational opportunities, as summarized in Table 15.4. The locations for shoreline day use areas are limited due to the steep and rocky elevations at the shorelines. To develop two swimming beaches at Trinity Lake, the rocky shorelines were covered with sand and/or decomposed granite at a specific elevation. Uses of these locations are less desirable when the water elevations decline.

Table 15.4 Trinity Lake Major Day Use Areas

Location	Day Use Area	Comments	Number
Trinity Lake	Clark Springs Day Use and Beach	Picnic and Swimming	34 picnic sites
Trinity Lake	North Shore Vista	Vistas and Interpretative Site	–
Trinity Lake	Osprey Info Site	Vistas and Interpretative Site	–
Trinity Lake	Stoney Creek	Picnic and Swimming	4 picnic sites
Trinity Lake	Tanbark Picnic	Picnic and Swimming	8 picnic sites
Trinity Lake	Trail of Trees	Interpretative Trail at Tannery Gulch Campground	0.5 miles
Trinity Lake	Trinity Lakeshore Trail	Trail	4 miles
Trinity Lake	Trinity Vista	Vistas and Interpretative Site	–

Source: USFS 2014

Trinity Lake fishing opportunities include Smallmouth Bass, Largemouth Bass, Rainbow Trout, Brown Trout, Chinook Salmon, and Kokanee Salmon (USFS 2014). White Catfish, Brown Bullhead, Green Sunfish, Bluegill, Klamath Smallscale Sucker, and Pacific Lamprey also are present but are not generally considered as part of the recreational fishing opportunities. Wildlife viewing opportunities extend throughout the Trinity Lake area, including viewing of Bald Eagles, Black-tailed Deer, Black Bear, Gray Squirrel, rabbit, turkey, and California Quail.

15.3.1.2 Lewiston Reservoir

Lewiston Reservoir is a CVP facility on the Trinity River that is located immediately downstream of the Trinity Dam, as described in Chapter 5, Surface Water Resources and Water Supplies. Lewiston Reservoir is part of the Whiskeytown-Shasta-Trinity National Recreation Area and part of the Shasta-Trinity National Forest. Recreational facilities and activities are administered by the USFS. When the water storage in the reservoir is at full capacity (water elevation at 1,874 feet msl), the reservoir has a surface area of 759 acres and 15 miles of shoreline (USFS 2014).

The water elevation is generally stable in Lewiston Reservoir because it is used as regulating reservoir for releases to downstream uses. Water is diverted from the lower outlets in Trinity Lake to Lewiston Reservoir to provide cold water to Trinity River and Whiskeytown Lake. Therefore, recreational opportunities in Lewiston Reservoir include boating and fishing; however, there are fewer opportunities for swimming and water skiing. Lewiston Reservoir does not support houseboats. There is one primary boat ramp and two marinas in Lewiston Reservoir, as summarized in Tables 15.5 and 15.6.

Table 15.5 Lewiston Reservoir Boat Ramps

Location	Boat Ramp	Comments	Useable Elevations (feet, msl)
Lewiston Lake	Pine Cove	Open all year	Around 1870

Source: USFS 2014

Table 15.6 Lewiston Lake Marinas and Moorage Facilities

Location	Marina and Moorage Facility	Number
Lewiston Lake	Lakeview Terrace Docks	14 Commercial and 7 Private Slips
Lewiston Lake	Pine Cove Marina	20 Commercial and 34 Private Slips

Source: USFS 2014

The Whiskeytown-Shasta-Trinity National Recreation Area includes campground sites near the Lewiston Reservoir shoreline, including campgrounds for group camping opportunities (USFS 2014), as summarized in Table 15.7. Lewiston Reservoir recreational areas also include day use areas for picnicking, swimming, and other recreational opportunities, as summarized in Table 15.8. Because the water surface elevations are more stable in Lewiston Reservoir than Trinity Lake, the day use areas have more vegetation along the shoreline.

Table 15.7 Lewiston Lake Major Campgrounds

Location	Campground	Comments	Number of Campsites
Lewiston Lake	Ackerman	–	51
Lewiston Lake	Cooper Gulch	–	5
Lewiston Lake	Mary Smith	–	17
Lewiston Lake	Tunnel Rock	–	6

Source: USFS 2014

Table 15.8 Lewiston Major Lake Day Use Areas

Location	Day Use Area	Comments	Number
Lewiston Lake	Baker Gulch Trail	Trail	0,2 miles
Lewiston Lake	Lewiston Vista	Vistas and Interpretative Site	–
Lewiston Lake	North Lakeshore Trail	Trail	2 miles
Lewiston Lake	Pine Cove	Picnic	2 picnic sites
Lewiston Lake	South Lakeshore Trail	Trail	1 mile

Source: USFS 2014

Lewiston Reservoir fishing opportunities include Smallmouth Bass, Rainbow Trout, Brown Trout, Three-spine Stickleback, Golden Shiner, and Kokanee Salmon (USFS 2014). Klamath Smallscale Sucker, and Pacific Lamprey also are present but are not generally considered as part of the recreational fishing opportunities. Wildlife viewing opportunities extend throughout the Lewiston Reservoir area, including viewing of Bald Eagles, Black-tailed Deer, River Otter, ring-tailed cats, raccoon, and California Quail. Waterfowl use Lewiston Reservoir throughout the year with increased populations in the winter.

15.3.1.3 Trinity River from Lewiston Dam to the Klamath River

The Trinity River flows approximately 112 miles from Lewiston Dam to the Klamath River (NCRWQCB et al. 2009) through Trinity, Humboldt, and Del Norte counties.

The first mile of the river below the Lewiston Dam is located within the Whiskeytown-Shasta-Trinity National Recreation Area. Portions of the Trinity River downstream of Lewiston Dam and Junction City to the confluence with North Fork Trinity River are under the jurisdiction of the Department of the Interior, Bureau of Land Management (BLM) (USFWS et al. 1999). Between the confluence with the North Fork Trinity River and the confluence of New River, the area along the Trinity River is located within the USFS Shasta-Trinity National Forest. Between the confluence with the New River and the Hoopa Indian Reservation, most of the area along the Trinity River is located within the USFS Six Rivers National Forest. The remaining portions of the Trinity River to the confluence with the Klamath River are located within the Hoopa Indian Reservation.

On January 19, 1981, the Secretary of the Interior designated the Trinity River starting 100 yards downstream of the Lewiston Dam to the confluence with the Klamath River as part of the National Wild and Scenic Rivers System. The designation also included portions of the South Fork, North Fork, and New River (BLM et al 2012). However, because the flows in the South Fork, North Fork, and New River are not affected by the alternatives considered in this EIS, these rivers are not evaluated in this EIS.

There are approximately 35 developed recreation sites and more than 200 access points along the Trinity River corridor within a half mile of the river, and numerous river access sites between Lewiston Dam and Weitchpec (NCRWQCB et al. 2009; USFWS et al. 1999).

Recreation occurs year-round in the Trinity River area. Water-related activities include boating, kayaking, canoeing, whitewater rafting, inner tubing, fishing, swimming, wading, gold panning, camping, and picnicking (NCRWQCB et al. 2009). Fishing opportunities include steelhead, Rainbow Trout, Brown Trout, and Chinook Salmon.

15.3.1.4 Lower Klamath River from Trinity River Confluence to the Pacific Ocean

The Klamath River continues for 43.5 miles from the Trinity River confluence to the Pacific Ocean (NCRWQCB et al. 2009).

Downstream of the Trinity River, the Klamath River flows through the Hoopa Indian Reservation, Yurok Indian Reservation, and Resighini Indian Reservation as well as lands owned by local agencies and private entities (DOI and DFG 2012). Near the confluence with the Pacific Ocean, the Klamath River flows through the Redwood National Park. These reaches are primarily within Humboldt and Del Norte counties.

The portion of the Klamath River from the confluence with the Trinity River to the Pacific Ocean is part of the Klamath River designated by the Secretary of the Interior to be part of the National Wild and Scenic Rivers System on January 19, 1981. The State of California also designated this reach of Klamath River as wild and scenic under Public Resources Code sections 5093.54 and 5093.545.

Recreation along the Klamath River downstream of the Trinity River is limited (DOI and DFG 2012). Canoeing, kayaking, and whitewater boating occurs along this reach. Whitewater rafting generally requires a minimum flow of 1,800 cfs in this portion of the Klamath River. Four campgrounds, picnic areas, and water access at public lands are located along the Klamath River near the confluence with the Pacific Ocean. Fishing opportunities in the lower Klamath River are primarily related to Chinook Salmon. Del Norte County operates two public boat ramps along the Klamath River. The Redwood National and State Parks operate Lagoon Creek near the confluence of the Klamath River and the Pacific Ocean (RNSP 2013; Del Norte County 2003). There are other trails near the Pacific Ocean, including the California Coastal Trail which is generally located along the northern and eastern banks of the Klamath River at the Pacific Ocean (California Coastal Trail 2014).

15.3.2 Central Valley Region

The Central Valley Region extends from above Shasta Lake to the Tehachapi Mountains, and includes the Sacramento Valley, San Joaquin Valley, Delta, and Suisun Marsh.

15.3.2.1 Sacramento Valley

Recreational opportunities in the Sacramento Valley upstream of the Delta that are influenced by CVP and SWP operations occur at Shasta Lake, Keswick Reservoir, Whiskeytown Lake, Clear Creek, Sacramento River between Keswick Dam and the Delta, Lake Oroville and Thermalito Afterbay, Yuba River from between New Bullards Bar and Feather River, Bear River between Camp Far West Reservoir and Feather River, Feather River between Thermalito Dam and the Sacramento River, Folsom Lake and Lake Natoma, American River between Nimbus Dam and the Sacramento River, and refuges that use CVP water supplies.

15.3.2.1.1 Shasta Lake

Shasta Lake is a CVP facility on the Sacramento River that is located near Redding, as described in Chapter 5, Surface Water Resources and Water Supplies. Shasta Lake is part of the Whiskeytown-Shasta-Trinity National Recreation Area and part of the Shasta-Trinity National Forest. Recreational facilities and activities at Shasta Lake are administered by the USFS. When the water storage in the lake is at full capacity (water elevation at 1067 feet msl), Shasta Lake has a surface area of approximately 30,000 acres and 365 miles of shoreline (Reclamation 2013a; USFS 2014).

Boating, water skiing, other water sports, and fishing occur in many locations in the lake. Many types of boats are used, including fishing boats, deck boats, houseboats, cabin cruisers, pontoon boats, personal watercraft, runabouts, and ski boats (Reclamation 2013a; USFS 2014). There are seven public boat ramps on Shasta Lake, as summarized in Table 15.9.

Table 15.9 Shasta Lake Boat Ramps

Location	Boat Ramp	Comments	Useable Elevations (feet, msl)
Shasta Lake	Antlers	–	1,067 to 992
Shasta Lake	Bailey Cove	–	1,067 to 1,017
Shasta Lake	Centimudi	–	1,067 to 857
Shasta Lake	Hirz Bay	–	1,067 to 972
Shasta Lake	Jones Valley	–	1,067 to 857
Shasta Lake	Packers Bay	–	1,067 to 952
Shasta Lake	Sugar Loaf	–	992 to 907

Source: USFS 2014

A boating safety issue that arises with fluctuations in water level is the associated fluctuation of the pattern of submerged obstacles. When the water level decreases, many rocks, shoals, and islands are much closer to the water surface, and can be easily struck by boats. When the water level rises, debris and obstacles that were previously easily visible may be dangerously out of sight and struck by boats (Reclamation 2013a).

Nine major marinas are located at Shasta Lake, as summarized in Table 15.10. The USFS can permit up to 3,000 boat slips at the Shasta Lake marinas (USFS 2014). Many commercial houseboats are available for rent at the marinas. Shasta Lake shoreline includes approximately 109 miles of prime houseboating areas and 153 miles of secondary houseboating areas. The USFS issues permits for houseboats and privately-owned recreational occupancy vehicles that use the water overnight. At Shasta Lake, up to 613 permits for privately-owned vessels and 450 permits for commercially-owned vessels may be issued each year.

Table 15.10 Shasta Lake Marinas and Moorage Facilities

Location	Marina and Moorage Facility	Number
Shasta Lake	Antlers Resort and Marina	101 Commercial and 200 Private Slips, including 35 Commercial Houseboats
Shasta Lake	Bridge Bay Resort	140 Commercial and 7,773 Private Slips, including 92 Commercial Houseboats
Shasta Lake	Digger Bay Marina	75 Commercial and 145 Private Slips, including 50 Commercial Houseboats
Shasta Lake	Holiday Harbor	95 Commercial and 330 Private Slips, including 70 Commercial Houseboats
Shasta Lake	Jones Valley Marina	90 Commercial and 99 Private Slips, including 64 Commercial Houseboats
Shasta Lake	Packers Bay Marina	51 Commercial Slips, including 26 Commercial Houseboats
Shasta Lake	Shasta Lake RV Resort	22 Private Slips
Shasta Lake	Shasta Marina	54 Commercial and 139 Private Slips, including 24 Commercial Houseboats
Shasta Lake	Silverthorn Resort Marina	59 Commercial and 113 Private Slips, including 35 Commercial Houseboats
Shasta Lake	Sugarloaf Cottages	16 Private Slips
Shasta Lake	Sugarloaf Marina	41 Commercial and 40 Private Slips, including 21 Commercial Houseboats
Shasta Lake	Tsasdi Resort	30 Private Slips

Source: USFS 2014

The Shasta Unit of the Whiskeytown-Shasta-Trinity National Recreation Area includes many campground sites, including campgrounds for group camping opportunities (USFS 2014), as summarized in Table 15.11. There are other campgrounds within the upper elevations of the Shasta Lake watershed that are not directly or indirectly affected by changes in surface water elevations.

Campers are also affected by declining water elevations because this increases the distance from the campsites to the shoreline. Drawdown of the reservoir has an aesthetic effect on users because the land exposed during drawdown is generally composed of bare earth and rock.

Table 15.11 Shasta Lake Major Campgrounds

Location	Campground	Comments	Number of Campsites
Shasta Lake	Antlers	–	59
Shasta Lake	Arbuckle Flat	Boat-In Campground	11
Shasta Lake	Beehive	Shoreline Campground	No specified number
Shasta Lake	Bailey Cove	–	7
Shasta Lake	Dekkas Rock	Group Campground	60
Shasta Lake	Ellery Creek	–	19
Shasta Lake	Gooseneck Cove	Boat-In Campground	8
Shasta Lake	Green's Creek	Boat-In Campground	9
Shasta Lake	Gregory Creek	Shoreline Campground	18
Shasta Lake	Hirz Bay	Individual and Group Campground	48 Individual Sites and 200 Group Sites
Shasta Lake	Jones Valley (Upper & Lower)	Includes Shoreline Campground at Inlet	21
Shasta Lake	Lakeshore East	–	26
Shasta Lake	Lower Salt Creek	Shoreline Campground	No specified number
Shasta Lake	Mariners Point	Shoreline Campground	No specified number
Shasta Lake	McCloud Bridge	–	14
Shasta Lake	Moore Creek	Individual and Group Campground	12 Individual Sites and 90 Group Sites
Shasta Lake	Nelson Point	Individual and Group Campground	8 Individual Sites and 60 Group Sites
Shasta Lake	Oak Grove	–	45
Shasta Lake	Pine Point	Individual and Group Campground	14 Individual Sites and 100 Group Sites
Shasta Lake	Ski Island	Boat-In Campground	23

Source: USFS 2014

Shasta Lake recreational areas also include day use areas for picnicking, swimming, and other recreational opportunities, as summarized in Table 15.12. The locations for shoreline day use areas are limited due to the steep and rocky elevations at the shorelines. Uses of these locations are less desirable when the water elevations decline.

Table 15.12 Shasta Lake Day Use Areas

Location	Day Use Area	Comments	Number
Shasta Lake	Bailey Cove	Picnic and Trail	9 picnic sites 3.1 miles
Shasta Lake	Clikapudi	Trail	8 miles with 1 mile advanced trail
Shasta Lake	Dekkas Rock	Picnic	5 picnic sites
Shasta Lake	Dry Fork Creek	Trail	4.7 miles
Shasta Lake	Fisherman’s Point	Picnic and Trail	7 picnic sites 0.5 miles
Shasta Lake	Hirz Bay	Trail	1.6 miles
Shasta Lake	McCloud Bridge	Picnic	5 picnic sites
Shasta Lake	Packers Bay	Trail	Four Trails: 0.4 to 2.8 miles
Shasta Lake	Potem Falls	Trail	0.3 miles
Shasta Lake	Samwel Cave Nature Trail	Interpretative Trail	1 mile
Shasta Lake	Sugarloaf	Trail	1 mile

Source: USFS 2014

Additional recreational opportunities are provided at the Shasta Dam Visitors Center.

Fishing is also popular at Shasta Lake, performed mostly by boat as opposed to from the shoreline. Anglers can catch warmwater and coldwater fish species year-round due to the summer stratification of the lake into a warm layer above a coldwater pool (Reclamation 2013a). Shasta Lake warm water fishing opportunities include Black Bass, Smallmouth Bass, Largemouth Bass, Spotted Bass, Black Crappie, Channel Catfish, and Bluegill (USFS 2014). There are many bass tournaments at Shasta Lake each summer. The cooler water strata supports fishing for Rainbow Trout and Chinook Salmon.

15.3.2.1.2 Keswick Reservoir

Keswick Reservoir is a CVP afterbay that extends 9 miles along the Sacramento River from Shasta Dam to Keswick Dam, as described in Chapter 5, Surface Water Resources and Water Supplies. Recreational facilities and activities at Keswick Reservoir are administered by BLM, Shasta County, and U.S. Forest Service for the Department of the Interior, Bureau of Reclamation (Reclamation). The maximum water storage elevation at the top of the Keswick Dam spillway is

587 feet msl (Reclamation 2009). The water level fluctuates frequently in Keswick Reservoir, depending on the operations of Shasta Dam.

Water-related activities include boating, fishing, and water sports. The Keswick Boat Launch, operated by BLM, is located on the western shoreline at the south end of the reservoir (BLM 2005).

There are several trails along Keswick Reservoir and areas for off highway vehicles (OHVs) with camping allowed at one of the locations (BLM 2005; BLM 2011). The Sacramento Rail Trail extends from Moccasin Creek below Shasta Dam to Redding along the western shoreline of Keswick Reservoir and the Sacramento River downstream of Keswick Dam. The Fisherman Trail extends along the shoreline from the lower Sacramento Rail Trail to Keswick Dam. The F.B. Trail extends from the Ribbon Bridge downstream of the Keswick Dam to Walker Mine Road along the eastern side of the Keswick Reservoir. There are several other trails at higher elevations above Keswick Reservoir, including the Hornbeck Tail, Upper and Lower Sacramento Ditch Trails, Flanagan Trail, and Chamise Peak Trail.

The Chappie-Shasta OHV Area provides over 200 miles of roads in approximately 52,000 acres (Reclamation 2013a). The area is accessed at two staging areas. The Chappie-Shasta OHV Staging Area and Shasta Campground includes a staging area for day use activities, including picnics, and 22 campsites (BLM 2005). This site is located along the western shoreline of Keswick Reservoir at the trailhead of the Sacramento Rail Trail at Moccasin Creek. The Copley Mountain OHV Staging Area is located along the western shoreline of Keswick Reservoir about midway between Shasta and Keswick dams. This site also provides a staging area for day use activities, including picnics.

Fishing opportunities are primarily for German Brown Trout and Rainbow Trout.

15.3.2.1.3 Whiskeytown Lake

Whiskeytown Lake is a CVP facility on Clear Creek that is located approximately 8 miles west of Redding on the eastern slope of the Coast Range, as described in Chapter 5, Surface Water Resources and Water Supplies. Whiskeytown Lake is part of the Whiskeytown-Shasta-Trinity National Recreation Area. Recreational facilities and activities administered by the National Park Service (NPS). When the water storage in the reservoir is at full capacity (water elevation at 1210 feet msl), Whiskeytown Lake has a surface area of 3,250 acres and 36 miles of shoreline (Reclamation 1997).

Boating, water skiing, sailing, kayaking, and canoeing, swimming, and fishing occur in many locations in the lake. Boat launches are available at Oak Bottom, Brandy Creek, and Whiskey Creek and at marinas at Oak Bottom and Brandy Creek (NPS 2012), as summarized in Table 15.13.

Table 15.13 Whiskeytown Lake Boat Ramps

Location	Boat Ramp	Comments	Useable Elevations (feet, msl)
Whiskeytown Lake	Brandy Creek	–	1210 to 1190
Whiskeytown Lake	Oak Bottom	–	1210 to 1195
Whiskeytown Lake	Oak Bottom Marina	–	1210 to 1198
Whiskeytown Lake	Whiskey Creek	–	1210 to 1195

Sources: NPS 2012; Reclamation 1997

The lake level is relatively stable and do not reduce the ability for boat launching until late summer or early fall.

The Whiskeytown Unit of the Whiskeytown-Shasta-Trinity National Recreation Area includes many campground sites, including campgrounds for group camping opportunities (NPS 2012), as summarized in Table 15.14.

Table 15.14 Whiskeytown Lake Major Campgrounds

Location	Campground	Comments	Number of Campsites
Whiskeytown Lake	Brandy Creek RV	–	37 RV Sites
Whiskeytown Lake	Brandy Creek	Primitive Campground	2 Sites
Whiskeytown Lake	Coggins Park	Primitive Campground	1 Site
Whiskeytown Lake	Crystal Creek	Primitive Campground near Crystal Creek	2 Sites
Whiskeytown Lake	Dry Creek	Group Campground	100 people
Whiskeytown Lake	Horse Camp	Primitive Campground	2 Sites
Whiskeytown Lake	Oak Bottom Tent and Recreation Vehicle (RV)	–	98 Tent Sites and 22 RV Sites
Whiskeytown Lake	Peltier Bridge	Primitive Campground near Clear Creek	9 Sites
Whiskeytown Lake	Sheep Camp	Primitive Campground	4 Sites

Source: NPS 2012

Whiskeytown Lake recreational areas also include day use areas for picnicking, swimming, and other recreational opportunities, as summarized in Table 15.15. Shoreline day use areas are limited at some locations due to the steep and rocky elevations at the shorelines.

Table 15.15 Whiskeytown Lake Day Use Areas

Location	Day Use Area	Comments	Number
Whiskeytown Lake	Boulder Creek Falls	Trail	1 mile with 2.75-mile advanced trail
Whiskeytown Lake	Brandy Creek Beach and Falls	Picnic, Swimming, and Trails	1.6 and 1.5 miles
Whiskeytown Lake	Buck Hollow	Trail	1 mile
Whiskeytown Lake	Camden Water Ditch	Trail	1.1 miles
Whiskeytown Lake	Clear Creek Canal and Vista	Picnic and Trails	2.4 and 4.5 miles
Whiskeytown Lake	Crystal Creek Water Ditch and Falls	Picnic and Trails	0.75 and 0.3 miles
Whiskeytown Lake	Davis Gulch	Trail	3.3 miles
Whiskeytown Lake	East Beach	Swimming	–
Whiskeytown Lake	Guardian Rock	Trail	0.25 miles
Whiskeytown Lake	James K. Carr Trail	Trail	1.7 miles
Whiskeytown Lake	Judge Francis Carr Powerhouse	Picnic	–
Whiskeytown Lake	Kanaka Peak	Trail	3.6 miles
Whiskeytown Lake	Logging Camp	Trail	1 mile
Whiskeytown Lake	Mill Creek	Trail	6.1 miles
Whiskeytown Lake	Mt. Shasta Mine	Trail	3.5 miles
Whiskeytown Lake	Mule Mountain Pass	Trail	4.4 miles
Whiskeytown Lake	Oak Bottom Beach	Picnic and Swimming	–
Whiskeytown Lake	Oak Bottom Ditch	Trail	2.75 miles
Whiskeytown Lake	Papoose Pass	Trail	5.5 miles
Whiskeytown Lake	Peltier	Trail	1.75 miles
Whiskeytown Lake	Rich Gulch	Trail	1.8 miles
Whiskeytown Lake	Salt Creek	Trail	1.8 miles
Whiskeytown Lake	Salt Gulch	Trail	1.6 miles
Whiskeytown Lake	Shasta Divide Nature Trail	Trail	0.4 miles
Whiskeytown Lake	Whiskey Creek	Group Picnic Area and Swimming	–

Source: NPS 2012

Additional recreational opportunities are provided at the Whiskeytown Visitors Center.

Fishing opportunities at Whiskeytown Lake include Brown Trout and Rainbow Trout; Kokanee Salmon; Smallmouth Bass, Largemouth Bass, and Spotted Bass; Bluegill; crappie; and Sacramento Pikeminnow (NPS No Date).

15.3.2.1.4 Clear Creek from Whiskeytown Dam to the Sacramento River

Whiskeytown Lake is operated to release most of the water through the Spring Creek Power Conduit into Keswick Reservoir, as described in Chapter 5, Surface Water Resources and Water Supplies. Flows are also released from Whiskeytown Lake to Clear Creek to be consistent with federal and state requirements. During high flow events, additional flows may be released into Clear Creek.

The initial reaches of Clear Creek downstream of the Whiskeytown Dam are located within the Whiskeytown-Shasta-Trinity National Recreation Area. The remaining portions of Clear Creek flow to the Sacramento River through lands owned by BLM and private owners. All of these reaches are located within Shasta County and the most eastern reaches are within the City of Redding.

BLM has established the Clear Creek Greenway along a large portion of the lower Clear Creek from within the Whiskeytown-Shasta-Trinity National Recreation Area to the Sacramento River (BLM n.d.). The area also includes the Horsetown-Clear Creek Preserve which is a private-public partnership recreation area.

Hiking, picnicking, kayaking, swimming, fishing, and gold panning occur along the lower Clear Creek (SRWP 2010). The Clear Creek Greenway includes ten trails and eight picnic areas (BLM n.d.). Hunting is allowed in the Swasey and Muletown Road areas of the Clear Creek Greenway. Fishing opportunities include steelhead, Chinook Salmon, carp, suckers, Bluegill, bass, and Sacramento Pikeminnow (SRWP 2010).

15.3.2.1.5 Sacramento River from Keswick Dam to the Delta

The Sacramento River from Keswick Dam to the Sacramento-San Joaquin Delta (Delta) is divided into three reaches for discussion in this section: Keswick Reservoir to Red Bluff, Red Bluff to the Feather River, and Feather River confluence to the Delta (near the City of West Sacramento).

Sacramento River from Keswick Dam to Red Bluff

The upper reach of the Sacramento River flows for approximately 60 miles from Keswick Dam to Red Bluff (Reclamation 1997). Water-related recreational activities include boating, picnicking, camping, and wildlife viewing. Boating opportunities include motor-boating, jet-skiing, kayaking, canoeing, and whitewater rafting in some locations (Reclamation 2013a, Reclamation et al. 2002). River flows can increase for short-term periods when water is being released from the CVP facilities and during and following storm events in the upper Sacramento River watershed. Flows in the late fall months may decrease to levels that are not favorable for boating. Water temperatures in this reach are generally cold throughout the year.

Much of the land along the Sacramento River between Balls Ferry and Red Bluff is owned and managed by BLM (Reclamation 2013a). Public access points are provided by the cities of Redding and Anderson and the BLM. Lake Redding Park, Turtle Bay, and the Anderson River Park are some of the prominent access areas. Boat launching can occur at eight public boat ramps and two smaller launch facilities, including at Turtle Bay, Caldwell Park, and South Bonneyview in the City of Redding; Ball Ferry; Battle Creek confluence with the Sacramento River; Bend Bridge; and Red Bluff River Park in the City of Red Bluff.

There are two whitewater river reaches, including between Keswick Dam and the Anderson-Cottonwood Irrigation District Diversion Dam and between Anderson River Park and William B. Ide Adobe State Historic Park.

Camping facilities include public campgrounds along the Sacramento River at Lake Red Bluff Recreation Area (Reclamation 2013a).

There are trails or trail access and picnicking facilities with access to the river in this reach of the Sacramento River (Reclamation 2013a). The trails include the 13-mile Sacramento River Trail between Keswick Dam to Turtle Bay Park in the City of Redding. Many of the picnicking locations are managed by local municipalities, including the cities of Redding, Anderson, and Red Bluff. Coleman National Fish Hatchery, located along Battle Creek near the Sacramento River, provides recreational and educational opportunities.

Fishing opportunities along the upper Sacramento River include Chinook Salmon, steelhead, Rainbow Trout, sunfish, and bass (Reclamation 2013a). Fishing can occur from boats along the Sacramento River and at four public fishing access points, including Turtle Bay East, Kapusta Property, Deschutes Road, Reading Island, Diestlehorst Pasture River Access, Jellys Ferry, and Sacramento River Island.

The Mouth of Cottonwood Creek Wildlife Area is operated by California Department of Fish and Wildlife (DFW). This area provides viewing opportunities for Swainson’s Hawk, Bald Eagle, ringtail cat, River Otter, and other birds and wildlife (Reclamation 2013a). Hunting opportunities on BLM land occur at Inks Creek, Massacre Flat, Perry Rifle, Paynes Creek, Bald Hill and Iron Canyon. Commonly hunted game includes quail, dove, waterfowl, deer, pig, turkey, and bear (Reclamation 2013a).

Sacramento River from Red Bluff to Feather River

The middle reach of the Sacramento River flows approximately 160 miles from Red Bluff to the confluence with the Feather River (Reclamation 1997).

Water-dependent activities along the middle reach include boating, swimming, and fishing (Reclamation 2005a). Water-contact activities are popular in this section of the river due to relatively warm water. Public access points are provided along this reach by California Department of Parks and Recreations (State Parks); and Tehama, Glenn, Colusa, and Sutter counties (Reclamation 2005a; Reclamation 1997). River access in this reach is primarily provided at private fishing access points, marinas, and resorts.

The three major State Parks properties along the middle reach include the Woodson Bridge State Recreation Area, the Bidwell-Sacramento River State Park, and the Colusa-Sacramento River State Recreation area (DFG 2004; Reclamation 2013a). Public access for fishing, hunting, and wildlife viewing also is provided at the DFW Fremont Weir Wildlife Area (DFW 2014a).

Fishing opportunities include Chinook Salmon, steelhead, trout, American Shad, sturgeon, catfish, and Striped Bass (Reclamation 2005a).

Seasonal game includes Ring-necked Pheasants, California Quail, various species of ducks and geese, Mourning Doves, and Mule Deer (Reclamation 2013a).

Sacramento River from Feather River to the Northern Delta Boundary

The lower reach of the Sacramento River flows for approximately 20 river miles between the confluence with Feather River and immediately downstream of the confluence with the American River (USACE 1991). The major portion of this reach of the Sacramento River flows along private property.

Water-related activities in this reach include boating, swimming and beach use, picnicking, biking, sightseeing, and fishing. Public access is provided by Yolo County at Elkhorn Regional Park (Yolo County); Sacramento County and the City of Sacramento at Discovery Park and Miller Park, respectively (Sacramento County 2012; Reclamation 2005a); and by the City of West Sacramento at Broderick Boat Ramp (West Sacramento 2000).

Fishing opportunities in this area include Chinook Salmon, steelhead, American Shad, sturgeon, catfish, and Striped Bass (Reclamation 1997, 2005a).

15.3.2.1.6 Sacramento Valley Wildlife Refuges

Wildlife refuges in the Sacramento Valley that rely upon CVP water supplies include the Sacramento National Wildlife Refuge (NWR) Complex include Sacramento, Delevan, Colusa, and Sutter NWRs and Gray Lodge Wildlife Area, as described in Chapter 5, Surface Water Resources and Water Supplies, and Chapter 10, Terrestrial Biological Resources (Reclamation 2012). Water-related activities include wildlife viewing, hiking along the refuge wetlands, and waterfowl hunting. Shoreline fishing opportunities at Gray Lodge Wildlife Area include bass, sunfish, perch, catfish, and carp (DFW 2014b)

15.3.2.1.7 Feather River Watershed

Antelope Lake, Lake Davis, and Frenchman Lake located in the Upper Feather River; Lake Oroville and Thermalito Forebay and Afterbay; and the lower Feather River are located within areas in the Feather River watershed that could be affected by changes in CVP and/or SWP operations.

Upper Feather River Lakes

The Upper Feather River Lakes, including Antelope Lake, Lake Davis, and Frenchman Lake, are SWP facilities on the upper Feather River upstream of Lake Oroville. These lakes are part of the Plumas National Forest (DWR 2013a).

Recreational facilities and activities at all three lakes are managed by private concessionaires under contract with the Plumas National Forest.

For Antelope Lake, when the water storage in the lake is at full capacity (water elevation at 5,002 feet), the lake has a surface area of 930 acres and 15 miles of shoreline (DWR 2013a; USFS 2011). Water related activities include boating, water skiing, swimming, fishing, camping, and picnicking. There is a boat launching ramp, three fishing access sites, and a picnic area. There are three campgrounds at Antelope Lake, including Boulder Creek, Lone Rock, and Long Point. There are approximately 194 campsites and 4 group campsites at the three campgrounds for use between May through October. Fishing opportunities in Antelope Lake include Rainbow Trout, Brook Trout, crappie, Channel Catfish, and Smallmouth Bass, Largemouth Bass. Hunting opportunities around Antelope Lake include Mule Deer and Black-tailed Deer.

For Lake Davis, when the water storage in the lake is at full capacity (water elevation at 5,785 feet), the lake has a surface area of 4,030 acres and 32 miles of shoreline (DWR 2013a; USFS 2006a). Water related activities include boating, fishing, camping, and picnicking. There are boat launching ramps at Lightning and Honker Cove, car-top boat ramp at Mallard Cove, a fishing access site, and a picnic area. There are three campgrounds at Lake Davis, including Grizzly, Grasshopper, and Lightning Tree. There are approximately 180 campsites at the three campgrounds for use between May through October. Fishing opportunities in Lake Davis include Rainbow Trout, German Brown Trout, Eagle Lake trout, Brown Bullhead, and Largemouth Bass. Hunting opportunities around Lake Davis include Mule Deer and Black-tailed Deer.

For Frenchman Lake, when the water storage in the lake is at full capacity (water elevation at 5,588 feet), the lake has a surface area of 1,580 acres and 21 miles of shoreline (DWR 2013a; USFS 2006b). Water related activities include boating, water skiing, swimming, fishing, camping, picnicking, and ice fishing. There are two boat launching ramps (Frenchman and Lunker Point), six fishing access sites, and a picnic area. There are five campgrounds at Frenchman Lake, including Chilcoot, Cottonwood Springs, Frenchman, Spring Creek, and Big Cove. There are approximately 209 campsites and 2 group campsites at the five campgrounds for use between May through October. Fishing opportunities in Frenchman Lake include Rainbow Trout, Brown Trout, Eagle Lake trout, and Smallmouth Bass. Hunting opportunities around Frenchman Lake include deer and waterfowl.

Lake Oroville and Thermalito Forebay and Afterbay

Lake Oroville and Thermalito Forebay and Afterbay are SWP facilities on the Feather River, as described in Chapter 5, Surface Water Resources and Water Supplies. The upper North Fork arm of Lake Oroville is part of the Lassen National Forest; and the upper Middle Fork and South Fork arms of Lake Oroville are part of Plumas National Forest. The Middle Fork Feather River (from Beckwourth downstream of Lake Davis to Lake Oroville) was designated as part of Public Law 90-542 (Wild and Scenic Rivers Act) to be part of the National Wild and Scenic Rivers System on October 2, 1968. Recreational facilities and activities at the Lake Oroville Complex (including Lake Oroville and Thermalito

Forebay and Afterbay) are managed by State Parks as part of the Lake Oroville State Recreation Area. When the water storage in the lake is at full capacity (water elevation at 900 feet msl), Lake Oroville has a surface area of 15,810 acres and 167 miles of shoreline. Thermalito Forebay has a surface area of 630 acres. Thermalito Afterbay has a surface area of 4,300 acres and 26 miles of shoreline when the water elevation is at 136.5 feet msl (DWR 2007a, 2007c, 2013b).

Water-related activities include boating, whitewater boating, camping, picnicking, and fishing (DWR 2007a). Boating includes kayaking, canoeing, and fishing boats. Whitewater boating occurs on the Big Bend area of the North Fork Feather River when Lake Oroville elevations are sufficiently low to expose several miles of river. This portion of the North Fork Feather River forms the Upper North Fork arm of Lake Oroville. Generally, this area is exposed in the late fall months. Another whitewater area is located in the Bald Rock Canyon on the Middle Fork Feather River. This whitewater area is located upstream of the Middle Fork arm of Lake Oroville.

There are 11 boat ramps on Lake Oroville, as summarized in Table 15.16. Two of the boat ramps are located at marinas (DWR 2007a).

Table 15.16 Lake Oroville, Thermalito Forebay, and Thermalito Afterbay Boat Ramps

Location	Boat Ramp	Comments	Useable Elevations (feet, msl)
Lake Oroville	Bidwell Canyon	Day Use Area Marina with 280 berths and 400 mooring anchors	900 to 700
Lake Oroville	Dark Canyon	Car-Top Launching	900 to 765
Lake Oroville	Enterprise		900 to 835
Lake Oroville	Foreman Creek	Car-Top Launching	900 to approximately 800
Lake Oroville	Lime Saddle	Day Use Area Marina, including houseboat rentals	900 to 702
Lake Oroville	Loafer Creek	Boat-In Campground	900 to 775
Lake Oroville	Monument Hill	Day Use Area	900 to approximately 700
Lake Oroville	Nelson Bar	Car-Top Launching	900 to 825
Lake Oroville	Spillway	Day Use Area	900 to 695
Lake Oroville	Stringtown Creek	Car-Top Launching	900 to 866
Lake Oroville	Vinton Gulch	Car-Top Launching	900 to 825

Location	Boat Ramp	Comments	Useable Elevations (feet, msl)
Thermalito Forebay	North Thermalito Forebay	Day Use Area Also used by California State University, Chico	Water elevation does not vary substantially
Thermalito Forebay	South Thermalito Forebay	Day Use Area	Water elevation does not vary substantially
Thermalito Afterbay	Larkin Road	Car-Top Launching	Water elevation does not vary substantially
Thermalito Afterbay	Oroville Wildlife Area		Water elevation does not vary substantially
Thermalito Afterbay	Thermalito Afterbay Outlet		Water elevation does not vary substantially
Thermalito Afterbay	Wilbur Road		Water elevation does not vary substantially

Sources: DWR 2006, 2007a

There are 16 campgrounds at Oroville Lake and Thermalito complex (DWR 2007a), as summarized in Table 15.17. Campers are affected by declining water elevations because this increases the distance from the campsites to the shoreline, and makes it difficult to access shoreline campgrounds at Bidwell Canyon, Lime Saddle, and Loafer Creek when water elevations are lower than 850 feet msl.

Table 15.17 Lake Oroville, Thermalito Forebay, and Thermalito Afterbay Major Campgrounds

Location	Campground	Comments	Number of Campsites
Lake Oroville	Bidwell Canyon	Campground	75
Lake Oroville	Bloomer Cove	Boat-In Campground	5
Lake Oroville	Bloomer Group	Boat-In Group Campground	75
Lake Oroville	Bloomer Knoll	Boat-In Campground	6
Lake Oroville	Bloomer Point	Boat-In Campground	25
Lake Oroville	Craig Saddle	Boat-In Campground	18
Lake Oroville	Floating Campsites	Boat-In Campground	10 Different Locations with approximately 15 sites per location
Lake Oroville	Foreman Creek	Boat-In Campground	26
Lake Oroville	Goat Ranch	Boat-In Campground	5
Lake Oroville	Lime Saddle	Campground and Group Campground	45

Location	Campground	Comments	Number of Campsites
Lake Oroville	Loafer Creek	Campground and Group Campground Horse Campground	137 6 15
Thermalito Forebay	North Thermalito Forebay "En Route"	Recreational Vehicle Campground	15
Thermalito Afterbay	Oroville Wildlife Area	Primitive Campground	Several

Sources: DWR 2006, 2007a

Lake Oroville recreational areas also include day use areas for picnicking, swimming, and other recreational opportunities, as summarized in Table 15.18. The locations for shoreline day use areas are limited due to the steep and rocky elevations at the shorelines. Uses of these locations are less desirable when the water elevations decline. It is difficult to access shoreline campgrounds at Bidwell Canyon and Loafer Creek when water elevations are lower than 850 feet msl.

Table 15.18 Lake Oroville, Thermalito Forebay, and Thermalito Afterbay Day Use Areas

Location	Day Use Area	Comments	Number
Lake Oroville	Bidwell Canyon With Saddle Dam trailhead	Trail and picnic	4.9 mile trail (hiking and bicycling) 21 picnic sites
Lake Oroville	Chaparral Trail	Interpretative Trail	0.2 miles
Lake Oroville	Dan Beebe Trail With Saddle Dam, Lakeland Boulevard, Oro Dam Boulevard, and visitor center trailheads	Trail	14.3 mile trail (equestrian and hiking)
Lake Oroville	Lake Oroville Visitors Center	Visitors Center and picnic	18 picnic sites
Lake Oroville	Lime Saddle	Picnic	13 picnic sites
Lake Oroville	Loafer Creek	Trail, swimming, and picnic	3.2 mile trail (equestrian and hiking) 1.7 mile trail (hiking and bicycling) 30 picnic sites
Lake Oroville	Model Aircraft Flying Facility	Aircraft staging and picnic	6 picnic sites

Location	Day Use Area	Comments	Number
Lake Oroville	Oroville Dam Overlook and Spillway Day Use Area	Trail, picnic, and shoreline fishing	1 mile along Oroville Dam crest 8 picnic sites
Lake Oroville	Potter's Ravine	Trail	5.5 miles
Lake Oroville	Roy Rogers Trail	Trail	4 miles (equestrian and hiking)
Lake Oroville	Sewim Bo Trail	Trail and picnic	0.5 miles (equestrian and hiking) 1 picnic site
Lake Oroville	Wyk Island Trail	Trail	0.2 miles
Feather River downstream of Oroville Dam	Feather River Fish Hatchery	Hatchery and picnic	1 picnic site
Oroville Dam Crest, Diversion Pool, Thermalito Forebay, and Thermalito Afterbay	Brad Freeman Trail Diversion Pool access road, East Hamilton Road, Powerhouse Road, Toland Road, and Tres Vias Road trailheads	Trail Loop	41 miles
Thermalito Forebay	North Thermalito Forebay	Picnic, swimming, and shoreline fishing	117 picnic sites
Thermalito Forebay	South Thermalito Forebay	Picnic, swimming, and shoreline fishing	10 picnic sites
Thermalito Afterbay	Monument Hill	Picnic, swimming, and shoreline fishing	10 picnic sites
Oroville Wildlife Area	Rabe Road Shooting Range	Range and target shooting and picnic	7 picnic sites
Oroville Wildlife Area	Clay Pit State Vehicular Recreation Area	Off-highway vehicle riding	–
Thermalito Afterbay	Thermalito Afterbay Outlet and Oroville Wildlife Area	Trail, picnic, shoreline fishing, and hunting	Several trails and day use areas

Sources: DWR 2006, 2007a

Fishing is popular at the Lake Oroville complex and is performed by boat and from the shoreline (DWR 2007a). Fishing opportunities in Lake Oroville include Smallmouth Bass, Largemouth Bass, Spotted Bass, red-eye bass, Black Crappie, Bluegill, Green Sunfish, Channel Catfish, and White Catfish, Coho Salmon, Rainbow Trout, and Brown Trout. In Thermalito Forebay, fish species include Brook Trout, Brown Trout, Rainbow Trout, and Chinook Salmon. In Thermalito Afterbay, fishing opportunities include Smallmouth Bass, Largemouth Bass, trout, Channel Catfish, White Catfish, and carp. Downstream in the Feather River, fishing opportunities include steelhead, Chinook Salmon, American Shad, Smallmouth Bass, Largemouth Bass, and White Sturgeon.

Hunting opportunities occur around Thermalito Afterbay and/or Oroville Wildlife Area for turkey (in the spring), dove, quail, waterfowl, pheasant, deer, squirrel, and rabbit.

Feather River from Thermalito Afterbay/Oroville Wildlife Area to Sacramento River

The Feather River flows from the Thermalito Dam to approximately 40 miles downstream to the confluence with the Sacramento River (Reclamation 1997). The Feather River Wildlife Area, managed by DFW, is located along the Feather River near the confluence with the Bear River. The Feather River Wildlife Area includes the Abbott Lake, Star Bend, O'Connor Lakes, Lake of the Woods, and Nelson Slough units; and Bobelaine Audubon Ecological Reserve (DFG 2008a). The southern boundary of the wildlife area is located adjacent to the Sutter Bypass. In Sutter County, water-related recreation opportunities along the Feather River also include public access at Donahue Road Park, Tisdale Boat Ramp, Boyd's Pump boat launch, Feather River parkway, Yuba City Boat Ramp, Riverfront Park in Marysville, and Live Oak Park and Recreation Area (Sutter County 2010). There are several private facilities that offer camping, boating, and river access.

15.3.2.1.8 Yuba River Watershed

Portions of the Yuba River watershed along the North Yuba River between New Bullards Bar Reservoir and Englebright Lake and along the Lower Yuba River between Englebright Lake and the Feather River could be affected by operation of the Lower Yuba River Water Accord (DWR et al. 2007), as described in Chapter 5, Surface Water Resources and Water Supplies. New Bullards Bar Dam and Reservoir are owned and operated by the Yuba County Water Agency to provide flood control, water storage, and hydroelectric generation. The Harry L. Englebright Dam and Reservoir were constructed by the California Debris Commission downstream of New Bullards Bar Reservoir to trap and store sediment from historical hydraulic mining sites in the upper watershed, and provide recreation and hydroelectric generation opportunities (USACE 2013). Following decommissioning of the California Debris Commission in 1986, administration of Englebright Dam and Reservoir (Lake) was assumed by the U.S. Army Corps of Engineers.

Portions of the watershed along the Middle Yuba River between New Bullards Bar Reservoir and Englebright Reservoir are within the Plumas and Tahoe national forests. There are also lands owned and managed by the Bureau of Land Management and U.S. Army Corps of Engineers along this reach of the river.

This reach also includes the confluence with the South Yuba River. Portions of the Lower South Yuba River are designated as a California Wild and Scenic River (USFS et al. No Date). Portions of the South Yuba River State Park located near the confluence along the South Yuba River and Yuba River provide recreational opportunities for swimming, fishing, bird watching, and gold panning (State Parks 2009).

New Bullards Bar Reservoir

The New Bullards Bar Reservoir has a storage capacity of 966,103 acre-feet when the water elevation is at 1,956 feet. When full, the lake has a surface area of 4,790 acres and 71.9 miles of shoreline (YCWA 2012). Recreational facilities and activities are the responsibility of Yuba County Water Agency. Water related activities include boating, fishing, camping from May through September, and picnicking (DWR et al. 2007). There are several campgrounds adjacent to the lake, including Schoolhouse and Dark Day campgrounds along the shoreline and Madrone Cove and Garden Point that are only accessed by boat. Boat access is provided at Emerald Cove Resort and Marina, Cottage Creek, and Dark Day. The Cottage Creek and Dark Day boat ramps are not useable when the lake elevation declines below 1,822 and 1,798 feet, respectively. Fishing opportunities include Rainbow Trout, Brown Trout, Kokanee Salmon, Bluegill, crappie, Bullhead, Smallmouth Bass, and Largemouth Bass.

Englebright Reservoir

The Englebright Reservoir has a storage capacity of approximately 70,000 acre-feet when the water elevation is at 527 feet (USACE 2012, 2013, 2014). When full, the lake has a surface area of 815 acres and 24 miles of shoreline. Recreational facilities and activities are the responsibility of U.S. Army Corps of Engineers. Water related activities include boating, water-skiing, fishing, boat-access camping, and picnicking. There are 96 boat-access only camping sites. There are two boat ramps to provide access to the lower part of the lake. The upper portion of the lake is characterized by narrow canyons and sharp bends which limit boat access. Fishing opportunities include Rainbow Trout, Brown Trout, Kokanee Salmon, sunfish, catfish, Smallmouth Bass, and Largemouth Bass.

Lower Yuba River

Hiking and boating opportunities occur along the 24 miles of the Lower Yuba River between Englebright Reservoir and the Feather River (DWR et al. 2007). Public river access is provided at several locations to support fishing, picnicking, rafting, kayaking, tubing, and swimming. Fishing opportunities include American Shad, Chinook Salmon, steelhead, Smallmouth Bass, and Striped Bass.

15.3.2.1.9 American River Watershed

Folsom Lake and Lake Natoma on the American River and the lower American River are located within areas in the American River watershed that could be affected by changes in CVP and/or SWP operations.

Folsom Lake and Lake Natoma

Folsom Lake is a CVP facility on the American River, as described in Chapter 5, Surface Water Resources and Water Supplies. The El Dorado National Forest is located in the upper American River watershed upstream of Folsom Lake. The State of California designated the North Fork American River from the source to Iowa Hill Bridge upstream of Folsom Lake as wild and scenic. Recreational facilities and activities in the Folsom Lake area are within the Folsom Lake State Recreation Area or the Folsom Powerhouse State Historic Park that are managed by State Parks. Recreational activities upstream of Folsom Lake occur on or adjacent to many lands owned by the Bureau of Land Management, State Parks, and El Dorado County. When the water storage in the lake is at full capacity (466 feet msl), Folsom Lake has a surface area of 11,450 acres and 75 miles of shoreline (State Parks and Reclamation 2003, 2007).

The upper extent of Lake Natoma is located about 1 mile downstream of Folsom Dam. Lake Natoma continues from the Rainbow Bridge to Nimbus Dam, about a 4-mile distance (State Parks and Reclamation 2003, 2007). Recreational facilities and activities at the Lake Natoma area are part of the Folsom Lake State Recreation Area and managed by State Parks. When the water storage in the reservoir is at full capacity (132 feet msl), Lake Natoma has a surface area of 540 acres and 14 miles of shoreline.

Water-related activities at Folsom Lake include boating, jet skiing, water skiing, wind surfing, rafting, sailing, canoeing, kayaking, swimming, and fishing (Reclamation 2005b; State Parks and Recreation 2003, 2007). White water rafting occurs along the South Fork American River upstream of Folsom Lake and at Skunk Hollow and Salmon Falls.

Water-related activities at Lake Natoma generally only includes paddling, rowing, and fishing due to a 5 miles/hour speed limit for motorized watercraft. California State University Sacramento operates an aquatic center at Lake Natoma (Reclamation et al. 2006).

Folsom Lake Marina at Brown's Ravine is the only marina at Folsom Lake. There are six boat launch facilities at Folsom Lake and three boat launch facilities at Lake Natoma, as summarized in Table 15.19.

Table 15.19 Folsom Lake and Lake Natoma Boat Ramps

Location	Boat Ramp	Comments	Useable Elevations (feet, msl)
Folsom Lake	Beal's Point	Day Use Area Informal Boat Ramp	465 to 420
Folsom Lake	Brown's Ravine	Day Use Area Folsom Lake Marina with 685 wet slips and 175 dry storage slips	466 to 395
Folsom Lake	Folsom Point	–	466 to 406

Location	Boat Ramp	Comments	Useable Elevations (feet, msl)
Folsom Lake	Granite Bay	Day Use Area Largest Boat Launch Facility at Folsom Lake	466 to 360
Folsom Lake	Hobie Cove	–	426 to 375
Folsom Lake	Peninsula	Day Use Area	466 to 410
Folsom Lake	Rattlesnake Bar	–	466 to 425
Lake Natoma	Negro Bar	–	121 to 115
Lake Natoma	Nimbus Flat	Main Boat Ramp Informal Boat Ramp	128 to 115 128 to 120
Lake Natoma	Willow Creek	Informal Boat Ramp	125 to 115

Sources: Reclamation et al. 2006; State Parks and Reclamation 2003, 2007

Campgrounds are located at Folsom Lake and Lake Natoma, as summarized in Table 15.20. Campers are also affected by declining water elevations because this increases the distance from the campsites to the shoreline. Drawdown of the reservoir has an aesthetic effect on users because the land exposed during drawdown is generally composed of bare earth and rock.

Table 15.20 Folsom Lake and Lake Natoma Major Campgrounds

Location	Campground	Comments	Number of Campsites
Folsom Lake	Beal's Point	–	49 Camp Sites 20 Recreation Vehicles
Folsom Lake	Peninsula	Campground Boat-In Campground	104 Camp Sites
Lake Natoma	Negro Bar	Group Campground	3 Major Camp Sites

Note: State Parks and Reclamation 2003, 2007; Reclamation et al. 2006

Folsom Lake and Lake Natoma recreational areas also include day use areas for picnicking, swimming, and other recreational opportunities, as summarized in Table 15.21. The locations for shoreline day use areas are limited due to the steep and rocky elevations at the shorelines. Uses of these locations are less desirable when the water elevations decline. The Jedediah Smith Memorial Trail begins at Beal's Point and extends along Lake Natoma to the confluence of the American River and Sacramento River downstream of Nimbus Dam. The Pioneer Express Trail which extends from the Auburn State Recreation Area to Beal's Point is part of the Western States Pioneer Express Trail (a National Recreation Trail).

1 **Table 15.21 Folsom Lake and Lake Natoma Day Use Areas**

Location	Day Use Area	Comments	Number
Folsom Lake	Beal’s Point	Picnic and Swimming Trailhead for Jedediah Smith Memorial Trail	53 picnic sites in Day Use area 69 at campground
Folsom Lake	Brown’s Ravine Trail	Trail (to Old Salmon Falls)	12 miles
Folsom Lake	Darrington Trail	Trail	9 miles
Folsom Lake	Doton’s Point ADA Trail	Trail	1 mile
Folsom Lake	Folsom Point	Picnic and water skiing Trail (to Brown’s Ravine Trail)	50 picnic sites 4 miles
Folsom Lake	Folsom Powerhouse	Historic Site and Museum Trail	10 picnic sites 1 mile
Folsom Lake	Folsom Reservoir River Access Areas	Whitewater rafting (South Fork)	40 commercial rafting outfitters with 67 permits No permits for private boats
Folsom Lake	Granite Bay	Trail Picnic, Swimming, fishing, equestrian, and hiking	Several trails: 1 to 5 miles 100 picnic sites
Folsom Lake	Los Lagos Trail	Trail	1.5 miles
Folsom Lake	Old Salmon Falls	Swimming, equestrian, and hiking Trailhead for Brown’s Ravine and Sweetwater trails	–
Folsom Lake	Peninsula	Trail Picnic	1 mile 6 picnic sites in Day Use area 104 at campground
Folsom Lake	Pioneer Express Trail	Trail	21 miles
Folsom Lake	Rattlesnake Bar	Equestrian	–
Folsom Lake	Skunk Hollow and Salmon Falls	Whitewater rafting (South Fork)	–

Location	Day Use Area	Comments	Number
Folsom Lake	Sweetwater Creek	Trailhead for Sweetwater Trail	–
Folsom Lake	Sweetwater Trail	Trail	2 miles
Lake Natoma	Lake Natoma Trails	Trail	Several trails: 1 to 10 miles
Lake Natoma	Lake Overlook	Trailhead for Lake Natoma Trail	–
Lake Natoma	Negro Bar	Picnic, fishing, and equestrian Trailhead for Lake Natoma Trail	32 picnic sites in Day Use area 17 at campground
Lake Natoma	Nimbus Fish Hatchery	Hatchery	–
Lake Natoma	Nimbus Flat	California State University, Sacramento Aquatic Center Trailhead for Lake Natoma Trail	37 picnic sites
Lake Natoma	Willow Creek	Trailhead for Lake Natoma Trail	4 picnic sites

Sources: Reclamation et al. 2006; State Parks and Reclamation 2003, 2007

Fishing is also popular at Folsom Lake and Lake Natoma from boats and the shoreline. Anglers can catch warmwater and coldwater fish species due to the summer stratification of the lake into a warm layer above a coldwater pool especially in Folsom Lake (State Parks and Reclamation 2007). Warm water fishing opportunities include Smallmouth Bass, Largemouth Bass, Spotted Bass, and black and White Crappie. The cooler water strata support fishing for Rainbow Trout, Brown Trout, and Chinook Salmon.

American River from Nimbus Dam to the Confluence with Sacramento River

The American River flows 14 miles between Nimbus Dam and the confluence with the Sacramento River was designated by the Secretary of the Interior to be part of the National Wild and Scenic Rivers System on January 19, 1981. The State of California also designated the Lower American River as wild and scenic under Public Resources Code sections 5093.54 and 5093.545.

The Jedediah Smith Memorial Trail (also known as the American River Bike Trail) continues along the American River from Beal's Point at Folsom Lake, along Folsom Lake and Lake Natoma, and along the Lower American River through Discovery Park to the confluence with the Sacramento River (Reclamation 2005b).

The American River Parkway is a 26-mile green space designated and managed by Sacramento County Parks and Recreation along the Lower American River from Nimbus Dam to the confluence with the Sacramento River at Discovery Park. This parkway provides extensive recreational opportunities, including boating rafting, kayaking, canoeing, swimming, and fishing (Reclamation 2005b; Sacramento County 2008). Pedestrian access is provided at 87 locations along the parkway. Bicycle access and equestrian access are provided at 65 and 37 locations, respectively. Boat launch ramps are provided at 7 locations and Car-top Boat Launch opportunities are provided at 17 locations. Picnic locations are located at numerous locations along the American River. Fishing opportunities along the Lower American River include Chinook Salmon, steelhead, trout, Striped Bass, American Shad, Largemouth Bass, Bluegill, crappie, sunfish, and catfish (Sacramento County 2008).

Sacramento Municipal Utility District – Rancho Seco Park and Lake

Rancho Seco Park and Lake, operated by Sacramento Municipal Utility District, is used to store CVP water (Reclamation 2005b). The lake has a surface are of 160 acres. Water-related activities include boating, camping, picnicking, bird watching and fishing. Facilities available for these activities are two boat ramps and a fish cleaning facility. Game fish species found at the lake include catfish, Bluegill, crappie, and trout. Birds that use the area include ducks, geese, hawks, Bald Eagles, blue heron, and migratory birds (SMUD 2013).

15.3.2.2 San Joaquin Valley

Recreational opportunities in the San Joaquin Valley upstream of the Delta that are influenced by CVP and SWP operations occur at Millerton Lake, San Joaquin River between Friant Dam and the Delta, New Melones Reservoir, Stanislaus River between Tulloch Dam and San Joaquin River, San Luis Reservoir complex, recreation areas along Delta Mendota Canal and California Aqueduct, and refuges that use CVP water supplies.

15.3.2.2.1 Millerton Lake

Millerton Lake is a CVP facility on the San Joaquin River, as described in Chapter 5, Surface Water Resources and Water Supplies. Millerton Lake is part of the Millerton State Recreation Area. Recreational facilities and activities at Millerton Lake are administered by State Parks. When the water storage in the lake is at full capacity (water elevation at 580.6 feet msl), Millerton Lake has a surface area of approximately 4,900 acres and 44 miles of shoreline (Reclamation and DWR 2011).

Boating, sailing, water skiing, jetskiing, swimming, tournament and recreational fishing, camping, and picnicking (Reclamation and DWR 2011; Reclamation and State Parks 2010). Whitewater rafting opportunities occur upstream of Millerton Lake. There are six public boat ramps on Millerton Lake, as summarized in Table 15.22.

Table 15.22 Millerton Lake Boat Ramps

Location	Boat Ramp	Comments	Useable Elevations (feet, msl)
Millerton Lake	Crow's Nest	On South Shore	580 to 487
Millerton Lake	Grange Cove	On South Shore	Several Boat Ramps: 580 to 500
Millerton Lake	McKenzie Point	On South Shore	580 to 472
Millerton Lake	North Shore	On North Shore	580 to 470
Millerton Lake	South Bay	On South Shore	580 to 500

Sources: Reclamation and DWR 2011; Reclamation and State Parks 2010

The marina at Millerton Lake is located at Winchell Cove on the South Shore (Reclamation and State Parks 2010). The marina includes 500 boat slips. There are also eight boat slips at Crow's Nest.

Campgrounds are located along the Millerton Lake North Shore, as summarized in Table 15.23. Many of these campsites are located along the shoreline. These campsites are affected by declining water elevations because this increases the distance from the campsites to the shoreline.

Table 15.23 Millerton Lake Major Campgrounds

Location	Campground	Comments	Number of Campsites
Millerton Lake	Dumna Strand	–	10
Millerton Lake	Fort Miller	Shoreline Campground	36
Millerton Lake	Group Campsites	Group Campground Amphitheater	Two sites with total of 120 sites
Millerton Lake	Meadows	Campsites Equestrian Campsites	59 4 corrals and campsites
Millerton Lake	Mono	–	16
Millerton Lake	North Fine Gold Campground	Boat-In Campground	15
Millerton Lake	Rocky Point	–	21
Millerton Lake	Temperance Flat Boat	Boat-In Campground	25
Millerton Lake	Valley Oak	–	6

Source: Reclamation and State Parks 2010

Millerton Lake recreational areas also include day use areas for picnicking, swimming, and other recreational opportunities, as summarized in Table 15.24 (Reclamation and State Parks 2010). The locations for shoreline day use areas are less desirable when the water elevations decline.

Table 15.24 Millerton Lake Day Use Areas

Location	Day Use Area	Comments	Number
Millerton Lake	Blue Oak	Picnic and Trail along the South Shore	3 sites 4 miles
Millerton Lake	Buzzard's Roost Trail	Picnic and Trail	2 sites 0.5 miles
Millerton Lake	Crow's Nest	Picnic	13 sites
Millerton Lake	Eagle's Nest	Picnic and Trailhead	2 sites
Millerton Lake	Fort Miller	Trail	0.25 miles
Millerton Lake	Grange Grove	Picnic	74 sites
Millerton Lake	La Playa	Picnic and Swimming	95 sites
Millerton Lake	McKenzie Point	Picnic	–
Millerton Lake	Meadows	Picnic	10 sites
Millerton Lake	Millerton Courthouse	Historic Site and Picnic	3 sites
Millerton Lake	San Joaquin River Trail	Portions along the Millerton Lake shoreline	14 miles
Millerton Lake	South Bay	Picnic	9 sites
Millerton Lake	South Fine Gold	Picnic and Trail	10 sites 11 miles

Sources: Reclamation and State Parks 2010; State Parks 2008

Fishing is also popular at Millerton Lake from boats and shoreline. Fishing opportunities include Striped Bass, Black Bass, Largemouth Bass, Green Sunfish, and American Shad (Reclamation and State Parks 2010).

15.3.2.2.2 San Joaquin River from Friant Dam to the Delta

The San Joaquin River flows 100 miles from Friant Dam to the Delta. Downstream of Friant Dam, the San Joaquin River flows 23 miles through lands within the San Joaquin River Parkway which includes parks, trails, and ecological reserve areas between Friant Dam and State Route 145 managed by the San Joaquin River Parkway and Conservation Trust (Reclamation and DWR 2011).

Water-related recreational activities include boating, canoeing, kayaking, whitewater rafting, camping, picnicking, fishing, and hunting (Reclamation and DWR 2011). Access and facilities for these activities are available at several locations along and adjacent to the San Joaquin River.

Between Friant Dam and the confluence with the Merced River, whitewater rafting occurs between Friant Dam to Skaggs Bridge Park at State Route 145. Public access locations are generally located within the San Joaquin River

Parkway. Seven boat launching locations along the San Joaquin River Parkway that are managed by the San Joaquin River Parkway and Conservation Trust and/or DFW, Fresno County, or private operators. Lost Lake Park, managed by the San Joaquin River Parkway and Conservation Trust and DFW, provides a non-powered car-top boat launch. Sycamore Island Park, managed by San Joaquin River Parkway and Conservation Trust offers a boat ramp for small boats. River access also is available at Skaggs Bridge Park, managed by Fresno County. Picnicking is provided at most of the public access locations and at several other locations within the parkway. Camping is provided at Scout Island and Lost Lake Park managed by Fresno County and the private Fort Washington Beach. Trails include the 5-mile long Lewis S. Eaton Trail.

Downstream of State Route 145, major recreational areas include the 85-acre Mendota Pool in Mendota; Dunkle and Maldonado parks in the City of Firebaugh; and Las Palmas Fishing Access and Laird Park in Stanislaus County. Public access is provided at all of these sites. A boat ramp is located upstream of Mendota Dam.

The majority of these areas permit fishing. Fishing opportunities in the San Joaquin River include sunfish, crappie, Bluegill, Striped Bass, Largemouth Bass, and catfish (Reclamation and DWR 2011).

15.3.2.2.3 San Joaquin Valley Refuges

Wildlife refuges in the San Joaquin Valley that rely upon CVP water supplies include the San Luis NWR (including the San Luis Unit, West Bear Creek Unit, East Bear Creek Unit, Freitas Unit, and Kesterson Unit); Merced NWR; Los Banos Wildlife Area; Volta Wildlife Area; Mendota Wildlife Area; North Grasslands Wildlife Area (including China Island Unit and Salt Slough Unit); and Grasslands Resource Conservation District, as described in Chapter 5, Surface Water Resources and Water Supplies, and Chapter 10, Terrestrial Biological Resources (Reclamation 2012). Water-related activities include wildlife viewing, and hunting. Hunting opportunities include waterfowl, shorebirds, and pheasants (Reclamation and DWR 2011).

Several wildlife areas along the San Joaquin River could be affected by CVP operations of Millerton Lake, including the West Hilmar Wildlife Area downstream of the confluence with the Merced River and the San Joaquin River NWR located between the Tuolumne and Stanislaus rivers (Reclamation and DWR 2011). West Hilmar Wildlife Area includes 340 acres of wildlife area accessible by boat. The San Joaquin River NWR includes over 7,000 acres of riparian woodlands, wetlands, and grasslands for native wildlife with limited access at Pelican Trail.

In the southern San Joaquin Valley, the Kern and Pixley NWRs provide wildlife viewing opportunities.

15.3.2.2.4 Stanislaus River Watershed

New Melones Reservoir and Tulloch Reservoir on the Stanislaus River and the lower Stanislaus River are located within areas in the Stanislaus River watershed that could be affected by changes in CVP operations.

New Melones Reservoir

New Melones Reservoir is a CVP facility on the Stanislaus River, as described in Chapter 5, Surface Water Resources and Water Supplies. Recreation activities and facilities at New Melones Reservoir area are managed by Reclamation. When the water storage in the reservoir is at full capacity, New Melones Reservoir has a surface area of approximately 12,500 acres and 105 miles of shoreline at a surface elevation of 1,088 feet msl (Reclamation 1997, 2010a).

Water-related activities include boating, waterskiing, camping, picnicking, wildlife viewing, spelunking, rock climbing, gold panning, and fishing (Reclamation 2010a). Float planes can land within the North, Middle, and South Bays of the reservoir. A model airplane club operates an airstrip near New Melones Dam. Cave exploration occurs in the Stanislaus River Canyon. Rock climbing occurs on Table Mountain. In years when the reservoir elevation is low, whitewater rafters launch at the Old Camp Nine Bridge.

There are five boat ramps at New Melones Reservoir, as summarized in Table 15.25.

Table 15.25 New Melones Reservoir Boat Ramps

Location	Boat Ramp	Comments	Useable Elevations (feet, msl)
New Melones Reservoir	Angels Creek	–	1,088 to 975
New Melones Reservoir	Glory Hole	Location of New Melones Lake Marina	Several Boat Ramps: 1,088 to 860
New Melones Reservoir	Mark Twain	Unimproved Ramp	1,088 to 760
New Melones Reservoir	Parrotts Ferry	Unimproved Ramp	Several Boat Ramps: 1,088 to 900

Source: Reclamation 2010a

The New Melones Marina is the only location with mooring facilities and houseboat rentals (Reclamation 2010a). Up to 50 private houseboats on mooring balls, 38 private houseboats in slips, and 20 rental houseboats may be maintained on the reservoir.

Campgrounds are located at Glory Hole and Tuttletown, as summarized in Table 15.26 (Reclamation 2010a). Some of the campsites are located along the shoreline. These campsites are affected by declining water elevations because this increases the distance from the campsites to the shoreline.

Table 15.26 New Melones Reservoir Major Campgrounds

Location	Campground	Comments	Number of Campsites
New Melones Reservoir	Glory Hole	Two campgrounds	144
New Melones Reservoir	Tuttletown	Three campgrounds Two Group campgrounds	161 16

Source: Reclamation 2010a

New Melones Reservoir recreational areas also include day use areas for picnicking, swimming, and other recreational opportunities, as summarized in Table 15.27 (Reclamation 2010a). The locations for shoreline day use areas are less desirable when the water elevations decline.

Table 15.27 New Melones Reservoir Day Use Areas

Location	Day Use Area	Comments	Number
New Melones Reservoir	Glory Hole	Picnic and Trails	61 sites Several trails: 0.25 to 2.5 miles
New Melones Reservoir	Mark Twain	Picnic and Norwegian Gulch Trail	0.5 miles
New Melones Reservoir	Natural Bridges	Trail	0.7 miles
New Melones Reservoir	Shoreline	Swimming and Recreational Gold Panning	–
New Melones Reservoir	Table Mountain	Trail	Several trails: 1.5 to 4.0 miles
New Melones Reservoir	New Melones Lake Visitor	Visitor Center	–
New Melones Reservoir	Tuttletown	Picnic and Trail	52 sites Several trails: 0.4 to 1.7 miles

Sources: Reclamation 2010a, 2010b, 2014

Tulloch Reservoir

Tulloch Reservoir is a reservoir owned and operated by the Oakdale and South San Joaquin Irrigation Districts on the Stanislaus River downstream of New Melones Reservoir, as described in Chapter 5, Surface Water Resources and Water Supplies. When the water storage in the reservoir is at full capacity (water elevation at 510 feet msl), the reservoir has a surface area of 1,260 acres and 55 miles of shoreline (CBC 2013; Tri-Dam Project 2002).

Water-related activities include boating, sailing, windsurfing, jet and water skiing, camping, picnicking, and fishing. Most of the shoreline is privately owned with shoreline access and more than 400 private docks for residents (Tri-Dam Project 2012). Public access is provided at a DFW marina and campground with a boat ramp at South Shore.

Stanislaus River from Tulloch Dam to the San Joaquin River

Downstream of Tulloch Dam, the Stanislaus River flows to Goodwin Dam, and then continues approximately 40 miles to the confluence with the San Joaquin River. Water-related activities along the lower portion of the Stanislaus River include whitewater rafting, camping, picnicking, swimming, and fishing. Whitewater rafting begins at Goodwin Dam and continues almost 4 miles to Knights Ferry (Reclamation 1997). Downstream of Knights Ferry, there are seven parks, including Caswell Memorial State Park, a 258-acre park managed by State Parks (Stanislaus County 1987; State Parks 2006a). Fishing opportunities on the lower Stanislaus River include bass, catfish, and crappie.

15.3.2.2.5 San Luis Reservoir State Recreation Area

The San Luis Reservoir complex includes CVP and SWP offstream storage facilities located south of the Delta, as described in Chapter 5, Surface Water Resources and Water Supplies. The San Luis Reservoir complex includes San Luis Reservoir, O'Neill Forebay, and Los Banos Creek Reservoir. The San Luis Reservoir complex is located within the San Luis Reservoir State Recreation Area, and the recreational facilities are operated by State Parks (State Parks 2003). Los Banos Creek Reservoir is a flood detention basin to protect the community of Los Banos and San Luis Canal/California Aqueduct. This reservoir and a similar flood management reservoir that is not within the San Luis Reservoir State Recreation Area (Little Panoche Creek Reservoir) are not affected by CVP and SWP operations. Therefore, Los Banos Creek Reservoir and Little Panoche Creek Reservoir are not considered in detail in this EIS.

When the water storage in the San Luis Reservoir is at full capacity (water elevation at 540 feet msl), the reservoir has a surface area of 12,700 acres and 65 miles of shoreline (Reclamation and State Parks 2013; State Parks 2010).

The O'Neill Forebay is east of the San Luis Reservoir downstream of the San Luis Dam. When the water storage in the forebay is at full capacity (water elevation of 230 feet msl), the reservoir has a surface area of 2,210 acres and 14 miles of shoreline (Reclamation and State Parks 2013; State Parks 2010).

Water-related activities include boating, camping, picnicking, wildlife and scenic viewing, fishing, and hunting occur throughout the San Luis Reservoir State Recreation Area (Reclamation 2005c; State Parks 2010; Reclamation and State Parks 2013). Boat ramps are located at all three reservoirs, as summarized below.

- San Luis Reservoir: Boat ramps at Basalt Area and Dinosaur Point (operational to 340 feet and 360 feet msl, respectively).

- O'Neill Forebay: Boat ramps at Group Campground and Medeiros Campground.
- Los Banos Creek Reservoir: Boat ramp at Los Banos Creek Campground.

Camping occurs at Basalt Area at San Luis Reservoir (79 sites), O'Neill Forebay (50 sites), San Luis Creek Area (53 sites and two group campsites with 90 sites), and Los Banos Creek Area (14 sites) (Reclamation and State Parks 2013). Picnic sites, swimming, and/or trails occur at Basalt Area, Medeiros Area, and Los Banos Creek Area (Reclamation 2005c; State Parks 2010; Reclamation and State Parks 2013).

Fishing opportunities include Striped Bass, American Shad, and catfish (Reclamation and State Parks 2013). Hunting opportunities occur at San Luis Reservoir for waterfowl, deer, and wild pig (Reclamation 2005c; Reclamation and State Parks 2013).

15.3.2.2.6 Delta Mendota Canal

Delta Mendota Canal is a CVP facility, as described in Chapter 5, Surface Water Resources and Water Supplies. The Delta-Mendota Canal includes two fishing sites: one in Stanislaus County and the other in Fresno County (Reclamation 2005c). Fishing opportunities include Striped Bass and catfish (Reclamation 1997).

15.3.2.2.7 California Aqueduct/San Luis Canal

The California Aqueduct is a SWP facility, as described in Chapter 5, Surface Water Resources and Water Supplies. A portion of the canal is also co-located with the CVP San Luis Canal. Fishing is permitted at 12 sites along the California Aqueduct between Bethany Reservoir and Perris Lake in Southern California. Fishing opportunities include Striped Bass, Largemouth Bass, catfish, crappie, Green Sunfish, Bluegill, and starry flounder (Reclamation 1997).

15.3.2.3 Delta

The Delta is located at the terminus of the Sacramento River and the San Joaquin River. Water-related activities in the Delta include boating, sailing, water skiing, canoeing, kayaking, picnicking, fishing, and hunting. Recreational opportunities exist in many areas of the Delta; however, the analysis in this EIS is related to areas that could be affected by changes in CVP and/or SWP water supply operations and restoration in the Yolo Bypass. The following discussion describes recreation throughout the Delta followed by more specific discussions of recreation within the Yolo Bypass and Cache Slough.

15.3.2.3.1 Delta Recreational Opportunities

The primary recreational activities in the Delta are related to boating and fishing (DPC 2012). Public recreation facilities are limited within the Delta. Most recreational opportunities are provided by private enterprises, including marinas, restaurants, hunting venues, and wineries and farm visits. Public access is provided at DFW and U.S. Fish and Wildlife Service (USFWS) sites.

The most recent survey of boating opportunities in the Delta was completed in 2002 by the California Department of Boating and Waterways (DBW 2014; DPC 2012). The survey indicated that of the 95 marinas surveyed, three were publically-owned and 92 were privately-owned (including 87 that were open to the public and five that were for members). The survey indicated that within the Delta there were over 11,600 boat slips, 55 boat launches, 2,182 campsites, and 324 picnic sites.

Public access sites for boating and wildlife and scenic viewing in the Delta include:

- USFWS: Stone Lakes NWR, Antioch Dunes NWR.
- DFW: Calhoun Cut Ecological Reserve, Decker Island Wildlife Area, Lower Sherman Island Wildlife Area, Miner Slough Wildlife Area, Rhode Island Wildlife Area, White Slough Wildlife Area, Woodbridge Ecological Reserve, Fremont Weir Wildlife Area, Sacramento Bypass Wildlife Area, and Yolo Bypass Wildlife Area.
- State Parks: Brannan Island-Franks Tract State Recreation Areas, Delta Meadows State Recreation Area.
- Department of Water Resources: Clifton Court Forebay.
- The Nature Conservancy/DFW: Cosumnes River Preserve.
- Solano Land Trust: Jepson Prairie Preserve.
- East Bay Regional Park District: Big Break Regional Shoreline, Antioch/Oakley Regional Shoreline, Browns Island Regional Preserve, Bay Point Regional Shoreline, Martinez Regional Shoreline, Carquinez Strait Regional Shoreline-Crockett Hills Regional Park, and Contra Costa Canal Trail.
- Municipal Marinas, Boat Launching, and Fishing Access Facilities: City of Antioch Marina and Municipal Boat Ramp; City of Pittsburg Riverview Park; Sacramento County Cliffhouse, Georgiana Slough Fishing Access, Hogback Island Access, and Sherman Island Public Access Facility; City of Sacramento Garcia Bend Park; several public and private marinas in Sacramento County; 12 public and private marinas with over 900 boat slips and boat access within the City of Stockton; San Joaquin County Dos Reis Regional Park, Mossdale Crossing Regional Park, and Westgate Landing Regional Park; and Yolo County Clarksburg River Access.

Several of these sites include launch sites for boats, canoes, and kayaks and numerous trails (DPC 2012; DSC 2011; DFG 2008b, 2008d, 2009; EBRPD 2013a; Antioch 2003; Pittsburg 2001; Sacramento County 2014; Sacramento 2005; Stockton 2007; Yolo County 2009).

One of the larger bodies of water in the Delta is the SWP Clifton Court Forebay. Fishing is the only recreational opportunity that occurs within the Clifton Court Forebay; and the opportunities are limited (DWR 2013c). Public access is restricted near the radial gate along West Canal. However, boat access occurs at a boat dock along West Canal to the east of the radial gate and by a trail from Clifton Court Road.

Fishing opportunities in the Delta generally include Striped Bass, Smallmouth Bass, Largemouth Bass, Spotted Bass, American Shad, Black Crappie, Chinook Salmon, steelhead, catfish, sunfish, Tule Perch, Warmouth, and White Sturgeon (DPC 2006).

Hunting opportunities for waterfowl, shorebirds, doves, and pheasants occur in many areas of the Delta on privately-owned land. Hunting also occurs at several publically-owned sites within the Delta, including:

- USFWS: Stone Lakes NWR.
- DFW: Decker Island Wildlife Area, Lower Sherman Island Wildlife Area, Miner Slough Wildlife Area, Rhode Island Wildlife Area, White Slough Wildlife Area, Yolo Bypass Wildlife Area; and on some lands owned by DWR (including Sherman and Twitchell islands and Clifton Court Forebay).

The Delta Protection Commission identified several physical constraints to Delta recreational opportunities that could be affected by CVP and SWP operations, including changes in water quality and operation of the CVP or SWP water facilities (Delta Cross Channel, South Delta Temporary Barriers, and Montezuma Slough Salinity Gates) (DPC 2012).

15.3.2.3.2 Yolo Bypass and Cache Slough Recreational Opportunities

The primary recreational activities in the Yolo Bypass and Cache Slough areas are related to wildlife viewing and hunting. Many recreational hunting opportunities occur on private lands, including private hunting clubs. Areas within Yolo Bypass and Cache Slough that provide public access for wildlife viewing or hunting within the Yolo Bypass and Cache Slough area, include:

- Fremont Weir Wildlife Area (DFW 2014a).
  - Wildlife viewing and fishing.
  - Hunting for pheasant, waterfowl, Mourning Dove, deer, quail, rabbit, and turkey.
- Sacramento Bypass Wildlife Area (DFW 2014c).
  - Wildlife viewing and fishing, including for White Sturgeon, White Catfish, and Black Crappie in the Tule Canal; and Largemouth Bass, Bluegill, and White Catfish in the borrow pits.
  - Hunting for pheasant and Mourning Dove.
- Yolo Bypass Wildlife Area (DFG 2008c, 2010).
  - Wildlife viewing and hiking.
  - Fishing for sturgeon, Striped Bass, Black Bass, and catfish.

  - Hunting for waterfowl, coots, Moorhens, Snipe, pheasants, and Mourning Doves.
  - Educational and interpretative programs.
- Calhoun Cut Ecological Reserve (DFG 2008d).
  - Waterfowl hunting and fishing from a boat.

There are other publically-owned lands within the Yolo Bypass and Cache Slough that provide habitat or will be restored to provide habitat. However, these lands are generally not available for public access to protect fragile ecosystems.

15.3.2.4 Suisun Marsh

Suisun Marsh is 106,511 acres of wetlands located between the Delta and the San Francisco Bay. Water-related activities at Suisun Marsh include waterfowl hunting, boating, kayaking, hiking, wildlife viewing, fishing, and hunting (Reclamation et al. 2011). Water-related recreation occurs within the two major channels, Montezuma and Suisun sloughs; and several moderately sized channels, Cordelia, Denverton, Nurse, and Hill sloughs.

The DFW manages several areas within the Suisun Marsh for public access, as described in Chapter 10, Terrestrial Biological Resources. These areas include (Reclamation et al. 2011):

- Grizzly Island Wildlife Area
  - Wildlife viewing, hiking, and fishing (February through July, and late September).
  - Hunting (August through mid-September, and October through January).
- Hill Slough Wildlife Area
  - Wildlife viewing and fishing.
- Peytonia Slough Ecological Preserve
  - Kayaking.
  - Wildlife viewing and fishing.
- Belden’s Landing Water Access Facility
  - Boat launch ramp and fishing pier.

Suisun City Marina and Solano Yacht Club, Suisun City Boat Launch, and McAvoy Yacht Harbor and Club also provide boat launch ramp facilities (Reclamation et al. 2011). Pier fishing opportunities are provided at Suisun City Boat Launch.

The Solano Land Trust’s Rush Ranch also provides opportunities for hiking and picnicking in the wetlands and upland areas near Potrero Hills (Reclamation et al. 2010).

Fishing opportunities within Suisun March include Striped Bass, White Sturgeon, catfish, and carp (Reclamation et al. 2011). Occasionally, Chinook Salmon, steelhead, and Largemouth Bass are caught in Suisun Marsh near Grizzly Island.

Duck hunting generates the most frequent recreational visits in Suisun Marsh (Reclamation et al. 2011). About 37,500 acres of Suisun Marsh are owned and operated by private duck clubs. DFW manages about 15,300 acres of public lands in Grizzly Island Wildlife Area for hunting of waterfowl, Snipe, coots, Moorhens, Mourning Doves, pheasants, rabbits, and Tule Elk.

There are other publically-owned lands within Suisun Marsh that provide habitat or will be restored to provide habitat. However, these lands are generally not available for public access to protect fragile ecosystems.

15.3.3 San Francisco Bay Area Region

The San Francisco Bay Area Region includes portions of Contra Costa, Alameda, Santa Clara, San Benito, and Napa counties that are within the CVP and SWP service areas. This section describes reservoirs in the San Francisco Bay Area Region that could be affected by CVP and SWP operations, including the CVP Contra Loma and San Justo reservoirs; the SWP Bethany Reservoir and Lake Del Valle; the Contra Costa Water District Los Vaqueros Reservoir; and the East Bay Municipal Utility District Upper San Leandro, San Pablo, Briones, and Lafayette reservoirs and Lake Chabot. CVP and SWP are generally not stored in reservoirs within Santa Clara County (SCVWD 2010).

15.3.3.1 Contra Loma Reservoir

The Contra Loma Reservoir is a CVP facility in Contra Costa County that provides offstream storage along the Contra Costa Canal, as described in Chapter 5, Surface Water Resources and Water Supplies. The recreation facilities are managed by East Bay Regional Park District. The 80 acre reservoir is part of 661-acre Contra Loma Regional Park and Antioch Community Park (Reclamation 2014a). Water-related activities include boating, wind surfing, kayaking, picnicking, and fishing. No bodily contact is to occur in Contra Loma Reservoir; therefore, a large swimming pool was constructed for the visitors by the East Bay Regional Park District. There is one boat launch at the reservoir. Contra Loma Reservoir accommodates fishing all year-round. Fishing opportunities include catfish, Black Bass, Striped Bass, Largemouth Bass, Bluegill, crappie, trout, and Redear Sunfish (EBRPD 2013c).

15.3.3.2 San Justo Reservoir

The San Justo Reservoir is a CVP facility in San Benito County that provides offstream storage as part of the San Felipe Division, as described in Chapter 5, Surface Water Resources and Water Supplies. San Justo Reservoir recreation facilities have been closed to the public since 2009 due to an infestation by the zebra mussel. Previously, the recreation facilities were managed by San Benito County Water District (SBCWD 2014).

15.3.3.3 Bethany Reservoir

Bethany Reservoir is a SWP facility located between the California Aqueduct and South Bay Aqueduct in Alameda County, as described in Chapter 5, Surface Water Resources and Water Supplies. The recreation facilities are part of the Bethany Reservoir State Recreation Area and are managed by State Parks. When the water storage in the reservoir is at full capacity (water elevation at 243 feet msl), Bethany Reservoir has 161 acres of surface area and 6 miles of shoreline (DWR 2001). Water-related activities include boating, windsurfing, picnicking, and fishing. There is one boat launch at the reservoir (State Parks 2013a). Fishing opportunities include Striped Bass, Smallmouth Bass, Largemouth Bass, Spotted Bass, White Bass, catfish, crappie, and trout.

15.3.3.4 Lake Del Valle

Lake Del Valle is a SWP facility located along the South Bay Aqueduct in Alameda County, as described in Chapter 5, Surface Water Resources and Water Supplies. The recreation facilities are managed by East Bay Regional Park District as part of the Del Valle Regional Park. When the water storage in the reservoir is at full capacity (water elevation at 703 feet msl), Lake Del Valle has 708 acres of surface area and 16 miles of shoreline (DWR 2001). Water-related activities include boating, windsurfing, camping, swimming, and fishing (DWR 2001). There is a boat launch at the lake (EBRPD 2014). Boating hazards can occur along the variable shoreline when the surface water elevation declines to 678 feet msl. There are seven group campsites for up to 475 and a family campground (DWR 2001; EBRPD 2014). Fishing opportunities include trout, catfish, Largemouth Bass, and Smallmouth Bass, Striped Bass, and Panfish (EBRPD 2014).

15.3.3.5 Los Vaqueros Reservoir

Los Vaqueros Reservoir is a Contra Costa Water District offstream storage facility in Contra Costa County, as described in Chapter 5, Surface Water Resources and Water Supplies. Recreation facilities are managed by Contra Costa Water District. Water-related activities include boating using rented electrical boats, and fishing (CCWD 2014). The Los Vaqueros recreation facilities include a marina, four fishing piers, 55 miles of trails, several individual and group picnic areas, and an interpretative center. Fishing opportunities include Rainbow Trout, Brown Bullhead, White Catfish, Channel Catfish, sunfish, White Crappie, Largemouth Bass, Striped Bass, Chinook Salmon, Kokanee Salmon, Green Sunfish, and Sacramento Perch (EBRPD 2014).

15.3.3.6 San Pablo Reservoir, Lafayette Reservoir, Lake Chabot, and East Bay Municipal Utility District Trails

The East Bay Municipal Utility District reservoirs in Alameda and Contra Costa County are used to store water within and near the East Bay Municipal Utility District service area. Water stored in these reservoirs includes water from local watersheds, the Mokelumne River watershed, and CVP water supplies, as described in Chapter 5, Surface Water Resources and Water Supplies. Recreation is allowed within the waters of San Pablo and Lafayette reservoirs and Lake

Chabot (EBMUD 2011). Recreation is not allowed within the waters of Upper San Leandro and Briones reservoir. East Bay Municipal Utility District maintains trails within the watersheds of the reservoirs.

Recreation facilities at San Pablo Reservoir are managed by East Bay Municipal Utility District. Water-related activities at San Pablo Reservoir include boating, picnicking, and fishing (EBMUD 2014a). There is a boat launch at the reservoir. There are individual sites and nine group picnic areas that can accommodate up to 100 people at each site. Hiking can occur in the San Pablo Reservoir watershed on 8.7 miles of trails which connect to about 13 miles of trails in the Briones Reservoir watershed (EBMUD 2007a). The surface water of the reservoirs can be viewed from many locations along these trails. Fishing opportunities at San Pablo Reservoir include Rainbow Trout, catfish, Black Bass, Bluegill, and crappie (EBMUD 2014a).

Recreation facilities at Lafayette Reservoir are managed by East Bay Municipal Utility District. Water-related activities at Lafayette Reservoir include boating, picnicking, and fishing (EBMUD 2014b). There is a private car-top boat launch at the reservoir. There are 125 picnic sites around the reservoir. Hiking can occur in the Lafayette Reservoir watershed on 7.4 miles of trails. Fishing opportunities at Lafayette Reservoir include Rainbow Trout, catfish, Black Bass, and sunfish.

There are no water-related activities within or adjacent to Upper San Leandro Reservoir. However, East Bay Municipal Utility District maintains over 26 miles of trails within the Upper San Leandro Reservoir watershed. The surface water of the reservoirs can be viewed from many locations along these trails (EBMUD 2007b).

Recreation facilities at Lake Chabot are managed by East Bay Regional Park District as part of the Lake Chabot Regional Park (EBRPD 2011). Water-related activities at Lake Chabot include boating, camping, picnicking, and fishing. There is a boat launch at the reservoir and boat rides are offered on the *Chabot Queen*. Individual campsites and group campsites are located near the southern portion of the park. Picnic sites are located near the Lake Chabot Marina. Hiking can occur along the shoreline on over 9 miles of trails which connect to more than 17 miles of other trails in the watershed (EBRPD 2011, 2013d). Other recreational activities, including equestrian trails and a marksmanship range, are located in the upper Lake Chabot watershed. Fishing opportunities at Lake Chabot include Rainbow Trout, catfish, Black Bass, crappie, Bluegill, and carp.

15.3.4 Central Coast Region

The Central Coast Region includes portions of San Luis Obispo and Santa Barbara counties served by the SWP. The SWP water supplies generally are conveyed to Central Coast municipal, industrial, and agricultural water users in pipelines and closed reservoirs. Water is delivered to southern Santa Barbara County communities through Cachuma Lake. Therefore, in the Central Coast Region, the only recreational opportunities that may be affected by changes in SWP operations would be Cachuma Lake in Santa Barbara County (CCWA 2014).

15.3.4.1 Cachuma Lake

Cachuma Lake is a facility owned and operated by Reclamation in Santa Barbara County, as described in Chapter 5, Surface Water Resources and Water Supplies. Recreation facilities are managed by Santa Barbara County Parks Department. Water-related activities include boating, and fishing within the lake and along the lake shoreline (Reclamation 2010c). Cachuma Lake recreation facilities include a marina with 87 rental boats and a public boat launch, 94 private boat slips, 520 campsites, equestrian campsites, family center, amphitheater, and trails that range from 0.25 to 9 miles in length. Fishing opportunities include trout, catfish, crappie, bass, Redear Perch, and Bluegill.

15.3.5 Southern California Region

The Southern California Region includes portions of Ventura, Los Angeles, Orange, San Diego, Riverside, and San Bernardino counties served by the SWP. The SWP water supplies generally are conveyed to Southern California municipal, industrial, and agricultural water users in canals and pipelines. There are six SWP reservoirs along the main canal, West Branch, and East Branch of the California Aqueduct and many other reservoirs owned and operated by regional and local agencies. The Metropolitan Water District of Southern California's Diamond Valley Lake and Lake Skinner primarily store water from the SWP. Other reservoirs that store SWP water, include United Water Conservation District's Lake Piru; City of Escondido's Dixon Lake; City of San Diego's San Vicente, El Capitan, Lower Otay, Hodges, and Murray reservoirs; Helix Water District's Lake Jennings; and Sweetwater Authority's Sweetwater Reservoir.

This section does not include reservoirs that do not provide recreational opportunities, such as Vail Lake in Riverside County or Olivenhain Reservoir in San Diego County, or reservoirs that do not store SWP water supplies, such as Lake Mathews in Riverside County which is used to store Colorado River water (RCWD 2011; SDCWA 2015; Riverside County 2000).

15.3.5.1 Quail Lake

Quail Lake is a SWP facility in Los Angeles County, as described in Chapter 5, Surface Water Resources and Water Supplies. Recreation facilities are managed by DWR (DWR 2014a). Water-related activities include fishing within the lake and along the shoreline. Fishing opportunities include Channel Catfish, Striped Bass, Blackfish, Tule Perch, Threadfin Shad, and Hitch.

15.3.5.2 Pyramid Lake

Pyramid Lake is a SWP facility located in Los Angeles County and upstream of Castaic Lake on the West Branch of the California Aqueduct, as described in Chapter 5, Surface Water Resources and Water Supplies. Recreation facilities are managed by the U.S. Forest Service (DWR 2000, 2014b). Water-related activities include boating, camping, water skiing, swimming, and fishing. Boat launch facilities are available at Vaqueros Beach and Emigrant Landing. A marina and picnic sites are available at Emigrant Landing. Four picnic and viewing sites are accessible only by boat. Family and group camping are available at two sites.

Fishing opportunities include largemouth, smallmouth, and Striped Bass; catfish, blue gill; crappie; and trout. Reservoir elevations can vary substantially on a daily basis because the lake provides short-term storage for the downstream Castaic Powerplant.

15.3.5.3 Castaic Lake

Castaic Lake is a SWP facility located in Los Angeles County at the terminal end of the West Branch of the California Aqueduct, as described in Chapter 5, Surface Water Resources and Water Supplies. Recreation facilities are managed by the Los Angeles County Department of Parks (DWR 2007b). Water-related activities include boating, water skiing, jet skiing, wakeboarding, camping, picnicking, swimming at the lagoon/afterbay, and fishing. Fishing opportunities include trout, Largemouth Bass, Striped Bass, catfish, and crappie (DWR 2014c).

15.3.5.4 Silverwood Lake

Silverwood Lake is a SWP facility located in San Bernardino County along the East Branch of the California Aqueduct, as described in Chapter 5, Surface Water Resources and Water Supplies. Recreation facilities are managed by State Parks as part of the Silverwood Lake State Recreational Area (State Parks 2006b). Water-related activities include boating, water skiing, camping, picnicking, swimming, and fishing. Facilities available for boating include a boat ramp, marina, and waterskiing area. Camping facilities include 136 family sites, seven walk-in sites, and several group sites for up to 120 people. The park includes two swimming beaches and 13 miles of trails. Fishing opportunities include Largemouth Bass, Striped Bass, Bluegill, crappie, and catfish.

15.3.5.5 Crafton Hills Reservoir

Crafton Hills Reservoir is a SWP facility located in the City of Yucaipa within San Bernardino County, as described in Chapter 5, Surface Water Resources and Water Supplies. Recreation facilities are managed by DWR (DWR 2009). Recreation activities in vicinity of the reservoir are associated with hiking trails in the open space within the Crafton Hills watershed. The surface water of the reservoirs can be viewed from many locations along these trails.

15.3.5.6 Lake Perris

Lake Perris is a SWP facility located in Riverside County at the terminal end of the East Branch of the California Aqueduct, as described in Chapter 5, Surface Water Resources and Water Supplies. Recreation facilities are managed by State Parks as part of the Lake Perris State Recreational Area (State Parks 2013b; DWR 2010). Water-related activities include boating, camping, swimming, picnicking, and fishing. Boating facilities include a marina and three boat launch ramps. Other recreational facilities include two swimming beaches, family campground, seven equestrian camp sites, boat-in picnic sites on Alessandro Island, and the Ya’i Hek’i Regional Indian Museum. Fishing opportunities include Largemouth Bass, catfish, crappie, carp, Bluegill, and Redear Sunfish.

15.3.5.7 Diamond Valley Lake

Diamond Valley Lake is an offstream storage facility located in Riverside County owned and operated by Metropolitan Water District of Southern California, as described in Chapter 5, Surface Water Resources and Water Supplies (MWD 2013). The lake is used to store SWP water. Water-related activities include boating, and fishing. Boating facilities include a marina with boat rentals. Other recreational facilities include a visitor center, Western Science Center, and the Valley-Wide Recreation and Park District Regional Aquatic Center and Community Park. Fishing opportunities include Black Bass, Bluegill, redear sunfish, Rainbow Trout, blue catfish, and Channel Catfish (DVM 2014).

15.3.5.8 Lake Skinner

Lake Skinner is an offstream storage facility located in Riverside County owned and operated by Metropolitan Water District of Southern California, as described in Chapter 5, Surface Water Resources and Water Supplies. Recreation facilities are managed by Riverside County Parks (Riverside County 2014). The lake is used to store SWP water. Water-related activities include boating, camping, and fishing. Other recreational facilities include an amphitheater and Splash Pad. Fishing opportunities include Striped Bass, Largemouth Bass, Bluegill, Rainbow Trout, catfish, and carp.

15.3.5.9 Lake Piru

Lake Piru is located on Piru Creek, a tributary of the Santa Clara River, in Ventura County (UWCD 2014). The lake is owned and operated by United Water Conservation District, as described in Chapter 5, Surface Water Resources and Water Supplies. Lake Piru is located within Los Padres National Forest (PMC 2014). The lake is used to store SWP water.

Recreation facilities are managed by a private concessionaire for the district (UWCD 2014; PMC 2014). Water-related activities include boating, camping, and picnicking. The marina includes a boat launch and private boat slips. There are over 220 campsites, including several group campsites.

15.3.5.10 Dixon Lake

Dixon Lake is located in the hills above the City of Escondido in San Diego County (Escondido 2014a). The lake is owned and operated by the City of Escondido, as described in Chapter 5, Surface Water Resources and Water Supplies. The lake is used to store SWP water.

Recreation facilities are managed by the City of Escondido (Escondido 2014b). Water-related activities include camping, picnicking, and fishing. Boats are allowed on the lake for fishing. There are 45 campsites and 22 picnic sites (Escondido 2014 n.d.; Escondido 2014c). Fishing opportunities include trout, bass, Bluegill, carp, catfish, and crappie.

15.3.5.11 San Vicente, El Capitan, Lower Otay, Hodges, and Murray Reservoirs

San Vicente Reservoir, El Capitan, Lower Otay, Hodges, and Murray reservoirs are located in San Diego County (San Diego 2011). The reservoirs are owned and operated by the City of San Diego, as described in Chapter 5, Surface Water Resources and Water Supplies. The reservoirs are used to store SWP water.

Recreation facilities are managed by the City of San Diego (San Diego 2014a, 2015a, 2015b). Water-related activities at the reservoirs include boating, picnicking, and fishing (San Diego 2014b, 2015a, 2015b). There are 16 picnic sites at Lower Otay Reservoir. Fishing opportunities at Lower Otay Reservoir include Largemouth Bass, Bluegill, black and White Crappie, Channel Catfish, blue catfish, White Catfish, and bullhead. Recreational activities at San Vicente Reservoir are temporarily closed during construction to raise the dam (San Diego 2014c). Fishing opportunities at El Capitan Reservoir include Largemouth Bass, Bluegill, crappie, Channel Catfish, Blue Catfish, Green Sunfish, and carp (San Diego 2014d). Hodges Reservoir provides recreational opportunities including boating, boardsailing, and fishing for bass, catfish, crappie, Bluegill, Bullhead, and carp (San Diego 2015a). Murray Reservoir provides recreational opportunities for boating, floating, swimming, and fishing for Largemouth Bass, Bluegill, Channel Catfish, Black Crappie, and trout (San Diego 2015b).

15.3.5.12 Lake Jennings

Lake Jennings is located in San Diego County (HWD 2014). The lake is owned and operated by Helix Water District, as described in Chapter 5, Surface Water Resources and Water Supplies. The lake is used to store SWP water.

Recreation facilities are managed by Helix Water District (HWD 2014). Water-related activities include boating, camping, picnicking, and fishing. There are 96 campsites. There are a variety of picnic sites at Lake Jennings including: Cloister Cover, Siesta Point, Hermit Cove, and Eagle Point. Bird watchers at Lake Jennings can see Loons, Grebes, Cormorants, Herons, Swans, Geese, Eagles, Hawks, Thrushes, Warblers, and many others. Hikers at Lake Jennings have access to a variety of different trails near the lake including a 5.5 mile loop around the lake. Fishing opportunities include trout, bass, and catfish.

15.3.5.13 Sweetwater Reservoir

Sweetwater Reservoir is located in San Diego County (Sweetwater Authority 2014). The lake is owned and operated by Sweetwater Authority, as described in Chapter 5, Surface Water Resources and Water Supplies. The reservoir is used to store SWP water. Recreation facilities are managed by Sweetwater Authority. Water-related activities include fishing.

15.3.5.14 Lake Arrowhead

Lake Arrowhead is located in San Bernardino County (LACSD 2014). The lake is owned and operated by Arrowhead Lake Association. The Lake Arrowhead Community Services District stores SWP water in the lake, as described in Chapter 5, Surface Water Resources and Water Supplies. Recreation facilities are managed by the Arrowhead Lake Association. Water-related activities include boating, camping, and fishing (Lake Arrowhead 2014).

15.3.6 Recreational Fishing in San Pablo and San Francisco Bays

Recreational fishing for sturgeon, Striped Bass, steelhead, trout, and salmon in San Pablo and San Francisco bays could be affected by changes in populations that may occur due to implementation of the alternatives considered in this EIS. Of these species, the majority of recreational fishing in the San Francisco Bay Estuary is related to Striped Bass and sturgeon fishing, especially in San Pablo and Suisun bays.

Recreational fishing for White Sturgeon is limited to three sturgeons per person each year, with a daily bag limit of one fish/day and a size limitation of 40 to 60 inches (from the nose tip to fork in the tail). In addition, White Sturgeon fishing is not allowed in San Francisco Bay from March 16 through December 31. Green sturgeon fishing is not allowed. Striped bass fishing occurs throughout the year with a daily bag limit two fish/day and a minimum size limitation of 18 inches. Salmon sportfishing also occurs within the San Francisco Bay Estuary during periods specified by the National Marine Fisheries Service (NMFS).

15.3.7 Recreational Salmon Fishing along Northern California Coast

Chinook Salmon, Coho Salmon, and steelhead are generally the primary species for recreational fishing that could be affected by changes in CVP and SWP operations along the Pacific Coast of Northern California from Pigeon Point to southern Oregon (near Elk River). The Pacific Coast salmon fisheries are managed by the Pacific Fishery Management Council (PFMC) in waters between the United States/Canada border to the United States/Mexico border between 3 and 200 nautical miles offshore (PFMC 2014). The State DFW manages the salmon fisheries within 0 to 3 nautical miles offshore with regulations that are generally similar to the PFMC to the salmon fishing requirements. The PFMC analyzes the a fisheries evaluation each year; and defines the periods of time for the fishing season and minimum size fish to be caught for commercial, recreational, and tribal salmon fishing activities, as described in more detail for recreational and commercial salmon fishing in Chapter 19, Socioeconomics.

15.4 Impact Analysis

This section describes the potential mechanisms and analytical methods for change in recreation resources; results of the impact analysis; potential mitigation measures; and cumulative effects.

15.4.1 Potential Mechanisms for Change and Analytical Methods

As described in Chapter 4, Approach to Environmental Analysis, the impact analysis considers changes in recreational resources conditions related to changes in CVP and SWP operations under the alternatives as compared to the No Action Alternative and Second Basis of Comparison.

As described in Section 15.3, Affected Environment, there are a wide range of recreational opportunities at the reservoirs and along the downstream rivers. This analysis focuses on the potential changes in these recreational opportunities and not specific recreational actions. For example, this analysis focuses on changes in surface water elevations at reservoirs which could affect boating, shoreline camping and picnicking, and use of trails. The changes in reservoir elevations would occur within the historical range of elevation changes; therefore, none of the recreational opportunities would be permanently reduced or expanded. The changes that would occur within the alternatives would change the potential for enjoyable recreational opportunities based upon changes in reservoir surface water elevations and river flows.

Changes in CVP and SWP operations under the alternatives as compared to the No Action Alternative and Second Basis of Comparison could change recreational opportunities at water bodies affected by CVP and SWP operations.

15.4.1.1 Changes in Recreational Resources at Reservoirs that Store CVP and SWP Water

Reservoirs that store CVP and SWP water provide a wide diversity of recreational experiences on the water surface, at shoreline campgrounds, and along shoreline trails. By the end of September, the surface water elevations can decline from higher elevations in the spring by up to 100 feet in Shasta Lake and Lake Oroville; and over 50 feet in Trinity and Folsom lakes and New Melones and San Luis reservoirs. As the water elevations declines, boat ramps become unavailable and the water surface recedes along steep slopes from shoreline campgrounds and trails. Changes in CVP and SWP operations under the alternatives could change the surface water elevations, especially in dry and critical dry years as compared to the No Action Alternative and Second Basis of Comparison.

The CalSim II model output includes monthly reservoir elevations for CVP and SWP reservoirs in the Central Valley and Trinity Lake. The end of September reservoir elevations generally indicate low reservoir elevations. To assess changes in recreational resources, changes in reservoir elevations for the end of September were compared between alternatives and the No Action Alternative and Second Basis of Comparison. The reservoir elevations at the end of September were compared to minimum allowable boat ramp elevations as a measure of surface water accessibility.

Reservoirs in the San Francisco Bay Area, Central Coast, and Southern California regions store water from multiple water supplies including CVP and SWP water; however, these reservoirs are not included in the CalSim II model simulation. For the purposes of this EIS analysis, changes in surface water elevations in these reservoirs were assumed to be related to changes in CVP and SWP water deliveries to the areas located to the south of the Delta.

15.4.1.2 Changes in Recreational Resources along Rivers downstream of CVP and SWP Reservoirs

Changes in CVP and SWP operations under the alternatives could change the river flows in Trinity, Sacramento, Feather, American, and Stanislaus rivers in a manner that would affect recreational opportunities including boating and swimming during the spring and summer months, especially in dry and critical dry years.

Results of the CalSim II model were used to assess changes in average monthly flows that could affect recreational opportunities under the alternatives, the No Action Alternative, and the Second Basis of Comparison. This analysis is focused on the Trinity, Sacramento, Feather, American, and Stanislaus rivers. Generally, flow in rivers downstream of San Luis Reservoir and the reservoirs in the San Francisco Bay Area, Central Coast, and Southern California that store CVP and SWP water are based upon minimum instream flow requirements except in high flow events because the reservoirs are operated primarily to provide water into downstream water distribution systems.

15.4.1.3 Changes in Recreational Opportunities at Wildlife Refuges

Changes in CVP and SWP operations under the alternatives would not change water supplies to wildlife refuges that use CVP water for Level 2 water demands, as described in Chapter 5, Surface Water Resources and Water Supplies. Therefore, these changes are not analyzed in this EIS.

15.4.1.4 Effects Related to Water Transfers

Historically water transfer programs have been developed on an annual basis. The demand for water transfers is dependent upon the availability of water supplies to meet water demands. Water transfer transactions have increased over time as CVP and SWP water supply availability has decreased, especially during drier water years.

Water transfers using CVP and SWP Delta pumping plants and south of Delta canals generally occur when there is unused capacity in these facilities. These conditions generally occur during drier water year types when the flows from upstream reservoirs plus unregulated flows are adequate to meet the Sacramento Valley water demands and the CVP and SWP export allocations. In non-wet years, the CVP and SWP water allocations would be less than full contract amounts; therefore, capacity may be available in the CVP and SWP conveyance facilities to move water from other sources.

Projecting future recreational conditions related to water transfer activities is difficult because specific water transfer actions required to make the water available, convey the water, and/or use the water would change each year due to changing hydrological conditions, CVP and SWP water availability, specific local agency operations, and local cropping patterns. Reclamation recently prepared a long-term regional water transfer environmental document which evaluated potential changes in conditions related to water transfer actions (Reclamation 2014f). Results from this analysis were used to inform the impact assessment of potential effects of water transfers under the alternatives as compared to the No Action Alternative and the Second Basis of Comparison.

15.4.2 Conditions in Year 2030 without Implementation of Alternatives 1 through 5

This EIS includes two bases of comparison, as described in Chapter 3, Description of Alternatives: the No Action Alternative and the Second Basis of Comparison. Both of these bases are evaluated at 2030 conditions. Changes that would occur over the next 15 years without implementation of the alternatives are not analyzed in this EIS. However, the changes to recreational resources that are assumed to occur by 2030 under the No Action Alternative and the Second Basis of Comparison are summarized in this section. Many of the changed conditions would occur in the same manner under both the No Action Alternative and the Second Basis of Comparison.

15.4.2.1 Common Changes in Conditions under the No Action Alternative and Second Basis of Comparison

Conditions in 2030 would be different than existing conditions due to:

- Climate change and sea level rise
- General plan development throughout California, including increased water demands in portions of Sacramento Valley
- Implementation of reasonable and foreseeable water resources management projects to provide water supplies

It is anticipated that climate change would result in more short-duration high-rainfall events and less snowpack in the winter and early spring months. The reservoirs would be full more frequently by the end of April or May by 2030 than in recent historical conditions. However, as the water is released in the spring, there would be less snowpack to refill the reservoirs. This condition would reduce reservoir storage and available water supplies to downstream uses in the summer. The reduced end of September storage also would reduce the ability to release stored water to downstream regional reservoirs. These conditions would occur for all reservoirs in the California foothills and mountains, including non-CVP and SWP reservoirs.

Under the No Action Alternative and the Second Basis of Comparison, land uses in 2030 would occur in accordance with adopted general plans. Development under the general plans would could increase demand for recreational resources.

The No Action Alternative and the Second Basis of Comparison assumes completion of water resources management and environmental restoration projects that would have occurred without implementation of Alternatives 1 through 5, including regional and local recycling projects, surface water and groundwater storage projects, conveyance improvement projects, and desalination projects, as described in Chapter 3, Description of Alternatives. The No Action Alternative and the Second Basis of Comparison also assumes implementation of actions included in the 2008 USFWS Biological Opinion (BO) and 2009 NMFS

BO that would have been implemented without the BOs by 2030, as described in Chapter 3, Description of Alternatives. These projects would include several projects that would affect recreational resources, including restoration of more than 10,000 acres of intertidal and associated subtidal wetlands in Suisun Marsh and Cache Slough; and at least 17,000 to 20,000 acres of seasonal floodplain restoration in Yolo Bypass.

15.4.3 Evaluation of Alternatives

Alternatives 1 through 5 have been compared to the No Action Alternative; and the No Action Alternative and Alternatives 1 through 5 have been compared to the Second Basis of Comparison.

During review of the numerical modeling analyses used in this EIS, an error was determined in the CalSim II model assumptions related to the Stanislaus River operations for the Second Basis of Comparison, Alternative 1, and Alternative 4 model runs. Appendix 5C includes a comparison of the CalSim II model run results presented in this chapter and CalSim II model run results with the error corrected. Appendix 5C also includes a discussion of changes in the comparison of groundwater conditions for the following alternative analyses.

- No Action Alternative compared to the Second Basis of Comparison
- Alternative 1 compared to the No Action Alternative
- Alternative 3 compared to the Second Basis of Comparison
- Alternative 5 compared to the Second Basis of Comparison

15.4.3.1 No Action Alternative

The No Action Alternative is compared to the Second Basis of Comparison.

15.4.3.1.1 Trinity River Region

Potential Changes in Recreational Resources at Reservoirs that Store CVP and SWP Water

Changes in CVP water supplies and operations under the No Action Alternative as compared to the Second Basis of Comparison would result in similar end of September reservoir elevations (changes within 5 percent) and related recreational resources at Trinity Lake in all water year types, as described in Chapter 5, Surface Water Resources and Water Supplies.

There are several boat ramps at Trinity Lake that provide access at different elevations. Boat ramps at Stuart Fork and Bowerman are not useable when the water elevation is less than 2,323 feet which occurs approximately 80 percent of the time under the No Action Alternative and Second Basis of Comparison. Boat ramps at Clark Springs, Fairview, and Trinity Center are not useable when the water elevation is lower than 2,300 feet which occurs approximately 62 percent of the time under the No Action Alternative and Second Basis of Comparison. The Minersville boat ramp is accessible until the elevation declines below 2,170 feet which occurs approximately 5 percent of the time under the No Action Alternative and Second Basis of Comparison.

Potential Changes in Recreational Resources along Rivers Downstream of the CVP and SWP Reservoirs

The following changes would occur on the Trinity River under the No Action Alternative as compared to the Second Basis of Comparison, as summarized in Chapter 5, Surface Water Resources and Water Supplies.

- Over long-term conditions, flows would be similar in March through November; and reduced in December through February (up to 9.5 percent).
- In wet years, flows would be similar in April through November; and reduced in December through March (up to 11.2 percent).
- In dry years, flows would be similar in all months.

Flows in Trinity River would be similar during the recreation season (spring and summer months); therefore, recreational opportunities would be similar.

15.4.3.1.2 Central Valley Region

Potential Changes in Recreational Resources at Reservoirs that Store CVP and SWP Water

Changes in CVP water supplies and operations under the No Action Alternative as compared to the Second Basis of Comparison would result in similar end of September reservoir elevations and related recreational resources at Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir in all water year types; and at San Luis Reservoir in above normal, below normal, and dry years, as described in Chapter 5, Surface Water Resources and Water Supplies. Changes in recreational resources at San Luis Reservoir would be reduced in wet year and critical dry years because the end of September surface water elevations would be reduced by 6.2 percent in wet and critical dry years.

There are several boat ramps at each of the reservoirs that provide access at different elevations. At Shasta Lake, boat ramps at Antlers, Hirz Bay, Packers Bay, Sugar Loaf, and Centimundi and Jones Valley are not accessible approximately 55, 35, 20, 10, and 9 percent of the time, respectively, under the No Action Alternative; and approximately 55, 30, 15, 10, and 7 percent of the time, respectively, under the Second Basis of Comparison.

At Lake Oroville, boat ramps at Enterprise, Vinton Gulch, and Nelson Bar; Foreman Creek; Dark Canyon and Loafer Creek; and Bidwell Canyon, Lime Saddle, and Spillway are not accessible approximately 95, 87, 73, and 35 percent of the time, respectively, under the No Action Alternative; and approximately 85, 75, 62, and 25 percent of the time, respectively, under the Second Basis of Comparison.

At Folsom Lake, boat ramps at Rattlesnake Bar, Beal’s Point; Peninsula, Brown’s Ravine, and Folsom Point; Hobie Cove; and Granite Bay are not accessible approximately 80, 65, 40, 10, and 7 percent of the time, respectively, under the No Action Alternative; and approximately 65, 40, 10, and 7 percent of the time, respectively, under the Second Basis of Comparison.

At New Melones Reservoir, the boat ramp at Angels Creek, Parrott's Ferry, Glory Hole, and Mark Twain are not accessible approximately 65, 25, 18, and 5 percent of the time, respectively, under the No Action Alternative; and approximately 30, 25, 15, 5 percent of the time, respectively, under the Second Basis of Comparison.

At San Luis Reservoir, the boat ramps at Dinosaur Point and Basalt Area are not useable approximately 50 and 10 percent of the time, respectively, under the No Action Alternative; and approximately 20 and 5 percent of the time, respectively, under the Second Basis of Comparison.

At all reservoirs, boating opportunities would be decreased, and shoreline recreational opportunities would be similar or decreased under the No Action Alternative as compared to the Second Basis of Comparison.

Potential Changes in Recreational Resources along Rivers Downstream of the CVP and SWP Reservoirs

The recreational opportunities along the Sacramento, Feather, American, and Stanislaus rivers would be affected by the following changes in river flows, as described in Chapter 5.

- Sacramento River downstream of Keswick Dam
  - Over long-term conditions, similar flows would occur in October, February through May, July, and August; increased flows in September and November (up to 37.7 percent); and reduced flows in December, January, and June (up to 7.8 percent).
  - In wet years, similar flows would occur in January through July; increased flows in September through November (up to 77.7 percent); and reduced flows in December and August (up to 14.6 percent).
  - In dry years, similar flows would occur in July through October, December through March, and May; increased flows in November (33.4 percent).
- Sacramento River at Freeport
  - Over long-term conditions, similar flows would occur in October, December through May, and August; increased flows in September, November, and July (up to 43.3 percent); and reduced flows in June (11.4 percent).
  - In wet years, similar flows would occur in January through June and October; increased flows in July through September and November (up to 90.3 percent); and reduced flows in December (10.7 percent).
  - In dry years, similar flows would occur in August through October and December through April; increased flows in November and July (up to 15.8 percent); and reduced flows in May and June (up to 11.9 percent).

- Feather River downstream of the Thermalito Complex
  - Over long-term conditions, similar flows would occur in November and April; increased flows in July through September (up to 76.1 percent); and reduced flows in October, December through March, May, and June (up to 27.2 percent).
  - In wet years, similar flows would occur in October through November and March through May; increased flows in July through September (up to 184 percent) and reduced flows in December through February (up to 26.0 percent).
  - In dry years, similar flows would occur in November through March; increased flows in April and July (up to 52.4 percent); and reduced flows in August through October and May and June (up to 27.6 percent).
- American River downstream of Nimbus Dam
  - Over long-term conditions, similar flows would occur in November through May and July; increased flows in September and October (up to 44.7 percent); and reduced flows in June and August (up to 6.1 percent).
  - In wet years, similar flows would occur in October through November and January through July; increased flows in September (91.1 percent) and reduced flows in December and August (up to 10.7 percent).
  - In dry years, similar flows would occur in all months except October, February and July; increased flows in October (16.5 percent); and reduced flows in February and July (up to 7.3 percent).
- Stanislaus River downstream of Goodwin Dam
  - Over long-term conditions, similar flows would occur in May and July through September; increased flows in October, March, and April (up to 148.7 percent); and reduced flows in November through February and June (up to 33.8 percent).
  - In wet years, similar flows would occur in February and April; increased flows in October, March, May, July, and August (up to 117.1 percent); and reduced flows in September, November through January, and June (up to 50.8 percent).
  - In dry years, similar flows would occur in July through September; increased flows in October and April (up to 154.3 percent); and reduced flows in November through March, May, and June (up to 35.7 percent).

During the spring and summer months, the changes in flow conditions between the No Action Alternative and the Second Basis of Comparison vary on a monthly basis in the Sacramento, Feather, American, and Stanislaus rivers within a water year type. For example, flows in the Sacramento River at Freeport would increase in several months under the No Action Alternative as compared to the Second Basis of Comparison by up to 90 percent, and decrease in several months up to 11 percent. The overall range of flows is within the historical operational range; therefore, recreational opportunities still exist. However, the value of the recreational opportunities would be both improved and reduced depending upon the timing of the changes.

Overall, under the No Action Alternative and the Second Basis of Comparison, recreational opportunities would be reduced on the Sacramento River downstream of Keswick Dam; and both improved and reduced on the Sacramento River near Freeport, Feather River downstream of Thermalito Complex, American River downstream of Nimbus Dam, and the Stanislaus River downstream of Goodwin Dam depending upon the month.

Effects Related to Cross Delta Water Transfers

Potential effects to recreational resources could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c). Potential effects to recreational resources were identified as changes in reservoir surface water elevations, streams, and the Delta. The analysis indicated that these potential impacts would not be substantial because the conditions with and without the water transfers would be similar.

Under the No Action Alternative, the timing of cross Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Under the Second Basis of Comparison, water could be transferred throughout the year without an annual volumetric limit. Overall, the potential for cross Delta water transfers would be less under the No Action Alternative than under the Second Basis of Comparison.

15.4.3.1.3 San Francisco Bay Area, Central Coast, and Southern California Region

Potential Changes in Recreational Resources at Reservoirs that Store CVP and SWP Water

Changes in recreational resources at reservoirs that store CVP and SWP water supplies are assumed to be related to changes in water deliveries over long-term conditions for this EIS analysis. Monthly deliveries are not necessarily indicative of reservoir storage because all or a portion of the water deliveries could be directly conveyed to water users in any specific month. Therefore, annual deliveries are considered to be relatively proportional to the amount of water that could be stored over all water year types. In the San Francisco Bay Area Region, values for the CVP municipal and industrial water deliveries and the SWP south of the Delta water deliveries (without Article 21 deliveries) were considered; and SWP south of the Delta water deliveries (without Article 21 deliveries) were considered for the Central Coast and Southern California regions. Under the No Action Alternative as compared to the Second Basis of Comparison CVP water deliveries would be reduced by 10 percent and SWP water deliveries would be reduced by 18 percent. Therefore, for this EIS analysis, it is assumed that recreational resources related to surface water elevations in reservoirs that store CVP and SWP water supplies would be reduced by 10 to 18 percent in the

San Francisco Bay Area Region and 18 percent in the Central Coast and Southern California regions.

15.4.3.2 Alternative 1

Alternative 1 is identical to the Second Basis of Comparison. As described in Chapter 4, Approach to Environmental Analysis, Alternative 1 is compared to the No Action Alternative and the Second Basis of Comparison. However, because recreational resource conditions under Alternative 1 are identical to recreational resource conditions under the Second Basis of Comparison; Alternative 1 is only compared to the No Action Alternative.

15.4.3.2.1 Alternative 1 Compared to the No Action Alternative

Trinity River Region

Potential Changes in Recreational Resources at Reservoirs that Store CVP and SWP Water

Changes in CVP water supplies and operations under Alternative 1 as compared to the No Action Alternative would result in similar end of September reservoir elevations and related recreational resources at Trinity Lake in all water year types, as described in Chapter 5, Surface Water Resources and Water Supplies.

There are several boat ramps at Trinity Lake that provide access at different elevations. Boat ramps at Stuart Fork and Bowerman are not useable when the water elevation is less than 2,323 feet which occurs approximately 80 percent of the time under Alternative 1 and the No Action Alternative. Boat ramps at Clark Springs, Fairview, and Trinity Center are not useable when the water elevation is lower than 2,300 feet which occurs approximately 62 percent of the time under Alternative 1 and the No Action Alternative. The Minersville boat ramp is accessible until the elevation declines below 2,170 feet which occurs approximately 5 percent of the time under Alternative 1 and the No Action Alternative.

The potential for reduced recreational resources at Trinity Lake related to shoreline activities would be less under the No Action Alternative as compared to the Second Basis of Comparison.

Potential Changes in Recreational Resources along Rivers Downstream of the CVP and SWP Reservoirs

The following changes would occur on the Trinity River under Alternative 1 as compared to the No Action Alternative, as summarized in Chapter 5, Surface Water Resources and Water Supplies.

- Over long-term conditions, flows would be similar in March through November; and increased in December through February (up to 10.5 percent).
- In wet years, flows would be similar in April through November; and increased in December through March (up to 12.6 percent).
- In dry years, flows would be similar all months.

Flows in Trinity River would be similar during the recreation season (spring and summer months); therefore, recreational opportunities would be similar.

Central Valley Region

Potential Changes in Recreational Resources at Reservoirs that Store CVP and SWP Water

Changes in CVP water supplies and operations under Alternative 1 as compared to the No Action Alternative would result in similar end of September reservoir elevations and related recreational resources at Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir in all water year types; and at San Luis Reservoir in above normal, below normal, and dry years, as described in Chapter 5, Surface Water Resources and Water Supplies. Changes in recreational resources at San Luis Reservoir would be reduced in wet year and critical dry years because the end of September surface water elevations would be increased by 6.6 percent in wet and critical dry years.

There are several boat ramps at each of the reservoirs that provide access at different elevations. At Shasta Lake, boat ramps at Antlers, Hirz Bay, Packers Bay, Sugar Loaf, and Centimundi and Jones Valley are not accessible approximately 55, 30, 15, 10, and 7 percent of the time, respectively, under Alternative 1; and approximately 55, 35, 20, 10, and 9 percent of the time, respectively, under the No Action Alternative.

At Lake Oroville, boat ramps at Enterprise, Vinton Gulch, and Nelson Bar; Foreman Creek; Dark Canyon and Loafer Creek; and Bidwell Canyon, Lime Saddle, and Spillway are not accessible approximately 85, 75, 62, and 25 percent of the time, respectively, under Alternative 1; and approximately 95, 87, 73, and 35 percent of the time, respectively, under the No Action Alternative.

At Folsom Lake, boat ramps at Rattlesnake Bar, Beal’s Point; Peninsula, Brown’s Ravine, and Folsom Point; Hobie Cove; and Granite Bay are not accessible approximately 65, 40, 10, and 7 percent of the time, respectively, under Alternative 1; and approximately 80, 65, 40, 10, and 7 percent of the time, respectively, under the No Action Alternative.

At New Melones Reservoir, the boat ramp at Angels Creek, Parrott’s Ferry, Glory Hole, and Mark Twain are not accessible approximately 30, 25, 15, 5 percent of the time, respectively, under Alternative 1 as compared to approximately 65, 25, 18, and 5 percent of the time, respectively, under the No Action Alternative.

At San Luis Reservoir, the boat ramps at Dinosaur Point and Basalt Area are not useable approximately 20 and 5 percent of the time, respectively, under Alternative 1; and approximately 50 and 10 percent of the time, respectively, under the No Action Alternative.

At all reservoirs, boating opportunities would be increased, and shoreline recreational opportunities would be similar or increased under Alternative 1 as compared to the No Action Alternative.

Potential Changes in Recreational Resources along Rivers Downstream of the CVP and SWP Reservoirs

The recreational opportunities along the Sacramento, Feather, American, and Stanislaus rivers would be affected by the following changes in river flows, as described in Chapter 5.

- Sacramento River downstream of Keswick Dam
  - Over long-term conditions, similar flows would occur in October, February through May, July, and August; reduced flows in September and November (up to 27.4 percent); and increased flows in December, January, and June (up to 8.4 percent).
  - In wet years, similar flows would occur in January through July; reduced flows in September through November (up to 43.7 percent); and increased flows in December and August (up to 17.0 percent).
  - In dry years, similar flows would occur in July through October, December through March, and May; reduced flows in November (25.0 percent); and increased flows in April and June (up to 7.8 percent).
- Sacramento River at Freeport
  - Over long-term conditions, similar flows would occur in October, December through May, and August; reduced flows in September, November, and July (up to 30.2 percent); and increased flows in June (12.8 percent).
  - In wet years, similar flows would occur in January through June and October; reduced flows in July through September and November (up to 47.4 percent); and increased flows in December (6.6 percent).
  - In dry years, similar flows would occur in August through October and December through April; reduced flows in November and July (up to 13.6 percent); and increased flows in May and June (up to 13.5 percent).
- Feather River downstream of the Thermalito Complex
  - Over long-term conditions, similar flows would occur in November and April; reduced flows in July through September (up to 43.2 percent); and increased flows in October, December through March, May, and June (up to 37.4 percent).
  - In wet years, similar flows would occur in October, November, and March through May; reduced flows in July through September (up to 64.9 percent); and increased flows in December through February and June (up to 35.1 percent).
  - In dry years, similar flows would occur in December through April; reduced flows in July (34.4 percent); and increased flows in August through October, May, and June (up to 38.1 percent).

- American River downstream of Nimbus Dam
  - Over long-term conditions, similar flows would occur in November through May and July; reduced flows in September and October (up to 30.9 percent); and increased flows in June (5.4 percent).
  - In wet years, similar flows would occur in October, November, and January through July; reduced flows in September (47.7 percent); and increased flows in August (12.0 percent).
  - In dry years, similar flows would occur in November through January, March through June, August, and September; reduced flows in October (14.1 percent); and increased flows in February and July (up to 7.9 percent).
- Stanislaus River downstream of Goodwin Dam
  - Over long-term conditions, similar flows would occur in July through September; reduced flows in October, March, and April (up to 59.8 percent); and increased flows in November through February and June (up to 51.1 percent).
  - In wet years, similar flows would occur in February and April; reduced flows in October, March, May, July, and August (up to 53.9 percent); and increased flows in September, November through January, and June (up to 103.2 percent).
  - In dry years, similar flows would occur in July through September; reduced flows in October and April (up to 60.7 percent); and increased flows in November through March, May, and June (up to 55.5 percent).

During the spring and summer months, the changes in flow conditions between Alternative 1 as compared to the No Action Alternative vary on a monthly basis in the Sacramento, Feather, American, and Stanislaus rivers within a water year type. For example, flows in the Sacramento River at Freeport would increase in several months under Alternative 1 as compared to the No Action Alternative by up to 17 percent, and decrease in several months up to 44 percent. The overall range of flows is within the historical operational range; therefore, recreational opportunities still exist. However, the value of the recreational opportunities would be both improved and reduced depending upon the timing of the changes.

Overall, under Alternative 1 as compared to the No Action Alternative, recreational opportunities would be improved on the Sacramento River downstream of Keswick Dam; and both improved and reduced on the Sacramento River near Freeport, Feather River downstream of Thermalito Complex, American River downstream of Nimbus Dam, and the Stanislaus River downstream of Goodwin Dam depending upon the month.

Effects Related to Cross Delta Water Transfers

Potential effects to recreational resources could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions would occur during implementation of cross Delta water transfers under Alternative 1 and the No Action Alternative, and that impacts on recreational resources would not be substantial in the seller's service area due to implementation requirements of the transfer programs.

Under Alternative 1, water could be transferred throughout the year without an annual volumetric limit. Under the No Action Alternative, the timing of cross Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Overall, the potential for cross Delta water transfers would be increased under Alternative 1 as compared to the No Action Alternative.

San Francisco Bay Area, Central Coast, and Southern California Regions

Potential Changes in Recreational Resources at Reservoirs that Store CVP and SWP Water

Changes in recreational resources at reservoirs that store CVP and SWP water supplies are assumed to be related to changes in water deliveries over long-term conditions for this EIS analysis, as described above under the No Action Alternative as compared to the Second Basis of Comparison. Therefore, under Alternative 1 as compared to the No Action Alternative, recreational resources related to surface water elevations in reservoirs that store CVP and SWP water supplies would be increased by 11 to 21 percent in the San Francisco Bay Area Region and 21 percent in the Central Coast and Southern California regions.

15.4.3.2.2 Alternative 1 Compared to the Second Basis of Comparison

Alternative 1 is identical to the Second Basis of Comparison.

15.4.3.3 Alternative 2

The CVP and SWP operations under Alternative 2 are identical to the CVP and SWP operations under the No Action Alternative; therefore, Alternative 2 is only compared to the Second Basis of Comparison.

15.4.3.3.1 Alternative 2 Compared to the Second Basis of Comparison

The CVP and SWP operations under Alternative 2 are identical to the CVP and SWP operations under the No Action Alternative. Therefore, changes to recreational resources conditions under Alternatives 2 as compared to the Second Basis of Comparison would be the same as the impacts described in Section 15.4.3.1, No Action Alternative.

15.4.3.4 Alternative 3

As described in Chapter 3, Description of Alternatives, CVP and SWP operations under Alternative 3 are similar to the Second Basis of Comparison with modified Old and Middle River flow criteria and New Melones Reservoir operations; and additional predation control actions to reduce the populations of striped bass. As described in Chapter 4, Approach to Environmental Analysis, Alternative 3 is compared to the No Action Alternative and the Second Basis of Comparison.

15.4.3.4.1 Alternative 3 Compared to the No Action Alternative

Trinity River Region

Potential Changes in Recreational Resources at Reservoirs that Store CVP and SWP Water

Changes in CVP water supplies and operations under Alternative 3 as compared to the No Action Alternative would result in similar end of September reservoir elevations and related recreational resources at Trinity Lake in all water year types, as described in Chapter 5, Surface Water Resources and Water Supplies.

There are several boat ramps at Trinity Lake that provide access at different elevations. Boat ramps at Stuart Fork and Bowerman are not useable when the water elevation is less than 2,323 feet which occurs approximately 80 percent of the time under Alternative 3 and the No Action Alternative. Boat ramps at Clark Springs, Fairview, and Trinity Center are not useable when the water elevation is lower than 2,300 feet which occurs approximately 62 percent of the time under Alternative 3 and the No Action Alternative. The Minersville boat ramp is accessible until the elevation declines below 2,170 feet which occurs approximately 5 percent of the time under Alternative 3 and the No Action Alternative.

Potential Changes in Recreational Resources along Rivers Downstream of the CVP and SWP Reservoirs

The following changes would occur on the Trinity River under Alternative 3 as compared to the No Action Alternative, as summarized in Chapter 5, Surface Water Resources and Water Supplies.

- Over long-term conditions, flows would be similar in March through November; and increased in December through February (up to 11.8 percent).
- In wet years, flows would be similar in April through October; reduced in November (7.0 percent); and increased in December through March (up to 15.1 percent).
- In dry years, flows would be similar in all months.

Flows in Trinity River would be similar during the recreation season (spring and summer months); therefore, recreational opportunities would be similar.

Central Valley Region

Potential Changes in Recreational Resources at Reservoirs that Store CVP and SWP Water

Changes in CVP water supplies and operations under Alternative 3 as compared to the No Action Alternative would result in similar end of September reservoir elevations and related recreational resources at Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir in all water year types; and at San Luis Reservoir in below normal, dry, and critical dry years, as described in Chapter 5, Surface Water Resources and Water Supplies. Changes in recreational resources at San Luis Reservoir would be reduced in wet year and critical dry years because the end of September surface water elevations would be increased by 7.9 percent in wet years and 5.7 percent in above normal years.

There are several boat ramps at each of the reservoirs that provide access at different elevations. At Shasta Lake, boat ramps at Antlers, Hirz Bay, Packers Bay, Sugar Loaf, and Centimundi and Jones Valley are not accessible approximately 55, 30, 15, 10, and 7 percent of the time, respectively, under Alternative 3; and approximately 55, 35, 20, 10, and 9 percent of the time, respectively, under the No Action Alternative.

At Lake Oroville, boat ramps at Enterprise, Vinton Gulch, and Nelson Bar; Foreman Creek; Dark Canyon and Loafer Creek; and Bidwell Canyon, Lime Saddle, and Spillway are not accessible approximately 85, 75, 62, and 25 percent of the time, respectively, under Alternative 3; and approximately 95, 87, 73, and 35 percent of the time, respectively, under the No Action Alternative.

At Folsom Lake, boat ramps at Rattlesnake Bar, Beal's Point; Peninsula, Brown's Ravine, and Folsom Point; Hobie Cove; and Granite Bay are not accessible approximately 65, 40, 10, and 7 percent of the time, respectively, under Alternative 3; and approximately 80, 65, 40, 10, and 7 percent of the time, respectively, under the No Action Alternative.

At New Melones Reservoir, the boat ramp at Angels Creek, Parrott's Ferry, Glory Hole, and Mark Twain are not accessible approximately 22, 18, 10, and 5 percent of the time, respectively, under Alternative 3 as compared to approximately 65, 25, 18, and 5 percent of the time, respectively, under the No Action Alternative.

At San Luis Reservoir, the boat ramps at Dinosaur Point and Basalt Area are not useable approximately 28 and 8 percent of the time, respectively, under Alternative 3; and approximately 50 and 10 percent of the time, respectively, under the No Action Alternative.

At Lake Oroville, Folsom Lake, New Melones Reservoir, and San Luis Reservoir, boating opportunities would be increased, and opportunities would be similar at Shasta Lake under Alternative 3 as compared to the No Action Alternative. At Shasta Lake, Lake Oroville, and New Melones Reservoir shoreline recreational opportunities would be increased, and opportunities would be similar at Folsom Lake and San Luis Reservoir under Alternative 3 as compared to the No Action Alternative.

Potential Changes in Recreational Resources along Rivers Downstream of the CVP and SWP Reservoirs

The recreational opportunities along the Sacramento, Feather, American, and Stanislaus rivers would be affected by the following changes in river flows, as described in Chapter 5.

- Sacramento River downstream of Keswick Dam
  - Over long-term conditions, similar flows would occur in October, February through May, July, and August; reduced flows in September and November (up to 20.1 percent); and increased flows in December, January, and June (up to 8.9 percent).
  - In wet years, similar flows would occur in February through August; reduced flows in September through November (up to 42.1 percent); and increased flows in December and January (up to 16.9 percent).
  - In dry years, similar flows would occur in July through September and December through May; reduced flows in November (24.6 percent); and increased flows in January and June (up to 7.3 percent).
- Sacramento River at Freeport
  - Over long-term conditions, similar flows would occur in October, December through May, July, and August; reduced flows in September and November (up to 30.1 percent); and increased flows in June (12.1 percent).
  - In wet years, similar flows would occur in January through May, July, and October; reduced flows in August, September, and November (up to 48.1 percent); and increased flows in December and June (up to 6.6 percent).
  - In dry years, similar flows would occur in July through October and December through April; reduced flows in November (14.2 percent); and increased flows in May and June (up to 15.7 percent).
- Feather River downstream of the Thermalito Complex
  - Over long-term conditions, similar flows would occur in October, November, March, April, and July; reduced flows in August and September (up to 49.4 percent); and increased flows in December through February, May, and June (up to 33.9 percent).
  - In wet years, similar flows would occur in October, November, February through May, and July; reduced flows in August and September (up to 70.0 percent) and increased flows in December, January, and June (up to 28.1 percent).
  - In dry years, similar flows would occur in September and January through April; reduced flows in October through December and July (up to 14.5 percent); and increased flows in May, June, and August (36.9 percent).
- American River downstream of Nimbus Dam
  - Over long-term conditions, similar flows would occur in November, January through May, July, and August; reduced flows in September and October (up to 28.7 percent); and increased flows in June (5.8 percent).

  - In wet years, similar flows would occur in October, November, and January through July; reduced flows in September (45.9 percent); and increased flows in August and December (up to 8.5 percent).
  - In dry years, similar flows would occur in November through January and March through September; reduced flows in October (11.2 percent); and increased flows in February (6.1 percent).
- Stanislaus River downstream of Goodwin Dam
  - Over long-term conditions, reduced flows would occur in October and March through June (up to 58.3 percent); and increased flows in November through February and July through September (up to 36.81 percent).
  - In wet years, similar flows would occur in April; reduced flows in October, March, and May (up to 52.9 percent); and increased flows in June through September and November through February (up to 67.8 percent).
  - In dry years, similar flows would occur in March and July through September; reduced flows in October and April through June (up to 59.6 percent); and increased flows in November through February (up to 37.0 percent).

During the spring and summer months, the changes in flow conditions between Alternative 3 and the No Action Alternative vary on a monthly basis in the Sacramento, Feather, American, and Stanislaus rivers within a water year type. For example, flows in the Sacramento River at Freeport would increase in several months under Alternative 3 as compared to the No Action Alternative by up to 15 percent, and decrease in several months up to 30 percent. The overall range of flows is within the historical operational range; therefore, recreational opportunities still exist. However, the value of the recreational opportunities would be both improved and reduced depending upon the timing of the changes.

Overall, under Alternative 3 as compared to the No Action Alternative, recreational opportunities would be similar or improved on the Sacramento River downstream of Keswick Dam and American River downstream of Nimbus Dam; and both improved and reduced on the Sacramento River near Freeport, Feather River downstream of Thermalito Complex, and the Stanislaus River downstream of Goodwin Dam depending upon the month.

Recreational opportunities related to Striped Bass fishing would initially be increased when Alternative 3 is implemented. However, by 2030, Striped Bass fishing opportunities would be reduced under Alternative 3 as compared to the No Action Alternative due to actions to reduce predation.

Recreational opportunities related to sport ocean salmon fishing would be reduced under Alternative 3 as compared to the No Action Alternative.

Effects Related to Cross Delta Water Transfers

Potential effects to recreational resources could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions would occur during implementation of cross Delta water transfers under Alternative 3 and the No Action Alternative, and that impacts on recreational resources would not be substantial in the seller's service area due to implementation requirements of the transfer programs.

Under Alternative 3, water could be transferred throughout the year without an annual volumetric limit. Under the No Action Alternative, the timing of cross Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Overall, the potential for cross Delta water transfers would be increased under Alternative 3 as compared to the No Action Alternative.

San Francisco Bay Area, Central Coast, and Southern California Regions

Potential Changes in Recreational Resources at Reservoirs that Store CVP and SWP Water

Changes in recreational resources at reservoirs that store CVP and SWP water supplies are assumed to be related to changes in water deliveries over long-term conditions for this EIS analysis, as described above under the No Action Alternative as compared to the Second Basis of Comparison. Therefore, under Alternative 3 as compared to the No Action Alternative, recreational resources related to surface water elevations in reservoirs that store CVP and SWP water supplies would be increased by 9 to 17 percent in the San Francisco Bay Area Region and 17 percent in the Central Coast and Southern California regions.

15.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison

Trinity River Region

Potential Changes in Recreational Resources at Reservoirs that Store CVP and SWP Water

Changes in CVP water supplies and operations under Alternative 3 as compared to the Second Basis of Comparison would result in similar end of September reservoir elevations and related recreational resources at Trinity Lake in all water year types, as described in Chapter 5, Surface Water Resources and Water Supplies.

There are several boat ramps at Trinity Lake that provide access at different elevations. Boat ramps at Stuart Fork and Bowerman are not useable when the water elevation is less than 2,323 feet which occurs approximately 80 percent of the time under Alternative 3 and the Second Basis of Comparison. Boat ramps at Clark Springs, Fairview, and Trinity Center are not useable when the water elevation is lower than 2,300 feet which occurs approximately 62 percent of the time under Alternative 3 and the Second Basis of Comparison. The Minersville boat ramp is accessible until the elevation declines below 2,170 feet which occurs approximately 5 percent of the time under Alternative 3 and the Second Basis of Comparison.

The potential for reduced recreational resources at Trinity Lake related to shoreline activities would be greater in critical dry years and similar in dry years and over the long-term average conditions under the No Action Alternative as compared to the Second Basis of Comparison.

Potential Changes in Recreational Resources along Rivers Downstream of the CVP and SWP Reservoirs

Flows in the Trinity River and recreational opportunities under Alternative 3 would be similar to the Second Basis of Comparison, as summarized in Chapter 5, Surface Water Resources and Water Supplies.

Central Valley Region

Potential Changes in Recreational Resources at Reservoirs that Store CVP and SWP Water

Changes in CVP water supplies and operations under Alternative 3 as compared to the Second Basis of Comparison would result in similar end of September reservoir elevations and related recreational resources at Shasta Lake, Lake Oroville, Folsom Lake, New Melones Reservoir, and San Luis Reservoir in all water year types, as described in Chapter 5, Surface Water Resources and Water Supplies.

There are several boat ramps at each of the reservoirs that provide access at different elevations. At Shasta Lake, boat ramps at Antlers, Hirz Bay, Packers Bay, Sugar Loaf, and Centimundi and Jones Valley are not accessible approximately 55, 30, 15, 10, and 7 percent of the time, respectively, under Alternative 3 and the Second Basis of Comparison.

At Lake Oroville, boat ramps at Enterprise, Vinton Gulch, and Nelson Bar; Foreman Creek; Dark Canyon and Loafer Creek; and Bidwell Canyon, Lime Saddle, and Spillway are not accessible approximately 85, 75, 62, and 35 percent of the time, respectively, under Alternative 3 and the Second Basis of Comparison.

At Folsom Lake, boat ramps at Rattlesnake Bar; Beal’s Point; Peninsula, Brown’s Ravine, and Folsom Point; Hobie Cove; and Granite Bay are not accessible approximately 70, 65, 40, 10, and 7 percent of the time, respectively, under Alternative 3 and the Second Basis of Comparison.

At New Melones Reservoir, the boat ramp at Angels Creek, Parrott’s Ferry, Glory Hole, and Mark Twain are not accessible approximately 22, 18, 10, and 8 percent of the time, respectively, under Alternative 3 as compared to approximately 30, 25, 15, and 3 percent of the time, respectively, under the Second Basis of Comparison.

At San Luis Reservoir, the boat ramps at Dinosaur Point and Basalt Area are not useable approximately 28 and 8 percent of the time, respectively, under

Alternative 3; and approximately 20 and 5 percent of the time, respectively, under the Second Basis of Comparison.

Boating opportunities would be increased at New Melones Reservoir, decreased at San Luis Reservoir, and similar at all other reservoirs under Alternative 3 as compared to the Second Basis of Comparison. Shoreline recreational opportunities would be increased at New Melones Reservoir, decreased at Lake Oroville, and similar at all other reservoirs under Alternative 3 as compared to the Second Basis of Comparison.

Potential Changes in Recreational Resources along Rivers Downstream of the CVP and SWP Reservoirs

The recreational opportunities along the Sacramento, Feather, American, and Stanislaus rivers would be affected by the following changes in river flows, as described in Chapter 5.

- Similar or increased flows in the Sacramento River downstream of Keswick Dam and at Freeport.
- Feather River downstream of the Thermalito Complex
  - Over long-term conditions, similar flows would occur in November and January through June; reduced flows in October, December, and September (up to 12.5 percent); and increased flows in July and August (up to 17.0 percent).
  - In wet years, similar flows would occur in November and January through May; reduced flows in October, December, and September (up to 14.6 percent); and increased flows in June through August (up to 10.9 percent).
  - In dry years, similar flows would occur in November and January through June; reduced flows in August through October (up to 21.2 percent); and increased flows in July (37.1 percent).
- Similar flows in American River downstream of Nimbus Dam.
- Stanislaus River downstream of Goodwin Dam
  - Over long-term conditions, similar flows would occur in October, December, January, and March; reduced flows would occur in November, May, and June (up to 52.3 percent); and increased flows in February, April, and July through September (up to 26.8 percent).
  - In wet years, similar flows would occur in October, November, January, and April; reduced flows in May and June (up to 44.8 percent); and increased flows in December, February, March, and July through September (up to 68.6 percent).
  - In dry years, similar flows would occur in July through October; reduced flows in November through March and May through June (up to 36.0 percent); and increased flows in April (40.2 percent).

During the spring and summer months, the changes in flow conditions between Alternative 3 and the Second Basis of Comparison vary on a monthly basis in the Sacramento, Feather, American, and Stanislaus rivers within a water year type. For example, flows in the Stanislaus River downstream of Goodwin Dam would increase in several months under Alternative 3 as compared to the Second Basis of Comparison by up to 90 percent, and decrease in several months up to 11 percent. The overall range of flows is within the historical operational range; therefore, recreational opportunities still exist.

Overall, under Alternative 3 as compared to the Second Basis of Comparison, recreational opportunities would be similar or improved on the Sacramento, Feather, and American rivers; and both improved and reduced on the Stanislaus River depending upon the month.

Recreational opportunities related to Striped Bass fishing would initially be increased when Alternative 3 is implemented. However, by 2030, Striped Bass fishing opportunities would be reduced under Alternative 3 as compared to the Second Basis of Comparison due to actions to reduce predation.

Recreational opportunities related to sport ocean salmon fishing would be reduced under Alternative 3 as compared to the Second Basis of Comparison.

Effects Related to Cross Delta Water Transfers

Potential effects to recreational resources could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions would occur during implementation of cross Delta water transfers under Alternative 3 and the Second Basis of Comparison, and that impacts on recreational resources would not be substantial in the seller's service area due to implementation requirements of the transfer programs.

Under Alternative 3 and the Second Basis of Comparison, water could be transferred throughout the year without an annual volumetric limit. Overall, the potential for cross Delta water transfers would be similar under Alternative 3 and the Second Basis of Comparison.

San Francisco Bay Area, Central Coast, and Southern California Regions

Potential Changes in Recreational Resources at Reservoirs that Store CVP and SWP Water

Changes in recreational resources at reservoirs that store CVP and SWP water supplies are assumed to be related to changes in water deliveries over long-term conditions for this EIS analysis, as described above under the No Action Alternative as compared to the Second Basis of Comparison. Therefore, under Alternative 3 as compared to the Second Basis of Comparison, recreational resources related to surface water elevations in reservoirs that store CVP and SWP water supplies would be similar (changes within 5 percent).

15.4.3.5 Alternative 4

The recreational resources under Alternative 4 would be similar to the conditions under the Second Basis of Comparison with additional predation control actions to reduce the populations of striped bass.

15.4.3.5.1 Alternative 4 Compared to the No Action Alternative

The CVP and SWP operations under Alternative 4 are identical to the CVP and SWP operations under the Second Basis of Comparison and Alternative 1. However, Alternative 4 includes predation controls as compared to the Second Basis. Therefore, reservoir and flow-related changes in recreational resources under Alternative 4 as compared to the No Action Alternative would be the same as the impacts described in Section 15.4.3.2.1, Alternative 1 Compared to the No Action Alternative.

Recreational opportunities related to Striped Bass fishing would initially be increased when Alternative 4 is implemented. However, by 2030, Striped Bass fishing opportunities would be reduced under Alternative 4 as compared to the No Action Alternative due to actions to reduce predation.

Recreational opportunities related to sport ocean salmon fishing would be reduced under Alternative 4 as compared to the No Action Alternative.

15.4.3.5.2 Alternative 4 Compared to the Second Basis of Comparison

The CVP and SWP operations under Alternative 4 are identical to the CVP and SWP operations under the Second Basis of Comparison and Alternative 1. However, Alternative 4 includes predation controls as compared to the Second Basis of Comparison. Therefore, flow-related changes in recreational resources under Alternative 4 are the same as recreational resources under the Second Basis of Comparison.

Recreational opportunities related to Striped Bass fishing would initially be increased when Alternative 4 is implemented. However, by 2030, Striped Bass fishing opportunities would be reduced under Alternative 4 as compared to the Second Basis of Comparison due to actions to reduce predation.

Recreational opportunities related to sport ocean salmon fishing would be reduced under Alternative 4 as compared to the Second Basis of Comparison.

15.4.3.6 Alternative 5

As described in Chapter 3, Description of Alternatives, CVP and SWP operations under Alternative 5 are similar to the No Action Alternative with modified Old and Middle River flow criteria and New Melones Reservoir operations. As described in Chapter 4, Approach to Environmental Analysis, Alternative 5 is compared to the No Action Alternative and the Second Basis of Comparison.

15.4.3.6.1 Alternative 5 Compared to the No Action Alternative

Trinity River Region

Potential Changes in Recreational Resources at Reservoirs that Store CVP and SWP Water

Changes in CVP water supplies and operations under Alternative 5 as compared to the No Action Alternative would result in similar end of September reservoir elevations and related recreational resources at Trinity Lake in all water year types, as described in Chapter 5, Surface Water Resources and Water Supplies.

There are several boat ramps at Trinity Lake that provide access at different elevations. Boat ramps at Stuart Fork and Bowerman are not useable when the water elevation is less than 2,323 feet which occurs approximately 80 percent of the time under Alternative 5 and the No Action Alternative. Boat ramps at Clark Springs, Fairview, and Trinity Center are not useable when the water elevation is lower than 2,300 feet which occurs approximately 62 percent of the time under Alternative 5 and the No Action Alternative. The Minersville boat ramp is accessible until the elevation declines below 2,170 feet which occurs approximately 8 percent of the time under Alternative 5 and 5 percent of the time under the No Action Alternative.

The potential for reduced recreational resources at Trinity Lake related to shoreline activities would be slightly less in critical dry years and similar over the long-term average conditions and dry years under Alternative 5 as compared to the No Action Alternative.

Potential Changes in Recreational Resources along Rivers Downstream of the CVP and SWP Reservoirs

Flows in the Trinity River and recreational opportunities under Alternative 5 would be similar to the No Action Alternative, as summarized in Chapter 5, Surface Water Resources and Water Supplies.

Central Valley Region

Potential Changes in Recreational Resources at Reservoirs that Store CVP and SWP Water

Changes in CVP water supplies and operations under Alternative 5 as compared to the No Action Alternative would result in similar end of September reservoir elevations and related recreational resources at Shasta Lake, Lake Oroville, Folsom Lake, New Melones Reservoir, and San Luis Reservoir in all water year types, as described in Chapter 5, Surface Water Resources and Water Supplies.

There are several boat ramps at each of the reservoirs that provide access at different elevations. At Shasta Lake, boat ramps at Antlers, Hirz Bay, Packers Bay, Sugar Loaf, and Centimundi and Jones Valley are not accessible approximately 55, 35, 20, 10, and 9 percent of the time, respectively, under Alternative 5 and the No Action Alternative.

At Lake Oroville, boat ramps at Enterprise, Vinton Gulch, and Nelson Bar; Foreman Creek; Dark Canyon and Loafer Creek; and Bidwell Canyon, Lime Saddle, and Spillway are not accessible approximately 95, 87, 73, and 35 percent of the time, respectively, under Alternative 5 and the Second Basis of Comparison.

At Folsom Lake, boat ramps at Rattlesnake Bar, Beal's Point; Peninsula, Brown's Ravine, and Folsom Point; Hobie Cove; and Granite Bay are not accessible approximately 80, 65, 40, 10, and 7 percent of the time, respectively, under Alternative 5 and the No Action Alternative.

At New Melones Reservoir, the boat ramp at Angels Creek, Parrott's Ferry, Glory Hole, and Mark Twain are not accessible approximately 35, 30, 22, and 8 percent of the time, respectively, under Alternative 5 as compared to approximately 65, 25, 18, and 5 percent of the time, respectively, under the No Action Alternative.

At San Luis Reservoir, the boat ramps at Dinosaur Point and Basalt Area are not useable approximately 50 and 10 percent of the time, respectively, under Alternative 5 and the No Action Alternative.

Increased shoreline recreational opportunities at New Melones Reservoir in long-term average conditions and dry years, decreased opportunities at New Melones Reservoir in critical dry years, and similar opportunities at all times analyzed at all other reservoirs under Alternative 5 as compared to the No Action Alternative. Increased boating opportunities at New Melones Reservoir and similar opportunities at all other reservoirs under Alternative 5 as compared to the No Action Alternative.

Potential Changes in Recreational Resources along Rivers downstream of the CVP and SWP Reservoirs

The recreational opportunities along the Sacramento, Feather, American, and Stanislaus rivers would be affected by the following changes in river flows, as described in Chapter 5.

- Flows in the Sacramento River downstream of Keswick Dam and near Freeport would be similar.
- Feather River downstream of the Thermalito Complex
  - Over long-term conditions, similar flows would occur in June through April; and reduced flows in May (6.6 percent).
  - In wet years, similar flows would occur in all months.
  - In dry years, similar flows would occur in September through April and June; reduced flows in May (27.1 percent); and increased flows in July and August (up to 8.9 percent).
- Flows in the American River downstream of Nimbus Dam would be similar.
- Stanislaus River downstream of Goodwin Dam
  - Over long-term conditions, flows would be similar in September through February and June; reduced flows would occur in March, July, and August

(up to 8.0 percent); and increased flows in April and May (up to 22.4 percent).

- In wet years, similar flows would occur in October, November, January, February, and April through June; reduced flows in December, March, and July through September (up to 18.0 percent).
- In dry years, similar flows would occur in June through March; and increased flows in April and May (up to 47.3 percent).

During the spring and summer months, the changes in flow conditions between Alternative 5 and the No Action Alternative vary on a monthly basis in the Sacramento, Feather, American, and Stanislaus rivers within a water year type. For example, flows in the Feather River downstream of Thermalito Complex would increase in several months under Alternative 5 and the No Action Alternative by up to 9 percent, and decrease in several months up to 27 percent. The overall range of flows is within the historical operational range; therefore, recreational opportunities still exist. However, the value of the recreational opportunities would be both improved and reduced depending upon the timing of the changes.

Overall, under Alternative 5 and the No Action Alternative, recreational opportunities would be similar or improved on the Sacramento and American rivers; and both improved and reduced on the Feather and Stanislaus rivers.

Effects Related to Cross Delta Water Transfers

Potential effects to recreational resources could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions would occur during implementation of cross Delta water transfers under Alternative 5 and the No Action Alternative, and that impacts on recreational resources would not be substantial in the seller's service area due to implementation requirements of the transfer programs.

Under Alternative 5 and the No Action Alternative, the timing of cross Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Overall, the potential for cross Delta water transfers would be similar under Alternative 5 and the No Action Alternative.

San Francisco Bay Area, Central Coast, and Southern California Region

Potential Changes in Recreational Resources at Reservoirs that Store CVP and SWP Water

Changes in recreational resources at reservoirs that store CVP and SWP water supplies are assumed to be related to changes in water deliveries over long-term conditions for this EIS analysis, as described above under the No Action Alternative as compared to the Second Basis of Comparison. Therefore, under

Alternative 5 as compared to the No Action Alternative, recreational resources would be similar.

15.4.3.6.2 Alternative 5 Compared to the Second Basis of Comparison

Trinity River Region

Potential Changes in Recreational Resources at Reservoirs that Store CVP and SWP Water

Changes in CVP water supplies and operations under Alternative 5 as compared to the Second Basis of Comparison would result in similar end of September reservoir elevations and related recreational resources at Trinity Lake in all water year types, as described in Chapter 5, Surface Water Resources and Water Supplies.

There are several boat ramps at Trinity Lake that provide access at different elevations. Boat ramps at Stuart Fork and Bowerman are not useable when the water elevation is less than 2,323 feet which occurs approximately 80 percent of the time under Alternative 5 and the Second Basis of Comparison. Boat ramps at Clark Springs, Fairview, and Trinity Center are not useable when the water elevation is lower than 2,300 feet which occurs approximately 62 percent of the time under Alternative 5 and the Second Basis of Comparison. The Minersville boat ramp is accessible until the elevation declines below 2,170 feet which occurs approximately 8 percent of the time under Alternative 5 and 5 percent of the time under the Second Basis of Comparison.

The potential for reduced recreational resources at Trinity Lake related to shoreline activities would be similar under Alternative 5 as compared to the Second Basis of Comparison.

Potential Changes in Recreational Resources along Rivers Downstream of the CVP and SWP Reservoirs

Flows in Trinity River would be similar during the recreation season (spring and summer months); therefore, recreational opportunities would be similar under Alternative 5 as compared to the Second Basis of Comparison.

Central Valley Region

Potential Changes in Recreational Resources at Reservoirs that Store CVP and SWP Water

Changes in CVP water supplies and operations under Alternative 5 as compared to the Second Basis of Comparison would result in similar end of September reservoir elevations and related recreational resources at Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir in all water year types; and at San Luis Reservoir in wet, above normal, and below normal years, as described in Chapter 5, Surface Water Resources and Water Supplies. Changes in recreational resources at San Luis Reservoir would be reduced in dry year and critical dry years because the end of September surface water elevations would be decreased by 6.2 percent in dry years and 8.5 percent in critical dry years.

There are several boat ramps at each of the reservoirs that provide access at different elevations. At Shasta Lake, boat ramps at Antlers, Hirz Bay, Packers Bay, Sugar Loaf, and Centimundi and Jones Valley are not accessible approximately 55, 35, 20, 10, and 9 percent of the time, respectively, under Alternative 5; and approximately 55, 30, 15, 10, and 7 percent of the time, respectively, under the Second Basis of Comparison.

At Lake Oroville, boat ramps at Enterprise, Vinton Gulch, and Nelson Bar; Foreman Creek; Dark Canyon and Loafer Creek; and Bidwell Canyon, Lime Saddle, and Spillway are not accessible approximately 95, 87, 73, and 35 percent of the time, respectively, under Alternative 5; and approximately 85, 75, 62, and 25 percent of the time, respectively, under the Second Basis of Comparison.

At Folsom Lake, boat ramps at Rattlesnake Bar are not accessible 80 percent of the time under Alternative 5, and 70 percent of the time, respectively, under the Second Basis of Comparison. Boat ramps at Beal's Point; Peninsula, Brown's Ravine, and Folsom Point; Hobie Cove; and Granite Bay are not accessible approximately 65, 40, 10, and 7 percent of the time, respectively, under Alternative 5 and the Second Basis of Comparison.

At New Melones Reservoir, the boat ramp at Angels Creek, Parrott's Ferry, Glory Hole, and Mark Twain are not accessible approximately 35, 30, 22, and 8 percent of the time, respectively, under Alternative 5 as compared to approximately 30, 25, 15, and 5 percent of the time, respectively, under the Second Basis of Comparison.

At San Luis Reservoir, the boat ramps at Dinosaur Point and Basalt Area are not useable approximately 50 and 10 percent of the time, respectively, under Alternative 5; and approximately 20 and 5 percent of the time, respectively, under the Second Basis of Comparison.

Decreased shoreline recreational opportunities at Shasta Lake, Lake Oroville, and New Melones Reservoir, and similar opportunities at all other reservoirs under Alternative 5 as compared to the Second Basis of Comparison. Decreased boating opportunities at Lake Oroville, New Melones Reservoir, and San Luis Reservoir and similar opportunities at all other reservoirs under Alternative 5 as compared to the Second Basis of Comparison.

Potential Changes in Recreational Resources along Rivers Downstream of the CVP and SWP Reservoirs

The recreational opportunities along the Sacramento, Feather, American, and Stanislaus rivers would be affected by the following changes in river flows, as described in Chapter 5.

- Sacramento River downstream of Keswick Dam
  - Over long-term conditions, flows would be similar in July, August, October, and February through April; reduced in December, January, May and June (up to 8.2 percent); and increased in September and November (up to 38.5 percent).

  - In wet years, flows would be similar in January through July; reduced in December and August (up to 15.0 percent); and increased in September through November (up to 77.3 percent).
  - In dry years, similar flows would occur in July through October and December through March; reduced in April through June (up to 10.1 percent); and increased flows in November (32.1 percent).
- Sacramento River at Freeport
  - Over long-term conditions, flows would be similar in October and December through April; reduced in May and June (up to 11.5 percent); and increased in July through September and November (43.4 percent).
  - In wet years, flows would be similar in October and January through June; reduced in December (6.2 percent); and increased in July through September and November (up to 89.0 percent).
  - In dry years, similar flows would occur in August through October and December through April; reduced in May and June (up to 13.6 percent); and increased flows in July and November (up to 19.3 percent).
- Feather River downstream of the Thermalito Complex
  - Over long-term conditions, similar flows would occur in November and April; reduced flows in October, December through March, May, and June (up to 27.7 percent); and increased flows in July through September (up to 76.2 percent).
  - In wet years, similar flows would occur in October, November, March through May; reduced flows in December through February and June (up to 25.6 percent); and increased flows in July through September (up to 181.9 percent).
  - In dry years, similar flows would occur in November through April; reduced flows in October, May, June, August, and September (up to 45.4 percent); and increased flows in July (60.4 percent).
- American River downstream of Nimbus Dam
  - Over long-term conditions, similar flows would occur in November through July; reduced flows in August (5.8 percent); and increased in September and October (42.4 percent).
  - In wet years, similar flows would occur in October, November, and January through July; reduced flows in December and August (up to 13.7 percent); and increased flows in September (88.2 percent).
  - In dry years, similar flows would occur in November through September; and increased flows in October (16.7 percent).
- Stanislaus River downstream of Goodwin Dam
  - Over long-term conditions, similar flows would occur in August; reduced flows would occur in November through February, June, July, August, and

September (up to 35.8 percent); and increased flows in October and March through May (up to 144.8 percent).

- In wet years, similar flows would occur in February and April; reduced flows in November through January and June through September (up to 52.8 percent); and increased flows in October and March (up to 113.1 percent).
- In dry years, similar flows would occur in July through September; reduced flows in November through March and June (up to 35.7 percent); and increased flows in October, April, and May (150.1 percent).

During the spring and summer months, the changes in flow conditions between Alternative 5 and the Second Basis of Comparison vary on a monthly basis in the Sacramento, Feather, American, and Stanislaus rivers within a water year type. For example, flows in the Sacramento River at Freeport would increase in several months under Alternative 5 as compared to the Second Basis of Comparison by up to 89 percent, and decrease in several months up to 13 percent. The overall range of flows is within the historical operational range; therefore, recreational opportunities still exist. However, the value of the recreational opportunities would be both improved and reduced depending upon the timing of the changes.

Overall, under Alternative 5 as compared to the Second Basis of Comparison, recreational opportunities would be similar or improved on the Sacramento River downstream of Keswick Dam and American River downstream of Nimbus Dam; and both improved and reduced on the Sacramento River near Freeport, Feather River downstream of Thermalito Complex, and the Stanislaus River downstream of Goodwin Dam depending upon the month.

Effects Related to Cross Delta Water Transfers

Potential effects to recreational resources could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions would occur during implementation of cross Delta water transfers under Alternative 5 and the Second Basis of Comparison, and that impacts on recreational resources would not be substantial in the seller's service area due to implementation requirements of the transfer programs.

Under Alternative 5, the timing of cross Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Under the Second Basis of Comparison, water could be transferred throughout the year without an annual volumetric limit. Overall, the potential for cross Delta water transfers would be reduced under Alternative 5 as compared to the Second Basis of Comparison.

San Francisco Bay Area, Central Coast, and Southern California Regions

Potential Changes in Recreational Resources at Reservoirs that Store CVP and SWP Water

Changes in recreational resources at reservoirs that store CVP and SWP water supplies are assumed to be related to changes in water deliveries over long-term conditions for this EIS analysis, as described above under the No Action Alternative as compared to the Second Basis of Comparison. Therefore, under Alternative 5 as compared to the Second Basis of Comparison, recreational resources related to surface water elevations in reservoirs that store CVP and SWP water supplies would be reduced by 10 to 18 percent in the San Francisco Bay Area Region and 18 percent in the Central Coast and Southern California regions.

15.4.3.7 Summary of Impact Assessment

The results of the impact assessment of implementation of Alternatives 1 through 5 as compared to the No Action Alternative and the Second Basis of Comparison are presented in Tables 15.28 and 15.29.

Table 15.28 Comparison of Alternatives 1 through 5 to No Action Alternative

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	Recreational resources would be similar at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir in all water year types; and at San Luis Reservoir in above normal, below normal, and dry years. Recreational resources would be increased by 6 percent in wet and critical dry years at San Luis Reservoir, by 11 to 21 percent in the San Francisco Bay Area Region, and by 21 percent in the Central Coast and Southern California regions. Recreational opportunities would be similar or improved on Trinity River, Sacramento River downstream of Keswick Dam, and American River downstream of Nimbus Dam. On the Sacramento River near Freeport, Feather River downstream of Thermalito Complex, and the Stanislaus River downstream of Goodwin Dam recreational opportunities would be similar or improved in most spring and summer months; and reduced in July in all years and August in wetter years.	No mitigation measures identified at this time to reduce flow reduction impacts on recreation opportunities.
Alternative 2	No effects on recreational resources.	None needed

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 3	Recreational resources would be similar at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir in all water year types; and at San Luis Reservoir in above normal, below normal, and dry years. Recreational resources would be increased by 8 percent in wet years and 6 percent in above normal years at San Luis Reservoir, by 9 to 17 percent in the San Francisco Bay Area Region, and by 17 percent in the Central Coast and Southern California regions. Recreational opportunities would be similar or improved on Trinity River, Sacramento River downstream of Keswick Dam, and American River downstream of Nimbus Dam. On the Sacramento River near Freeport and Feather River downstream of Thermalito Complex, recreational opportunities would be similar or improved in most spring and summer months; and reduced in August in all years on both rivers and in July on the Feather River in dry years. On the Stanislaus River downstream of Goodwin Dam recreational opportunities would be similar or improved in summer months; and reduced in May and June in all water year types. Recreational opportunities related to Striped Bass fishing and sport ocean salmon fishing would be reduced.	No mitigation measures identified at this time to reduce flow reduction impacts on recreation opportunities. No mitigation measures identified at this time to reduce impacts to reduction in Striped Bass and sport ocean salmon fishing opportunities.
Alternative 4	Reservoir and flow-related recreational opportunities would be as described for Alternative 1 compared to the No Action Alternative. Recreational opportunities related to Striped Bass fishing and sport ocean salmon fishing would be reduced.	No mitigation measures identified at this time to reduce flow reduction impacts on recreation opportunities. No mitigation measures identified at this time to reduce impacts to reduction in Striped Bass and sport ocean salmon fishing opportunities.
Alternative 5	Recreational resources would be similar at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, San Luis Reservoir, and other reservoirs that store CVP and SWP water in the San Francisco Bay Area, Central Coast, and Southern California regions. Recreational opportunities would be similar or improved on Trinity River, Sacramento River downstream of Keswick Dam and near Freeport, and American River downstream of Nimbus Dam. On the Feather River downstream of Thermalito Complex, recreational opportunities would be similar or improved in most spring and summer months; and reduced in May in all years. On the Stanislaus River downstream of Goodwin Dam recreational opportunities would be similar or improved in spring months; and reduced in July and August in most water year types.	No mitigation measures identified at this time to reduce flow reduction impacts on recreation opportunities.

Note: Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools, incremental differences of 5 percent or less between alternatives and the No Action Alternative are considered to be "similar."

Table 15.29 Comparison of No Action Alternative and Alternatives 1 through 5 to Second Basis of Comparison

Alternative	Potential Change	Consideration for Mitigation Measures
No Action Alternative	Recreational resources would be similar at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir in all water year types; and at San Luis Reservoir in above normal, below normal, and dry years. Recreational resources would be reduced by 6 percent in wet and critical dry years at San Luis Reservoir, by 10 to 18 percent in the San Francisco Bay Area Region, and by 18 percent in the Central Coast and Southern California regions. Recreational opportunities would be similar or improved on Trinity River. On the Sacramento River downstream of Keswick Dam and near Freeport, Feather River downstream of Thermalito Complex, American River downstream of Nimbus Dam, and the Stanislaus River downstream of Goodwin Dam recreational opportunities would be similar or improved in most spring and summer months; and reduced in June in most years, August in some years on the Feather and American rivers, and in May in some years on Sacramento River near Freeport and on the Feather River.	Not considered for this comparison.
Alternative 1	No effects on recreational resources.	Not considered for this comparison.
Alternative 2	Same effects as described for No Action Alternative as compared to the Second Basis of Comparison.	Not considered for this comparison.
Alternative 3	Recreational resources would be similar at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, San Luis Reservoir, and other reservoirs that store CVP and SWP water in the San Francisco Bay Area, Central Coast, and Southern California regions. Recreational opportunities would be similar or improved on Trinity River, Sacramento River downstream of Keswick Dam and near Freeport, and American River downstream of Nimbus Dam. On the Feather River downstream of Thermalito Complex, recreational opportunities would be similar or improved in most spring and summer months; and reduced in August in dry years. On the Stanislaus River downstream of Goodwin Dam recreational opportunities would be similar or improved in summer months; and reduced in May and June in all water year types. Recreational opportunities related to Striped Bass fishing and sport ocean salmon fishing would be reduced.	Not considered for this comparison.
Alternative 4	Reservoir and flow-related recreational opportunities would be similar. Recreational opportunities related to Striped Bass fishing and sport ocean salmon fishing would be reduced.	Not considered for this comparison.

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 5	Recreational resources would be similar at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir in all water year types; and at San Luis Reservoir in above normal, below normal, and dry years. Recreational resources would be reduced by 6 percent in dry years and 9 percent in critical dry years at San Luis Reservoir, by 10 to 18 percent in the San Francisco Bay Area Region, and by 18 percent in the Central Coast and Southern California regions. Recreational opportunities would be similar or improved on Trinity River. On the Sacramento River downstream of Keswick Dam and near Freeport, Feather River downstream of Thermalito Complex, American River downstream of Nimbus Dam, and the Stanislaus River downstream of Goodwin Dam recreational opportunities would be similar or improved in many spring and summer months. Flows would reduce in May and June in most years on the Sacramento and Feather rivers; in August on the American River; and in June through August on the Stanislaus River.	Not considered for this comparison.

Note: Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools, incremental differences of 5 percent or less between alternatives and the No Action Alternative are considered to be “similar.”

15.4.3.8 Potential Mitigation Measures

Mitigation measures are not included in this EIS to address adverse impacts under the alternatives as compared to the Second Basis of Comparison because this analysis was included in this EIS for information purposes only.

Changes in CVP and SWP operations under Alternatives 1 through 5 as compared to the No Action Alternative would not result in adverse changes in recreational resources at reservoirs. However, implementation of Alternatives 1, 3, 4, and 5 would result in adverse changes in recreational opportunities along rivers downstream of CVP and SWP reservoirs. Implementation of Alternatives 3 and 4 would result in adverse changes in recreational Striped Bass and sport ocean salmon fishing opportunities. Mitigation measures have not been identified at this time.

15.4.3.9 Cumulative Effects Analysis

As described in Chapter 3, the cumulative effects analysis considers projects, programs, and policies that are not speculative; and are based upon known or reasonably foreseeable long-range plans, regulations, operating agreements, or other information that establishes them as reasonably foreseeable.

The cumulative effects analysis for Alternatives 1 through 5 for Recreational Opportunities are summarized in Table 15.30.

Table 15.30 Summary of Cumulative Effects on Recreational Opportunities with Implementation of Alternatives 1 through 5 as Compared to the No Action Alternative

Scenarios	Actions	Cumulative Effects of Actions
Past & Present, and Future Actions Included and in the No Action Alternative and in All Alternatives in Year 2030	Consistent with Affected Environment conditions plus: Actions in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives), including climate change and sea level rise Actions not included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives): - Implementation of Federal and state policies and programs, including Clean Water Act (e.g., Total Maximum Daily Loads); Safe Drinking Water Act; Clean Air Act; and flood management programs - General plans for 2030. - Trinity River Restoration Program. - Central Valley Project Improvement Act programs - Folsom Dam Water Control Manual Update - FERC Relicensing for the Middle Fork of the American River Project - San Joaquin River Restoration Program - Contra Loma Recreation Resource Management Plan - San Luis Reservoir State Recreation Area Resource Management Plan/General Plan	<u>These effects would be the same under all alternatives.</u> Climate change and sea level rise and development under the general plans are anticipated to reduce carryover storage in reservoirs and changes in stream flow patterns in a manner that would change recreational opportunities, and could reduce the opportunities for sport ocean salmon fishing. Other actions, including restoration projects, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to improve recreational opportunities.
Future Actions Considered as Cumulative Effects Actions in All Alternatives in Year 2030	Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives): - Bay-Delta Water Quality Control Plan Update - FERC Relicensing Projects - Bay Delta Conservation Plan (including the California WaterFix alternative) - Shasta Lake Water Resources, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations - El Dorado Water and Power Authority Supplemental Water Rights Project - Semitropic Water Storage District Delta Wetlands - North Bay Aqueduct Alternative Intake - Irrigated Lands Regulatory Program	<u>These effects would be the same under all alternatives.</u> Some of the future reasonably foreseeable actions to improve water quality and FERC Relicensing projects would improve recreational opportunities. Other future reasonably foreseeable actions, such as expanded or new reservoirs would improve recreational opportunities.
No Action Alternative with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO	Implementation of No Action Alternative with future reasonably foreseeable actions would result in changes stream flows would result in changes to related recreational opportunities as compared to historical conditions prior to the BOs.

Scenarios	Actions	Cumulative Effects of Actions
Alternative 1 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternative 1 with future reasonably foreseeable actions would result in reduced stream flows and related recreational opportunities along the Sacramento River near Freeport, Feather River downstream of Thermalito Complex, American River downstream of Nimbus Dam, and the Stanislaus River downstream of Goodwin Dam in July in all years and August in wetter years compared to the No Action Alternative with the added actions.
Alternative 2 with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions No implementation of structural improvements or other actions that require further study to develop a more detailed action description.	Implementation of Alternative 2 with future reasonably foreseeable actions for recreational opportunities would be the same as for the No Action Alternative with the added actions.
Alternative 3 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant) Slight increase in positive Old and Middle River flows in the winter and spring months Increased bag limits for Striped Bass and Pikeminnow Increased sport ocean salmon fishing harvest limitations	Implementation of Alternative 3 with future reasonably foreseeable actions would result in reduced stream flows and related recreational opportunities along the Sacramento River near Freeport, Feather River downstream of Thermalito Complex would be reduced in August in all years on both rivers and in July on the Feather River in dry years. On the Stanislaus River downstream of Goodwin Dam recreational opportunities would be reduced in May and June in all water year types compared to the No Action Alternative with the added actions. Recreational opportunities related to Striped Bass fishing would initially be increased; however by 2030 recreational fishing related to Striped Bass would be reduced. Recreational opportunities related to sport ocean salmon fishing would be reduced.
Alternative 4 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant) Increased bag limits for Striped Bass and Pikeminnow Increased sport ocean salmon fishing harvest limitations	Implementation of Alternative 4 with future reasonably foreseeable actions would result in reduced stream flows and related recreational opportunities along the Sacramento River near Freeport, Feather River downstream of Thermalito Complex, American River downstream of Nimbus Dam, and the Stanislaus River downstream of Goodwin Dam in July in all years and August in wetter years compared to the No Action Alternative with the added actions. Recreational opportunities related to Striped Bass fishing would initially be increased; however by 2030 recreational fishing related to Striped Bass would be reduced. Recreational opportunities related to sport ocean salmon fishing would be reduced.

Scenarios	Actions	Cumulative Effects of Actions
Alternative 5 with Associated Cumulative Effects Actions in Year 20530	Full implementation of the 2008 USFWS BO and 2009 NMFS BO Positive Old and Middle River flows and increased Delta outflow in spring months	Implementation of Alternative 5 with future reasonably foreseeable actions would result in reduced stream flows and related recreational opportunities along the Feather River downstream of Thermalito Complex would be reduced in May in all years compared to the No Action Alternative with the added actions. On the Stanislaus River downstream of Goodwin Dam recreational opportunities would be reduced in July and August in most water year types compared to the No Action Alternative with the added actions.

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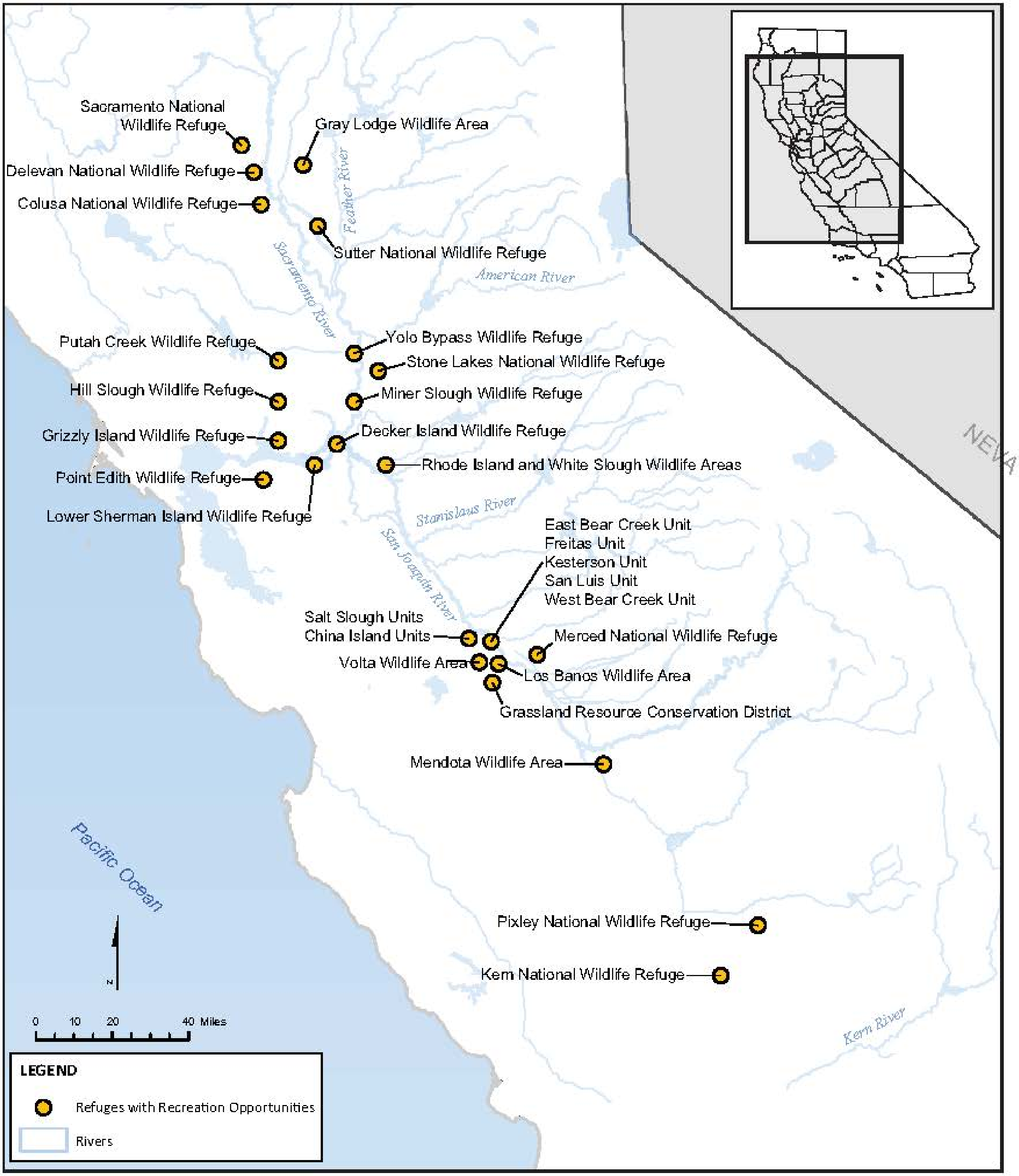

Figure 15.1 Wildlife Refuges Identified to Receive Central Valley Project Water Supplies

Chapter 16

Air Quality and Greenhouse Gas Emissions

16.1 Introduction

This chapter describes existing and future air quality conditions and the potential for greenhouse gas emissions that could occur as a result of implementing the alternatives that could change the long-term operation of the Central Valley Project (CVP) and State Water Project (SWP) as evaluated in this Environmental Impact Statement (EIS). Implementation of the alternatives could affect CVP and SWP water deliveries which could indirectly affect air quality.

16.2 Terminology

Important air quality and greenhouse gas emission terminology used in this chapter are defined by the U.S. Environmental Protection Agency (USEPA) and the California Air Resources Board (ARB), as summarized below.

- **Attainment Area:** A geographic area considered to have air quality as good as or better than the national and/or state ambient air quality standards. An area may be an attainment area for one pollutant and a non-attainment area for others (USEPA 2006).
- **California Ambient Air Quality Standard (CAAQS):** A legal limit that specifies the maximum level and time of exposure in the outdoor air for a given air pollutant and which is protective of human health and public welfare (California Health and Safety Code section 39606b). CAAQS are recommended by the California Office of Environmental Health Hazard Assessment and adopted into regulation by the ARB. CAAQS are the standards which must be met per the requirements of the California Clean Air Act (ARB 2010).
- **Criteria Pollutant:** An air pollutant for which acceptable levels of exposure can be determined and for which an ambient air quality standard has been set (ARB 2010). The criteria pollutants are ozone (O_3), carbon monoxide (CO), nitrogen oxides (NO_x), sulfur dioxide (SO_2), particulate matter less than 10 microns in aerodynamic diameter (PM_{10}), particulate matter less than 2.5 microns in aerodynamic diameter ($PM_{2.5}$), and lead (Pb).
- **Greenhouse Gases (GHGs):** Atmospheric gases (such as carbon dioxide (CO_2), methane (CH_4), hydrofluorocarbons (HFC), nitrous oxide (N_2O), O_3, perfluorocarbons (PFC), sulfur hexafluoride (SF_6), and water vapor) that slow the passage of re-radiated heat through the Earth's atmosphere (ARB 2010).

Six of the GHGs are the subject of reductions under the Kyoto Protocol and California Assembly Bill 32 are CO_2, CH_4, N_2O, HFC, PFC, and SF_6.

- **National Ambient Air Quality Standard (NAAQS):** Standards established by USEPA that apply for outdoor air throughout the United States (USEPA 2006).
- **Nonattainment Area:** A geographic area identified by the USEPA and/or ARB as not meeting either NAAQS or CAAQS for a given pollutant (ARB 2010).
- **Precursor:** In photochemistry, a compound antecedent to a pollutant. For example, volatile organic compounds (VOC) and NO_x react in sunlight to form the criteria pollutant ozone. As such, VOCs and NO_x are precursors to O_3 (USEPA 2006).
- **Reactive Organic Gas (ROG):** A photochemically reactive chemical gas composed of non-methane hydrocarbons (HCs) that may contribute to the formation of smog (ARB 2010). ROG may also be referred to as non-methane organic gases, VOCs, or HCs.
- **State Implementation Plan (SIP):** A plan prepared by states and submitted to USEPA describing how each area will attain and maintain NAAQS. SIPs include the technical foundation for understanding the air quality (e.g., emission inventories and air quality monitoring), control measures and strategies, and enforcement mechanisms (ARB 2010).
- **Toxic Air Contaminant (TAC):** An air pollutant, identified in regulation by the ARB, which may cause or contribute to an increase in deaths or in serious illness, or which may pose a present or potential hazard to human health. Health effects of TACs may occur at extremely low levels and it is typically difficult to identify levels of exposure that do not produce adverse health effects (ARB 2010).

In California, local air districts have been established to oversee the attainment of air quality standards within air basins as defined by the State. Local air districts administer air quality laws and regulations within the air basins. The local air districts have permitting authority over all stationary sources of air pollutants within their district boundaries and provide the primary review of environmental documents prepared for projects with air quality issues.

16.3 Regulatory Environment and Compliance Requirements

Potential actions that could be implemented under the alternatives evaluated in this EIS could affect future air quality conditions and the potential for GHG emissions. Implementation of the alternatives could affect CVP and SWP water deliveries which could affect air quality related to agricultural operations and fugitive dust generation. Changes in air quality and GHG emissions are analyzed in this EIS relative to appropriate Federal and state agency policies and regulations, as described in Chapter 4, Approach to Environmental Analyses.

Several of the Federal and state laws and regulations that provide quantitative criteria to determine compliance also are summarized in this subsection of this chapter to provide context for information provided in the remaining sections of this chapter, including:

- Federal Clean Air Act
  - National Ambient Air Quality Standards and Federal Air Quality Designations
  - Federal General Conformity Requirements
- California Clean Air Act
- California Assembly Bill 32, California Global Warming Solutions Act of 2006

16.3.1 Federal Clean Air Act

National air quality policies are regulated through the Federal Clean Air Act (FCAA) of 1970 and its 1977 and 1990 amendments. Basic elements of the FCCA include NAAQS for criteria air pollutants, hazardous air pollutants standards, state attainment plans, motor vehicle emissions standards, stationary source emissions standards and permits, acid rain control measures, stratospheric ozone protection, and enforcement provisions.

16.3.1.1 National Ambient Air Quality Standards and Federal Air Quality Designations

Pursuant to the FCAA, the USEPA established NAAQS for O_3, CO, NO_2, sulfur dioxide (SOx as SO_2), PM_{10}, $PM_{2.5}$, and lead. These pollutants are referred to as criteria pollutants because numerical health-based criteria have been established that define acceptable levels of exposure for each pollutant. The NAAQS and the CAAQS are summarized in Table 16.1 (ARB 2013).

Table 16.1 Federal and State Ambient Air Quality Standards

Pollutant	Averaging Time	National Standards[a] Primary[b, i]	National Standards[a] Secondary[c, i]	California Standards[d]
Ozone	8 Hour 1 Hour	0.075 ppm –	0.075 ppm –	0.07 ppm 0.09 ppm
Carbon monoxide	8 Hour 1 Hour	9 ppm 35 ppm	– –	9.0 ppm 20 ppm
Nitrogen dioxide[j]	Annual Arithmetic Mean 1 Hour	0.053 ppm 100 ppb	0.053 ppm –	0.30 ppm 0.18 ppm
Sulfur dioxide[e]	Annual Arithmetic Mean 24 Hour 3 Hour 1 Hour	0.030 ppm 0.14 ppm – 75 ppb	– – 0.5 ppm –	– 0.04 ppm – 0.25 ppm
PM_{10} [f]	Annual Arithmetic Mean 24 Hour	– 150 $\mu g/m^3$	– 150 $\mu g/m^3$	20 $\mu g/m^3$ 50 $\mu g/m^3$
$PM_{2.5}$[f]	Annual Arithmetic Mean 24 Hour	12 $\mu g/m^3$ 35 $\mu g/m^3$	15 $\mu g/m^3$ 35 $\mu g/m^3$	12 $\mu g/m^3$ –
Sulfates	24 Hour	–	–	25 $\mu g/m^3$
Lead[g, k]	30 Day Average Calendar Quarter Rolling 3-Month Average	– 1.5 $\mu g/m^3$ 0.15 $\mu g/m^3$	– 1.5 $\mu g/m^3$ 0.15 $\mu g/m^3$	1.5 $\mu g/m^3$ – –
Hydrogen sulfide	1 Hour	–	–	0.03 ppm
Vinyl chloride	24 Hour	–	–	0.01 ppm
Visibility-reducing particles	8 Hour	–	–	See Note[h]

Source: ARB 2012, ARB 2013b.

Notes:

a. 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 eight hour concentration in a year, averaged over three years, is equal to or less than the standard. For PM_{10}, the 24-hour standard is attained when the expected number of days per calendar year with a 24-hour average concentration above 150 $\mu g/m^3$ is equal to or less than one. For $PM_{2.5}$, the 24-hour standard is attained when 98 percent of the daily concentrations, averaged over 3 years, are equal to or less than the standard.

b. National Primary Standards: The levels of air quality necessary, with an adequate margin of safety, to protect the public health.

c. National Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.

d. California standards for ozone, carbon monoxide, sulfur dioxide (1-hour and 24-hour), nitrogen dioxide, suspended particulate matter (PM_{10}, $PM_{2.5}$, and visibility reducing particles), are values that are not to be exceeded. All others are not to be equaled or 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.

e. On June 2, 2010, a new 1-hour SO_2 standard was established and the existing 24-hour and annual primary standards were revoked. To attain the 1-hour national standard, the 3-year average of the annual 99th percentile of the 1-hour daily maximum concentrations at each site must not exceed 75 ppb. The 1971 SO_2 national standards (24-hour and annual) remain in effect until one year after an area is designated for the 2010 standard, except for areas designated nonattainment for the 1971 standards, where the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standards are approved.

f. On December 14, 2012, the national annual $PM_{2.5}$ primary standard was lowered from 15 $\mu g/m^3$ to 12.0 $\mu g/m^3$. The existing national 24-hour $PM_{2.5}$ standards (primary and secondary) were retained at 35 $\mu g/m^3$, as was the annual secondary standard of 15 $\mu g/m^3$. The existing 24-hour PM_{10} standards (primary and secondary) of 150 $\mu g/m^3$ also were retained. The form of the annual primary and secondary standards is the annual mean, averaged over 3 years.

g. The national standard for lead was revised on October 15, 2008, to a rolling 3-month average. The 1978 lead standard (1.5 µg/m3 as a quarterly average) remains in effect until one year after an area is designated for the 2008 standard, except for areas designated nonattainment for the 1978 standard, where the 1978 standard remains in effect until implementation plans to attain or maintain the 2008 standard are approved.

h. In 1989, the ARB converted both the general statewide 10-mile visibility standard and the Lake Tahoe 30-mile visibility standard to instrumental equivalents, which are "extinction of 0.23 per kilometer" and "extinction of 0.07 per kilometer" for the statewide and Lake Tahoe Air Basin standards, respectively.

i. Concentration expressed first in units in which it was promulgated. Equivalent units given in parentheses are based upon a reference temperature of 25°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.

j. To attain the 1-hour national standard, the 3-year average of the annual 98th percentile of the 1-hour daily maximum concentrations at each site must not exceed 100 ppb. Note that the national 1-hour standard is in units of parts per billion (ppb). California standards are in units of parts per million (ppm). To directly compare the national 1-hour standard to the California standards the units can be converted from ppb to ppm. In this case, the national standard of 100 ppb is identical to 0.100 ppm.

k. The ARB has identified lead and vinyl chloride as 'toxic air contaminants' with no threshold level 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.

$\mu g/m^3$ = micrograms per cubic meter.
ppb = parts per billion (by volume).
ppm = parts per million (by volume).

The USEPA designates areas as attainment, nonattainment, or unclassified for individual criteria pollutants depending on whether the areas achieve (i.e., attain) the applicable NAAQS for each pollutant. For some pollutants, there are numerous classifications of the nonattainment designation, depending on the severity of an area's nonattainment status. Areas that lack monitoring data are designated as unclassified areas, and considered as attainment areas for regulatory purposes.

Under the 1977 FCAA amendments, states (or areas within states) with ambient air quality concentrations that do not meet the NAAQS are required to develop and maintain SIPs. These implementation plans constitute a federally enforceable definition of the state's approach and schedule for the attainment of the NAAQS. If a nonattainment area achieves compliance, the area is classified as an attainment maintenance area for 20 years.

16.3.1.2 Federal General Conformity Requirements

The 1977 FCAA amendments state that the Federal government is prohibited from engaging in, supporting, providing financial assistance for, licensing, permitting, or approving any activity that does not conform to an applicable SIP. In the 1990 FCAA amendments, the USEPA included provisions requiring Federal agencies to ensure that actions undertaken in nonattainment or attainment maintenance areas are consistent with applicable SIPs. The process of determining whether a Federal action is consistent with applicable SIPs is called "conformity" determination. A conformity determination is required only for the project alternative that is ultimately selected and approved. The USEPA general conformity regulation applies only to Federal actions that result in emissions of "nonattainment or maintenance pollutants" or their precursors in federally designated nonattainment or maintenance areas. The emission thresholds that trigger requirements of the general conformity regulation for Federal actions emitting nonattainment or maintenance pollutants, or their precursors, are called *de Minimis* levels, as summarized in Table 16.2.

Table 16.2 General Conformity *de Minimis* Levels

Pollutant	Area Type	Tons/Year
Ozone (VOC or NOx)	Serious nonattainment	50
	Severe nonattainment	25
	Extreme nonattainment	10
	Other areas outside an ozone transport region	100
Ozone (NOx)	Marginal and moderate nonattainment inside an ozone transport region	100
	Maintenance	100
Ozone (VOC)	Marginal and moderate nonattainment inside an ozone transport region	50
	Maintenance within an ozone transport region	50
	Maintenance outside an ozone transport region	100
Carbon monoxide, SO_2 and NO_2	All nonattainment and maintenance	100
PM_{10}	Serious nonattainment	70
	Moderate nonattainment and maintenance	100
$PM_{2.5}$ Direct emissions, SO_2, NOx (unless determined not to be a significant precursor), VOC or ammonia (if determined to be significant precursors)	All nonattainment and maintenance	100
Lead (Pb)	All nonattainment and maintenance	25

Source: USEPA 2015b

16.3.1.3 California Clean Air Act

The California Clean Air Act (CCAA) provides the State with a comprehensive framework for air quality planning regulation. Prior to passage of the CCAA, Federal law contained the only comprehensive planning framework. The CCAA requires attainment of state ambient air quality standards by the earliest practicable date.

The FCAA requires adoption of SIPs for nonattainment areas to describe actions that will be undertaken to achieve the NAAQS. In addition, the CCAA requires local air districts in nonattainment areas to prepare and maintain Air Quality Management Plans (AQMPs) to achieve compliance with CAAQS. These AQMPs also serve as a basis for preparing the SIP for the State of California, which must ultimately be approved by the USEPA and codified in the Code of Federal Register (CFR).

16.4 Affected Environment

This section describes the area of analysis, ambient air quality and conditions, and GHG emissions in the study area.

The air basins and air districts in California, including those in the study area, do not specifically align with the study area regions, as noted below and in the description of each air basin (ARB 2011a; ARB 2011b).

The discussion in this chapter area is organized by the study area regions and air basins. The study area regions include the following air basins and counties.

- Trinity River Region is located within portions of the North Coast Air Basin.
  - The Trinity River Region includes the area in Trinity County along the Trinity River from Trinity Lake to the confluence with the Klamath River; and the area in Humboldt and Del Norte counties along the Klamath River from the confluence with the Trinity River to the Pacific Ocean.
- Central Valley Region is located within portions of the Sacramento Valley, Mountain Counties, San Joaquin Valley, San Francisco Bay Area, Mojave Desert air basins.
  - The Central Valley Region includes all or portions the counties of Shasta, Plumas, Tehama, Glenn, Colusa, Butte, Sutter, Yuba, Nevada, Placer, El Dorado, Sacramento, Yolo, Solano, Napa, San Joaquin, Stanislaus, Merced, Madera, Fresno, Kings, Tulare, and Kern that are within the CVP and SWP service areas.
- San Francisco Bay Area Region is located within portions of the San Francisco Bay Area and North Central Coast air basins.
  - The San Francisco Bay Area Region includes portions of Contra Costa, Alameda, Santa Clara, and San Benito counties that are within the CVP and SWP service areas.
- Central Coast Region is located within portions of the South Central Coast Air Basin.
  - The Central Coast Region includes portions of San Luis Obispo and Santa Barbara counties served by the SWP.
- Southern California Region is located within portions of the South Central Coast, South Coast, San Diego, Mojave Desert, and Salton Sea air basins.
  - The Southern California Region includes portions of Ventura, Los Angeles, Orange, San Diego, Riverside, and San Bernardino counties served by the SWP.

16.4.1 Ambient Air Quality

Air quality conditions and potential impacts in the project area are evaluated and discussed qualitatively, rather than quantitatively. The following subsections briefly describe the existing air quality environmental setting by air basin for the project area. The counties within each air basin in the project area are presented in Table 16.3, along with non-attainment designations to characterize existing ambient air quality. Non-attainment designations indicate that concentrations of pollutants measured in ambient air exceed the applicable ambient air quality standards. As shown in Table 16.3, many of the counties included in the project area are designated as nonattainment for the Federal and/or State ozone and particulate matter standards. These air quality issues may be exacerbated under dry conditions because when irrigation water supplies are decreased, there is increased potential for the formation and transport of fugitive dust.

Table 16.3 Pollutants Designated as Nonattainment Pursuant to Federal and State Ambient Air Quality Standards

County	Air Basin	Air District	Federal Nonattainment Designations[a]	State Nonattainment Designations[b]
Trinity River Region				
Trinity	North Coast	North Coast Unified	–	–
Humboldt	North Coast	North Coast Unified	–	–
Del Norte	North Coast	North Coast Unified	–	–
Central Valley Region				
Shasta	Sacramento Valley	Shasta	–	Ozone, PM_{10}
Tehama	Sacramento Valley	Tehama	Ozone (Tuscan Buttes area)	Ozone, PM_{10}
Butte	Sacramento Valley	Butte	Ozone and $PM_{2.5}$ in Chico	Ozone, PM_{10}, $PM_{2.5}$
Glenn	Sacramento Valley	Glenn	–	PM_{10}
Colusa	Sacramento Valley	Colusa	–	PM_{10}
Yuba	Sacramento Valley	Feather River	–	Ozone, PM_{10}
Sutter	Sacramento Valley	Feather River	Ozone	Ozone, PM_{10}
Yolo	Sacramento Valley	Yolo-Solano	Ozone, $PM_{2.5}$	Ozone, PM_{10}
Sacramento	Sacramento Valley	Sacramento Metro	Ozone, $PM_{2.5}$	Ozone, PM_{10}

County	Air Basin	Air District	Federal Nonattainment Designations[a]	State Nonattainment Designations[b]
Plumas	Mountain Counties	Northern Sierra	–	PM_{10} $PM_{2.5}$ (Portola Valley)
Placer	Sacramento Valley, Mountain Counties, Lake Tahoe	Placer	Ozone, $PM_{2.5}$	Ozone, PM_{10}
El Dorado	Sacramento Valley, Mountain Counties, Lake Tahoe	El Dorado	Ozone, $PM_{2.5}$	Ozone, PM_{10}
San Joaquin	San Joaquin Valley	San Joaquin Valley	Ozone, $PM_{2.5}$	Ozone, PM_{10}, $PM_{2.5}$
Stanislaus	San Joaquin Valley	San Joaquin Valley	Ozone, $PM_{2.5}$	Ozone, PM_{10}, $PM_{2.5}$
Merced	San Joaquin Valley	San Joaquin Valley	Ozone, $PM_{2.5}$	Ozone, PM_{10}, $PM_{2.5}$
Fresno	San Joaquin Valley	San Joaquin Valley	Ozone, $PM_{2.5}$	Ozone, PM_{10}, $PM_{2.5}$
Madera	San Joaquin Valley	San Joaquin Valley	Ozone, $PM_{2.5}$	Ozone, PM_{10}, $PM_{2.5}$
Kings	San Joaquin Valley	San Joaquin Valley	Ozone, $PM_{2.5}$	Ozone, PM_{10}, $PM_{2.5}$
Tulare	San Joaquin Valley	San Joaquin Valley	Ozone, $PM_{2.5}$	Ozone, PM_{10}, $PM_{2.5}$
Kern	San Joaquin Valley, Mojave Desert	San Joaquin Valley, Kern	Ozone, $PM_{2.5}$, PM_{10} (East Kern)	Ozone, PM_{10}, $PM_{2.5}$ (San Joaquin Valley Air Basin)
San Francisco Bay Area Region				
Napa	San Francisco Bay Area	Bay Area	Ozone, $PM_{2.5}$	Ozone, PM_{10}, $PM_{2.5}$
Solano	Sacramento Valley, San Francisco Bay Area	Yolo-Solano and Bay Area	Ozone, $PM_{2.5}$	Ozone, PM_{10}, $PM_{2.5}$
Contra Costa	San Francisco Bay Area	Bay Area	Ozone, $PM_{2.5}$	Ozone, PM_{10}, $PM_{2.5}$
Alameda	San Francisco Bay Area	Bay Area	Ozone, $PM_{2.5}$	Ozone, PM_{10}, $PM_{2.5}$
Santa Clara	San Francisco Bay Area	Bay Area	Ozone, $PM_{2.5}$	Ozone, PM_{10}, $PM_{2.5}$

County	Air Basin	Air District	Federal Nonattainment Designations[a]	State Nonattainment Designations[b]
San Benito	North Central Coast	Monterey Bay Unified	–	Ozone, PM_{10}
Central Coast Region				
San Luis Obispo	South Central Coast	San Luis Obispo	Ozone (Eastern San Luis Obispo)	Ozone, PM_{10}
Santa Barbara	South Central Coast	Santa Barbara	–	Ozone, PM_{10}
Southern California Region				
Ventura	South Central Coast	Ventura	Ozone	Ozone, PM_{10}
Los Angeles	South Coast, Mojave Desert	South Coast, Antelope Valley	Ozone, $PM_{2.5}$, Lead	Ozone; PM_{10}; $PM_{2.5}$
San Bernardino	South Coast, Mojave Desert	South Coast, Mojave Desert	Ozone, PM_{10}, $PM_{2.5}$	Ozone, PM_{10}, $PM_{2.5}$
Riverside	South Coast, Mojave Desert, Salton Sea	South Coast, Mojave Desert	Ozone, PM_{10}, $PM_{2.5}$	Ozone; PM_{10}; $PM_{2.5}$
Orange	South Coast	South Coast	Ozone, $PM_{2.5}$	Ozone, PM_{10}, $PM_{2.5}$
San Diego	San Diego County	San Diego	Ozone	Ozone, PM_{10}, $PM_{2.5}$

Sources: USEPA 2014; ARB 2015

Notes:

a. Areas designated as nonattainment by U.S. Environmental Protection Agency related to National Ambient Air Quality Standards as of January 30, 2015.

b. Areas designated as nonattainment by California Air Resources Board related to California Ambient Air Quality Standards as of April 10, 2014. No changes to the state area designations were proposed for 2014.

16.4.1.1 North Coast Air Basin

The North Coast Air Basin includes Humboldt, Del Norte, Trinity, Mendocino, and north Sonoma counties (ARB 2013a). This air basin is located within the Trinity River Region of the study area. The basin is sparsely populated, and stretches along the northern coastline through forested mountains. Prevailing winds blow clean air inland from the Pacific Ocean, and air quality is typically good. Humboldt, Del Norte, and Trinity counties are designated attainment for the federal and state air quality standards (USEPA 2015b, ARB 2014).

16.4.1.2 Sacramento Valley Air Basin

The Sacramento Valley Air Basin encompasses 9 air districts and 11 counties, including: all of Shasta, Tehama, Glenn, Colusa, Butte, Sutter, Yuba, Sacramento, and Yolo counties; the westernmost portion of Placer County; and the northeastern half of Solano County. The air basin is bounded by tall mountains, including the Coast Range to the west, the Cascade Range to the north, and the Sierra Nevada Range to the east. This air basin is located within the northern portion of the Central Valley Region of the study area.

Winters are wet and cool, and summers are hot and dry. When air stagnates, or is trapped by an inversion layer in the valley, ambient pollutant concentrations can reach or exceed threshold levels. On-road vehicles are the largest source of smog-forming pollutants, and particulate matter emissions are primarily from area sources, such as fugitive dust from paved and unpaved roads and vehicle travel (ARB 2013a).

To characterize the existing ambient air quality in the Sacramento Valley Air Basin, data from area monitoring stations were reviewed (ARB 2011d). For the three years from 2007 to 2009, monitoring data indicated the following:

- Concentrations of O_3 and 24-hour $PM_{2.5}$ have exceeded the NAAQS and CAAQS.
- Concentrations of PM_{10} have exceeded the CAAQS but are below the NAAQS.
- Measured concentrations of CO and NO_2 have complied with the NAAQS and CAAQS.
- Monitored SO_2 concentrations are extremely low, and lead concentrations are monitored as part of the air toxics program.

In the time since ARB compiled the 2007 to 2009 air quality monitoring data reported above, Glenn and Colusa counties have been redesignated as attainment for the California ozone standards (ARB 2014). In addition, Sacramento County has been redesignated as attainment for the California $PM_{2.5}$ standards (ARB 2014). No other changes in air quality nonattainment designations have been recorded (USEPA 2014; ARB 2014).

16.4.1.3 Mountain Counties Air Basin

The Mountain Counties Air Basin includes the mountainous areas of the central and northern Sierra Nevada Mountains, from Plumas County south to Mariposa County, including Plumas, Sierra, Nevada, Central Placer, West El Dorado, Amador, Calaveras, Tuolumne, and Mariposa counties (ARB 2013a). This air basin includes portions of the central-eastern Central Valley Region of the study area; as well as areas located to the east of the study area.

Sparsely populated, motor vehicles are the primary source of emissions in the air basin. Air quality issues often result when eastward surface winds transport pollution from more populated air basins to the west and south. Wood smoke from stoves and fireplaces contribute to elevated ambient PM_{10} concentrations during winter. Nevada, Placer, El Dorado, Amador, Calaveras, Tuolumne, and Mariposa counties are designated as nonattainment for the Federal and State ozone standards (ARB 2014). Plumas, Sierra, Nevada, Placer, El Dorado, and Calaveras counties are designated as nonattainment for the State PM_{10} standards (ARB 2014).

16.4.1.4 San Joaquin Valley Air Basin

The San Joaquin Valley Air Basin encompasses eight counties, including: all of San Joaquin, Stanislaus, Madera, Merced, Fresno, Kings, Tulare counties; and western Kern County. It is bounded on the west by the Coast Range, on the east by the Sierra Nevada, and in the south by the Tehachapi Mountains. This air basin is located within the central and southern portions of the Central Valley Region of the study area.

Winters are cool and wet and summers are dry and very hot. The area is heavily agricultural, and hosts other localized industries such as forest products, oil and gas production, and oil refining. On-road vehicles are the largest source of smog-forming pollutants, and PM_{10} emissions are primarily from sources such as agricultural operations and fugitive dust from paved and unpaved roads and vehicle travel (ARB 2013a). Air quality issues may be exacerbated under dry conditions. When water supplies and irrigation levels are decreased in urban, rural, and agricultural areas, there is increased potential for the formation and transport of fugitive dust.

To characterize the existing ambient air quality for the San Joaquin Valley Air Basin, data from area monitoring stations were reviewed (ARB 2011d). For the three years from 2007 to 2009, monitoring data indicated the following:

- Concentrations of O_3 and 24-hour $PM_{2.5}$ have exceeded the NAAQS and CAAQS.
- Concentrations of PM_{10} have exceeded the CAAQS but are below the NAAQS.
- Measured concentrations of CO and NO_2 have complied with the NAAQS and CAAQS.
- Monitored SO_2 concentrations are extremely low, and lead concentrations are monitored as part of the air toxics program.

In the time since ARB compiled the 2007 to 2009 air quality monitoring data reported above, no changes in air quality nonattainment designations have been recorded in the San Joaquin Valley Region counties in this study (USEPA 2015; ARB 2014).

16.4.1.4.1 Dust and Particulate Matter in San Joaquin Valley

The San Joaquin Valley Air Pollution Control District (SJVAPCD) is the local regulatory agency with jurisdiction over air quality issues in the San Joaquin Valley area. In response to the area's historical air quality problems with dust and particulate matter, the SJVAPCD was the first agency in the state to regulate emissions from on-field agricultural operations. In 2004, the agency adopted Rule 4550, the Conservation Management Practices rule, and Rule 3190, the Conservation Management Practices Fee rule. To comply with these rules, farmers with 100 acres or more of contiguous land must prepare and implement biennial Conservation Management Plans to reduce dust and particulate matter emissions from on-farm sources, such as unpaved roads and equipment yards, land preparation, harvest activities, and other farming activities. A handbook titled "Agricultural Air Quality Conservation Management Practices for San Joaquin Valley Farms" was published by the agriculture industry in 2004 to provide guidance to farmers on Conservation Management Practices (SJVAPCD 2004a, 2004b). Examples of Conservation Management Practices include activities that reduce or eliminate the need for soil disturbance, activities that protect soil from wind, dust suppressants, alternatives to burning agricultural wastes, and reduced travel speeds on unpaved roads and equipment yards. Lands not currently under cultivation or used for pasture are exempt from Rule 4550, other than recordkeeping to document the exemption. Fees vary depending on the size of the farm, and include an initial application fee, and a biennial renewal fee.

In addition to requirements for on-field agricultural practices, the SJVAPCD rules and regulations address avoidance of nuisance conditions (Rule 4102), prohibitions on opening burning (Rule 4103), and fugitive-dust control (Regulation VIII). Specifically, the SJVAPCD dust-control rules include Rule 8021 for control of PM_{10} from construction, demolition, excavation, extraction, and other earth moving activities; Rule 8031 for control of PM_{10} from handling and storage of bulk materials; Rule 8051 for control of PM_{10} from disturbed open areas; Rule 8061 for control of PM_{10} from travel on paved and unpaved roads; Rule 8071 for control of PM_{10} from unpaved vehicle and equipment traffic areas; and Rule 8081 for off-field agricultural sources, such as bulk materials handling and transport and travel on unpaved roads. Each of these rules requires fugitive dust control, often through application of water, gravel, or chemical dust stabilizers.

16.4.1.5 San Francisco Bay Area Air Basin

The San Francisco Bay Area Air Basin consists of a single air district and nine counties, including: all of Napa, Marin, San Francisco, Contra Costa, Alameda, San Mateo, and Santa Clara counties; the southern portion of Sonoma County; and the southwestern portion of Solano County (ARB 2013a). The hills of the Coast Range bound the San Francisco and San Pablo bays and the inland valleys of the air basin. This air basin includes the San Francisco Bay Area Region of the study area.

The San Francisco Bay Area Air Basin includes the second largest urban area in California, hosting industry, airports, international ports, freeways, and surface streets. On-road vehicles are the largest source of smog-forming pollutants, and PM_{10} emissions are primarily from area sources, such as fugitive dust from paved and unpaved roads and vehicle travel (ARB 2013a). Air quality in the San Francisco Bay Area is often good as sea breezes blow clean air from the Pacific Ocean into the air basin, but transport of pollutants from the San Francisco Bay

Area can exacerbate air quality problems in the downwind portions of the San Francisco Bay Area Air Basin; as well as in the Sacramento Valley and San Joaquin Valley air basins.

To characterize the existing ambient air quality for the San Francisco Bay Area Air Basin, data from area monitoring stations were reviewed (ARB 2011d). For the three years from 2007 to 2009, monitoring data indicated the following:

- Concentrations of O_3 and 24-hour $PM_{2.5}$ have exceeded the NAAQS and CAAQS.
- Concentrations of PM_{10} exceeded the CAAQS in 2008 but were below the CAAQS in 2007 and 2009. Concentrations of PM_{10} were below the NAAQS.
- Measured concentrations of CO and NO_2 have complied with the NAAQS and CAAQS.
- Monitored SO_2 concentrations are extremely low, and lead concentrations are monitored as part of the air toxics program.

In the time since ARB compiled the 2007 to 2009 air quality monitoring data reported above, no changes in air quality nonattainment designations have been recorded in the San Francisco Bay Region counties in this study (USEPA 2015; ARB 2014).

16.4.1.6 North Central Coast Air Basin

The North Central Coast Air Basin includes Santa Cruz, San Benito and Monterey counties (ARB 2013a). This air basin includes San Benito County which is located within the San Francisco Bay Area Region of the study area.

The North Central Coast Air Basin is in attainment for all NAAQS, and is designated as nonattainment for the State ozone and PM_{10} standards (ARB 2014). Though separated by the Santa Cruz Mountains and Coast Ranges to the north, wind can transport air pollution from the San Francisco Bay Area Air Basin and contribute to elevated ozone concentrations in the area (ARB 2013a).

16.4.1.7 South Central Coast Air Basin

The South Central Coast Air Basin includes San Luis Obispo, Santa Barbara and Ventura counties. It is bordered by the Pacific Ocean on the south and west and lies just north of the highly populated South Coast Air Basin. This air basin includes the Central Coast Region and the northern Southern California Region of the study area.

Sources of pollutants in the air basin include power plants, oil production and refining, vehicle travel, and agricultural operations. San Luis Obispo, Santa Barbara, and Ventura counties are designated as nonattainment for the State ozone and PM_{10} standards. Eastern San Luis Obispo and Ventura counties are designated as nonattainment for the Federal ozone standard (USEPA 2015). Wind patterns link Ventura and Santa Barbara counties, resulting in pollutant transport between the South Central Coast and South Coast air basins. San Luis Obispo County is separated from these counties by mountains, and the air quality in San Luis Obispo County is linked more with conditions in the San Francisco Bay Area Air Basin and San Joaquin Valley Air Basin. Additionally, air emissions from the South Coast Air Basin can be blown offshore, and then carried to the coastal cities of the South Central Coast Air Basin. Under some conditions, the reverse air flow can carry pollutants from the South Central Coast Air Basin to the South Coast Air Basin and contribute to ozone violations there (ARB 2013a).

16.4.1.8 South Coast Air Basin

The South Coast Air Basin is California's largest metropolitan region. The area includes the southern two-thirds of Los Angeles County, all of Orange County, and the western urbanized portions of Riverside and San Bernardino counties. The South Coast Air Basin is bounded by the Pacific Ocean on the west and by mountains on the other three sides. This air basin includes the western-central portion of the Southern California Region of the study area.

The area includes industry, airports, international ports, freeways, and surface streets. On-road vehicles are the largest source of smog-forming pollutants, and PM_{10} emissions are primarily from area sources, such as fugitive dust from paved and unpaved roads and vehicle travel (ARB 2013a). One-third of the state's total criteria pollutant emissions are generated within the basin (ARB 2013a). The pollutant emissions and fugitive dust generated in the South Coast Air Basin affects other air basins. For example, fugitive dust generated in the South Coast Air Basin contributes to poor air quality in the Salton Sea Air Basin and the Coachella Valley portion of Riverside County (USGS 2014).

The persistent high pressure system and frequent low inversion heights caused by the surrounding mountains on three sides of the air basin trap pollutants in the air basin (ARB 2013a). Sunny weather contributes to smog formation. Portions of the South Coast Air Basin are designated as nonattainment for the Federal and State ozone, PM_{10}, and $PM_{2.5}$ standards (ARB 2014; USEPA 2015). Wind often transports air pollutants from the South Coast Air Basin to nearby air basins.

16.4.1.9 Mojave Desert Air Basin

The sparsely populated Mojave Desert Air Basin covers most of California's high desert and is made up of eastern Kern and Riverside counties and northern Los Angeles and San Bernardino counties. The San Gabriel and San Bernardino mountains lie to the south, separating the Mojave Desert Air Basin from the South Coast Air Basin. To the northwest, the Tehachapi Mountains separate the Mojave Desert Air Basin from the San Joaquin Valley Air Basin. This air basin includes the southeastern portion of the Central Valley Region and the northeastern portion of the Southern California Region of the study area.

The primary sources of air pollution in the air basin are military bases, highways, railroads, cement manufacturing, and mineral processing (ARB 2013a). The Mojave Desert Air Basin also is affected by air quality conditions in the San Joaquin Valley and South Coast air basins. Air from the South Coast Air Basin is transported over the San Gabriel Mountains, heavily impacting the areas of the Mojave Desert Air Basin located to the north of the South Coast Air Basin.

The Mojave Desert Air Basin also is located downwind of the San Joaquin Valley Air Basin; and the winds pass through the Tehachapi Mountains carrying air emissions from the San Joaquin Valley Air Basin. Due to the impacts from the South Coast Air Basin, the worst air quality in the Mojave Desert Air Basin is along the southern edge that borders the South Coast Air Basin. This is also where most of the population within the Mojave Desert Air Basin is located (ARB 2013a).

Portions of the Mojave Desert Air Basin are designated as nonattainment for the Federal and State ozone and PM_{10} standards (ARB 2014; USEPA 2015).

16.4.1.10 San Diego Air Basin

The San Diego Air Basin is in the southwest corner of California and comprises all of San Diego County. This air basin includes the southwestern portion of the Southern California Region of the study area.

The population and emissions are concentrated in the western portion of the air basin, which is bordered on the west by the Pacific Ocean. The climate is relatively mild near the ocean, with higher temperatures and seasonal variations further inland (ARB 2013a).

The air basin includes industrial facilities, airports, an international port, freeways, and surface streets. The San Diego Air Basin is designated as nonattainment for the Federal ozone standard and the State ozone, PM_{10}, and $PM_{2.5}$ standards (ARB 2014). Air quality in the San Diego Air Basin is impacted not only by local emission sources, but also from transport of air emissions from the South Coast Air Basin and Mexico.

16.4.1.11 Salton Sea Air Basin

The Salton Sea Air Basin is in the southeast corner of California and includes all of Imperial County and central Riverside County. The air basin is characterized by flat terrain and the Salton Sea surrounded by high mountains to the west, north, and east. The southern portion of the air basin extends towards the Gulf of California. The flat terrain and strong temperature differentials created by intense heating and cooling patterns produce moderate winds and deep thermal circulation systems which disperse local air emissions (DWR 2006). This air basin includes the northeastern portion of the Southern California Region of the study area.

The primary sources of air pollution are from vehicles and equipment exhaust and particulate matter from disturbed soils and wind erosion. The Salton Sea Air Basin is designated as nonattainment for the Federal and State ozone and PM_{10} standards (ARB 2014; USEPA 2015). Portions of the Salton Sea Air Basin located outside of the study area near Calexico also are in nonattainment for $PM_{2.5}$ standards.

16.4.2 Existing Greenhouse Gases and Emissions Sources

This subsection presents an overview of the greenhouse effect and climate change, and potential sources of GHG emissions and information related to climate change and GHG emissions in California. GHG emissions and their climate-related impacts are not limited to specific geographic locations, but occur on global or regional scales. GHG emissions contribute cumulatively to the overall heat-trapping capability of the atmosphere, and the effects of the warming, such as climate change, are manifested in different ways across the planet.

16.4.2.1 Greenhouse Gas Emissions Regulations and Analyses

Global warming is the name given to the increase in the average temperature of the Earth's near-surface air and oceans since the mid-20th century and its projected continuation. Warming of the climate system is now considered to be unequivocal (DWR 2010) with global surface temperature increasing approximately 1.33°F over the last one hundred years. Continued warming is projected to increase global average temperature between 2 and 11 degrees Fahrenheit (°F) over the next one hundred years.

The causes of this warming have been identified as both natural processes and as the result of human actions. The Intergovernmental Panel on Climate Change (IPCC) concludes that variations in natural phenomena such as solar radiation and volcanoes produced most of the warming from pre-industrial times to 1950 and had a small cooling effect afterward. However, after 1950, increasing GHGs concentrations resulting from human activity such as fossil fuel burning and deforestation have been responsible for most of the observed temperature increase. These basic conclusions have been endorsed by more than 45 scientific societies and academies of science, including all of the national academies of science of the major industrialized countries.

Increases in GHG concentrations in the Earth’s atmosphere are thought to be the main cause of human-induced climate change. GHGs naturally trap heat by impeding the exit of solar radiation that has hit the Earth and is reflected back into space. Some GHGs occur naturally and are necessary for keeping the Earth’s surface inhabitable. However, increases in the concentrations of these gases in the atmosphere during the last hundred years have decreased the amount of solar radiation that is reflected back into space, intensifying the natural greenhouse effect and resulting in the increase of global average temperature (DWR 2010).

The principal GHGs considered in this EIS are CO_2, CH_4, N_2O, SF_6, PFC, and HFC, in accordance with the California Health and Safety Code section 38505(g) (DWR 2010). Each of the principal GHGs has a long atmospheric lifetime (one year to several thousand years). In addition, the potential heat-trapping ability of each of these gases varies significantly from one another, and also vary over time. For example, CH_4 is 25 times as potent as CO_2; while SF_6 is 32,800 times more potent than CO_2 with a 100-year time horizon (IPCC 2007).

The primary man-made processes that release these gases include: burning of fossil fuels for transportation, heating and electricity generation; agricultural practices that release CH_4, such as livestock grazing and crop residue decomposition; and industrial processes that release smaller amounts of high global warming potential gases such as SF_6, PFCs, and HFCs (DWR 2010). Deforestation and land cover conversion have also been identified as contributing to global warming by reducing the Earth's capacity to remove CO_2 from the air and altering the Earth's albedo or surface reflectance, allowing more solar radiation to be absorbed.

16.4.2.2 An Overview of the Greenhouse Effect

The greenhouse effect is a natural phenomenon that is essential to keeping the Earth's surface warm (DWR 2010). Like a greenhouse window, GHGs allow sunlight to enter and then prevent heat from leaving the atmosphere. Solar radiation enters the Earth's atmosphere from space. A portion of this radiation is reflected by particles in the atmosphere back into space, and a portion is absorbed by the Earth's surface and emitted back into space. The portion absorbed by the Earth's surface and emitted back into space is emitted as lower-frequency infrared radiation. This infrared radiation is absorbed by various GHGs present in the atmosphere. While these GHGs are transparent to the incoming solar radiation, they are effective at absorbing infrared radiation emitted by the Earth's surface. Therefore, some of the lower-frequency infrared radiation emitted by the Earth's surface is retained in the atmosphere, creating a warming of the atmosphere.

16.4.2.2.1 Global Climate Trends and Associated Impacts

The rate of increase in global average surface temperature over the last hundred years has not been consistent (DWR 2010). The last three decades have warmed at a much faster rate than the previous seven decades – on average 0.32°F per decade. Eleven of the twelve years from 1995 to 2006, rank among the twelve warmest years in the instrumental record of global average surface temperature since 1850.

Increased global warming has occurred concurrent with many other changes have occurred in other natural systems (DWR 2010). Global sea levels have risen on average 1.8 millimeters per year; precipitation patterns throughout the world have shifted, with some areas becoming wetter and other drier; tropical storm activity in the North Atlantic has increased; peak runoff timing of many glacial and snow fed rivers has shifted earlier; as well as numerous other observed conditions. Though it is difficult to prove a definitive cause and effect relationship between global warming and other observed changes to natural systems, there is high confidence in the scientific community that these changes are a direct result of increased global temperatures.

16.4.2.2.2 Overview of Greenhouse Gas Emission Sources

Naturally occurring GHGs include water vapor, CO_2, methane, and nitrous oxide. Water vapor is introduced to the atmosphere from oceans and the natural biosphere. Water vapor introduced directly to the atmosphere from agricultural or other activities is not long lived, and thus does not contribute substantially to a warming effect (NAS 2005). Carbon and nitrogen contained in CO_2, methane, and nitrous oxide naturally cycle from gaseous forms to organic biomass through processes such as plant and animal respiration and seasonal cycles of plant growth and decay (USEPA 2012). Although naturally occurring, the emissions and sequestration of these gases are also influenced by human activities, and in some cases, are caused by human activities (anthropogenic). In addition to these GHGs, several classes of halogenated substances that contain fluorine, chlorine, or bromine also contribute to the greenhouse effect. However, these compounds are the product of industrial activities for the most part.

Each of the GHGs has a different capacity to trap heat in the atmosphere, with some of these gases being more effective at trapping heat than others. For calculating emissions, ARB (ARB 2007) uses a metric developed by the IPCC to account for these differences and to provide a standard basis for calculations. The metric, called the global warming potential (GWP), is used to compare the future climate impacts of emissions of various long-lived GHGs. The GWP of each GHG is indexed to the heat-trapping capability of CO_2, and allows comparison of the global warming influence of each GHG relative to CO_2. The GWP is used to translate emissions of each GHG to emissions of carbon dioxide equivalents, or CO_2e. In this way, emissions of various GHGs can be summed, and total GHG emissions can be inventoried in common units of metric tons per year of CO_2e. Most international inventories, including the United States inventory, use GWP values from the IPCC Fourth Assessment Report, per international consensus (IPCC 2007; USEPA 2012).

CO_2 is a byproduct of burning fossil fuels and biomass, as well as land-use changes and other industrial processes (USEPA 2012). It is the principal anthropogenic GHG that contributes to the Earth’s radiative balance, and it represents the dominant portion of GHG emissions from activities that result from the combustion of fossil fuels (e.g., construction activities, electrical generation, and transportation).

16.4.2.3 California Climate Trends and Greenhouse Gas Emissions

Maximum (daytime) and minimum (nighttime) temperatures are increasing almost everywhere in California but at different rates. The annual minimum temperature averaged over all of California has increased 0.33°F per decade during the period 1920 to 2003, while the average annual maximum temperature has increased 0.1°F per decade (DWR 2010).

With respect to California’s water resources, the most significant impacts of global warming have been changes to the water cycle and sea level rise. Over the past century, the precipitation mix between snow and rain has shifted in favor of more rainfall and less snow, and snow pack in the Sierra Nevada is melting earlier in the spring (DWR 2010). The average early spring snowpack in the Sierra Nevada has decreased by about 10 percent during the last century, a loss of 1.5 million acre-feet of snowpack storage. These changes have significant implications for water supply, flooding, aquatic ecosystems, energy generation, and recreation throughout the state.

During the same period, sea levels along California's coast have risen. The Fort Point tide gauge in San Francisco was established in 1854 and is the longest continually monitored gauge in the United States. Sea levels measured at this gauge and two other west coast gauges indicate that the sea levels have risen at an average rate of about 7.9 inches/century (0.08 inch/year) over the past 150 years (BCDC 2011). Continued sea level rise associated with global warming may threaten coastal lands and infrastructure, increase flooding at the mouths of rivers, place additional stress on levees in the Sacramento-San Joaquin Delta, and intensify the difficulty of managing the Sacramento-San Joaquin Delta as the heart of the state's water supply system (DWR 2010).

16.4.2.3.1 Potential Effects of Global Climate Change in California

Warming of the atmosphere has broad implications for the environment. In California, one of the effects of climate change could be increases in temperature that could affect the timing and quantity of precipitation. California receives most of its precipitation in the winter months, and a warming environment would raise the elevation of snow pack and result in reduced spring snowmelt and more winter runoff. These effects on precipitation and water storage in the snow pack could have broad implications on the environment in California.

The following are some of the potential effects of a warming climate in California (California Climate Change Portal 2007):

- Loss of snowpack storage will cause increased winter runoff that generally would not be captured and stored because of the need to reserve flood capacity in reservoirs during the winter.
- Less spring runoff would mean lower early summer storage at major reservoirs, which would result in less hydroelectric power production.
- Higher temperatures and reduced snowmelt would compound the problem of providing suitable cold water habitat for salmonid species. Lower reservoir levels would also contribute to this problem, reducing the flexibility of cold water releases.
- Sea level rise would affect the Delta, worsening existing levee problems, causing more saltwater intrusion, and adversely affecting many coastal marshes and wildlife reserves. Release of water to streams to meet water quality requirements could further reduce storage levels.
- Increased temperatures would increase the agricultural demand for water and increase the level of stress on native vegetation, potentially allowing for an increase in pest and insect epidemics and a higher frequency of large, damaging wildfires.

Future climate scenarios have also been evaluated in the U.S. Global Change Research Program National Climate Assessments. The most recent assessment, *Climate Change Impacts in the United States*, was released in May 2014 (USGCRP 2014). For the Southwest Region of the United States, the report projects that water supply availability would be reduced as compared to recent conditions due to reduced snowpack and declining stream flows. Rising temperatures in the future would increase disruptions to electricity generation which could further reduce water availability. The National Climate Assessment also indicates that mitigation policies and other factors have lowered the United States' nationwide GHG emissions in recent years; however, substantial global emissions reductions are needed to avoid many of the predicted consequences. A considerable amount of planning for resilience and adaptation is underway, but implementation of adaptive measures have been limited in scope.

16.4.2.3.2 Current California Emission Sources

The recent California's GHG emission inventory was released on April 6, 2012, with data updated through October 2011. The GHG emissions in California have been estimated for each year from 2000 to 2009, and are reported for several large sectors of emission sources. The estimates for 2009 are summarized in Table 16.4, reported by sector as millions of tons per year of CO_2 (ARB 2011e).

Table 16.4 California Greenhouse Gas Emissions by Sector in 2009

Sector	Total Emissions (million tons/year of CO_2e)	Percent of Statewide Total Gross Emissions[a]
Agriculture	32.1	7
Commercial and Residential	43	9.4
Electric Power	103.6	22.7
Forestry (excluding CO_2 sinks)	0.2	< 1.0
Industrial	81.4	17.8
Recycling and Waste	7.3	1.6
Transportation	172.9	37.9
High Global Warming Potential substance and ozone-depleting substance use[b]	16.3	3.6
Total	**456.8**	**100**
Forestry Net Emissions	-3.8	–

Source: ARB 2011e.

Notes:

a. Based on the 456.8 million tons/year of CO_2e Total Gross Emissions estimate.

b. High Global Warming Potential substance and ozone-depleting substance use are not attributed to an individual sector.

Total gross statewide GHG emissions in 2009 were estimated to be 456.8 million tons per year of CO_2e. The two largest sectors contributing to emissions in California are transportation and electric power (the latter sector includes both in-state generation and imported electricity). The agricultural sector represents only 7 percent of the total gross statewide emissions.

The agricultural sector includes manure management, enteric fermentation, agricultural residue burning, and soils management. The forestry sector contributes to overall emissions, but is a net sink of emissions.

The California Global Warming Solutions Act of 2006 (California Assembly Bill 32) requires California to reduce statewide emissions to 1990 levels by 2020.

In December 2007, ARB adopted an emission limit for 2020 of 427 million tons per year of CO_2e. Increases in the stateside renewable energy portfolio and reductions in importation of coal-based electrical power will contribute to meeting California's near-term GHG emission reduction goals. The ARB estimates that a reduction of 169 million metric tons net CO_2e emissions below business-as-usual would be required by 2020 to meet the 1990 levels (ARB 2007). This amounts to approximately a 30 percent reduction from projected "business-as-usual" levels in 2020.

16.5 Impact Analysis

This section describes the potential mechanisms and analytical methods for change in air quality and GHG emissions; results of the impact analysis; potential mitigation measures; and cumulative effects.

16.5.1 Potential Mechanisms for Change and Analytical Methods

As described in Chapter 4, Approach to Environmental Analysis, the impact analysis considers changes in air quality and GHG emissions related to changes in CVP and SWP operations under the alternatives as compared to the No Action Alternative and Second Basis of Comparison.

Changes in CVP and SWP operations under the alternatives as compared to the No Action Alternative and Second Basis of Comparison could directly or indirectly change air quality and GHG emissions due to use of engines or electricity that operate groundwater wells, changes in cropping patterns, or odor emissions.

16.5.1.1 Changes in Emissions of Criteria Air Pollutants and Precursors, and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants

Changes in CVP and SWP operations under the alternatives could change the use of individual engines to operate groundwater wells. The CVHM model is used to evaluate changes in groundwater conditions in the Central Valley, as described in Chapter 7, Groundwater Resources and Groundwater Quality. To evaluate the potential for changes in emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants, results from the CVHM model that indicate changes in groundwater withdrawals due to changes in CVP and SWP operations. However, it is not known how many of the groundwater pumps use electricity and how many use diesel engines. The diesel engines have the potential to emit criteria air pollutants and precursors, and toxic air contaminants.

Most of the groundwater wells in the Central Valley use electrical pumps. As reported in a recent environmental assessment, approximately 14 to 15 percent of the pumps used diesel fuel in 2003 (Reclamation 2013a). It is assumed for this EIS, that the portion of groundwater pumps that use electricity would remain approximately at 85 percent. Therefore, it is assumed that increases or decreases in groundwater pumping would be indicative of an increase or decrease in the use of diesel engines in the Central Valley as well as in the San Francisco Bay Area, Central Coast, and Southern California regions. Changes in CVP and SWP operations would not result in changes in groundwater pumping in the Trinity River Region; therefore, this analysis does not address Trinity River Region.

16.5.1.2 Changes in Exposure of Sensitive Receptors to Particulate Matter

Changes in CVP and SWP operations under the alternatives could change the potential for dust generation on irrigated lands that would be idled due to reduced CVP and SWP water supplies. However, as described in Chapter 12, Agricultural Resources, irrigated acreage under Alternatives 1 through 5 would be similar to irrigated acreage under both the No Action Alternative and the Second Basis of Comparison. Therefore, there would be no change in potential for dust generation. Therefore, these changes are not analyzed in this EIS.

16.5.1.3 Changes in Exposure of Sensitive Receptors to Odor Emissions from Wetlands

Restoration of seasonal floodplains and tidally-influenced wetlands could result in additional odors at surrounding sensitive receptors near the restoration locations. However, these actions would occur in a similar manner under the No Action Alternative, Alternatives 1 through 5, and Second Basis of Comparison, as described in Chapter 3, Description of Alternatives. Therefore, odor emissions would be the same under all of the alternatives and the Second Basis of Comparison. Therefore, this change is not analyzed in this EIS.

16.5.1.4 Changes in GHG Emissions due to Changes in Energy Generation or Use

Changes in CVP and SWP operations under the alternatives could change CVP and SWP energy generation and use, and the associated GHG emissions. In addition, operational changes could also affect the use of energy by CVP and SWP water users through the implementation of regional and local alternative water supplies, such as recycling or desalination. When CVP and SWP water deliveries decline, CVP and SWP net energy generation changes; and water users are anticipated to increase use of groundwater, recycled water, and/or desalinated water from existing facilities or facilities that are reasonably foreseeable to be constructed by 2030. When CVP and SWP water deliveries increase, CVP and SWP net energy generation would change; and water users are anticipated to reduce use of alternate water supplies either due to economic considerations or to allow the amount of stored water to increase under a conjunctive use pattern. It is not known whether the changes in CVP and SWP net energy generation would be similar to the changes in energy use for alternate regional and local water supplies.

Changes in the timing and magnitude of net CVP and SWP hydropower generation would result in changes in GHG emissions. Increased net CVP and SWP hydropower generation would reduce the need for electricity generated through fossil fuel combustion, and would avoid the GHG emissions that would result from fossil fuel use. In comparison, reduced hydroelectric generation would increase the need for other types of electricity production, including electricity generated from fossil fuels, with the result that GHG emissions would increase.

Potential changes in GHG emissions due to changes in CVP and SWP energy generation or use, and the evaluation of potential for changes in use of energy by CVP and SWP water users to implement alternative water supplies, are analyzed broadly and qualitatively across the overall study area. Some of the changes in energy use and generation will occur across the CVP and SWP system, others may require additional energy resources. Specific locations of the energy sources and users have not been defined.

16.5.1.5 Effects due to Cross Delta Water Transfers

Historically water transfer programs have been developed on an annual basis. The demand for water transfers is dependent upon the availability of water supplies to meet water demands. Water transfer transactions have increased over time as CVP and SWP water supply availability has decreased, especially during drier water years.

Parties seeking water transfers generally acquire water from sellers who have available surface water who can make the water available through releasing previously stored water, pump groundwater instead of using surface water (groundwater substitution); idle crops; or substitute crops that uses less water in order to reduce normal consumptive use of surface water.

Water transfers using CVP and SWP Delta pumping plants and south of Delta canals generally occur when there is unused capacity in these facilities. These conditions generally occur during drier water year types when the flows from upstream reservoirs plus unregulated flows are adequate to meet the Sacramento Valley water demands and the CVP and SWP export allocations. In non-wet years, the CVP and SWP water allocations would be less than full contract amounts; therefore, capacity may be available in the CVP and SWP conveyance facilities to move water from other sources.

Projecting future air quality conditions related to water transfer activities is difficult because specific water transfer actions required to make the water available, convey the water, and/or use the water would change each year due to changing hydrological conditions, CVP and SWP water availability, specific local agency operations, and local cropping patterns. Reclamation recently prepared a long-term regional water transfer environmental document which evaluated potential changes in conditions related to water transfer actions (Reclamation

2014c). Results from this analysis were used to inform the impact assessment of potential effects of water transfers under the alternatives as compared to the No Action Alternative and the Second Basis of Comparison.

16.5.2 Conditions in Year 2030 without Implementation of Alternatives 1 through 5

This EIS includes two bases of comparison, as described in Chapter 3, Description of Alternatives: the No Action Alternative and the Second Basis of Comparison. Both of these bases are evaluated at 2030 conditions. Changes that would occur over the next 15 years without implementation of the alternatives are not analyzed in this EIS. However, the changes to air quality that are assumed to occur by 2030 under the No Action Alternative and the Second Basis of Comparison are summarized in this section. Many of the changed conditions would occur in the same manner under both the No Action Alternative and the Second Basis of Comparison.

16.5.2.1 Common Changes in Conditions under the No Action Alternative and Second Basis of Comparison

Conditions in 2030 would be different than existing conditions due to:

- Climate change and sea level rise
- General plan development throughout California, including increased water demands in portions of Sacramento Valley
- Implementation of reasonable and foreseeable water resources management projects to provide water supplies

It is anticipated that climate change would result in warmer temperatures, more short-duration high-rainfall events, and less snowpack in the winter and early spring months. The reservoirs would be full more frequently by the end of April or May by 2030 than in recent historical conditions. However, as the water is released in the spring, there would be less snowpack to refill the reservoirs. This condition would reduce reservoir storage and available water supplies to downstream uses in the summer. The reduced end of September storage also would reduce the ability to release stored water to downstream regional reservoirs. These conditions would occur for all reservoirs in the California foothills and mountains, including non-CVP and SWP reservoirs.

These changes would result in a decline of the long-term average CVP and SWP water supply deliveries by 2030 as compared to recent historical long-term average deliveries under the No Action Alternative and the Second Basis of Comparison. However, the CVP and SWP water deliveries would be less under the No Action Alternative as compared to the Second Basis of Comparison, as described in Chapter 5, Surface Water Resources and Water Supplies, which could result in more crop idling which could result in increased dust generation.

Under the No Action Alternative and the Second Basis of Comparison, land uses in 2030 would occur in accordance with adopted general plans. Development under the general plans would be required to be implemented in accordance with adopted air quality management plans.

The No Action Alternative and the Second Basis of Comparison assumes completion of water resources management and environmental restoration projects that would have occurred without implementation of Alternatives 1 through 5, including regional and local recycling projects, surface water and groundwater storage projects, conveyance improvement projects, and desalination projects. These projects would increase energy demand and could be associated with increases in indirect greenhouse gas emissions.

By 2030, more efficient energy use, increases in renewable energy production, and energy conservation are also anticipated to reduce future GHG emissions rates.

Under the No Action Alternative and the Second Basis of Comparison, there are several major variables with varying degrees of uncertainty. These variables include future population growth in the air basins, the extent and emissivity of various emissions sources from existing and future activities, and the success of the local jurisdictions and others in implementing effective air emissions control measures. It is assumed that air quality in 2030 will be similar to the conditions described in the Affected Environment even with population growth because the current air quality management plans were developed with consideration of future growth by at least 2030. It is anticipated that the non-attainment areas will reduce the contaminants to a level of attainment in accordance with adopted air quality management plans. In addition, it is assumed that the California Renewables Portfolio Standard (RPS) will be implemented by 2020. The RPS was established in accordance with California Senate Bill 1078 in 2002, Senate Bill 107 in 2006, and Senate Bill 2 in 2011 to require investor-owned utilities, electric service providers, and community-choice aggregators (e.g., local agencies that purchase or generate electricity for their community) to provide at least 33 percent of their total energy procurement from renewable energy sources by 2020.

Increased groundwater use and related groundwater elevation reductions could occur due to reduction in CVP and SWP water supplies. The increased pumping would increase demand for electricity, and could result indirectly in increases in greenhouse gas emissions. As described above, approximately 15 percent of groundwater pumps rely upon diesel fuels. Increased groundwater pumping could result in increased emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants from increased use of diesel engines.

The No Action Alternative and the Second Basis of Comparison would include restoration of more than 10,000 acres of intertidal and associated subtidal wetlands in Suisun Marsh and Cache Slough; and 17,000 to 20,000 acres of seasonal floodplain restoration in Yolo Bypass. Operation of wetlands restoration projects could result in periodic odors due to anaerobic decomposition of organic matter in portions of the wetlands. As a result, odorous compounds, such as ammonia and hydrogen sulfide, are generated and may be released into the environment. Marshes and wetlands can also be a source of odors during some time periods when ponds or shallow water areas undergo algal or vegetative growth. Marshes, wetlands, shallow water areas, or canals may require periodic maintenance to inhibit algal or vegetative growth, and avoid conditions conducive to anaerobic digestion. The occurrence and severity of odor impacts depend on numerous factors, including the nature, frequency, and intensity of the source; wind speed and direction; and the presence of sensitive receptors. Although odors rarely cause any physical harm, they can still be unpleasant to some individuals.

16.5.3 Evaluation of Alternatives

Alternatives 1 through 5 have been compared to the No Action Alternative; and the No Action Alternative and Alternatives 1 through 5 have been compared to the Second Basis of Comparison.

During review of the numerical modeling analyses used in this EIS, an error was determined in the CalSim II model assumptions related to the Stanislaus River operations for the Second Basis of Comparison, Alternative 1, and Alternative 4 model runs. Appendix 5C includes a comparison of the CalSim II model run results presented in this chapter and CalSim II model run results with the error corrected. Appendix 5C also includes a discussion of changes in the comparison of groundwater conditions for the following alternative analyses.

- No Action Alternative compared to the Second Basis of Comparison
- Alternative 1 compared to the No Action Alternative
- Alternative 3 compared to the Second Basis of Comparison
- Alternative 5 compared to the Second Basis of Comparison

16.5.3.1 No Action Alternative

The No Action Alternative is compared to the Second Basis of Comparison.

16.5.3.1.1 Central Valley Region

Changes in Emissions of Criteria Air Pollutants and Precursors, and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants Related to Changes in Groundwater Pumping

As described in Chapter 7, Groundwater Resources and Groundwater Quality, groundwater pumping in the San Joaquin Valley portion of the Central Valley Region would increase by 8 percent under the No Action Alternative as compared to the Second Basis of Comparison. It is not known if the additional groundwater pumping would rely upon electricity or diesel to drive the pump engines. Under the worst case analysis, it is assumed that the increased use of diesel engines would be proportional to the increased use of groundwater. Therefore, under the No Action Alternative, there would be a potential increase in emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants as compared to the Second Basis of Comparison.

Effects Related to Cross Delta Water Transfers

Potential effects to air quality could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c). Potential effects to air quality were identified as increased emissions of air pollutants due to the use of diesel engines for groundwater pumps that were used to provide transfer water through groundwater substitution programs. The analysis indicated that the effects could be reduced to avoid substantial impacts through the use of electric engines or reducing the amount of groundwater substitution. Other identified effects were considered to be not substantial or beneficial as related to crop idling to provide transfer water in the seller's service area; and reduction of groundwater pumping that could use diesel engines or dust generation from crop idled lands in the purchaser's service area.

Under the No Action Alternative, the timing of cross Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Under the Second Basis of Comparison, water could be transferred throughout the year without an annual volumetric limit. Overall, the potential for cross Delta water transfers would be less under the No Action Alternative than under the Second Basis of Comparison.

16.5.3.1.2 San Francisco Bay Area, Central Coast, and Southern California Regions

Changes in Emissions of Criteria Air Pollutants and Precursors, and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants Related to Changes in Groundwater Pumping

It is anticipated that CVP and SWP water supplies would be decreased by 10 percent and 18 percent, respectively, in the San Francisco Bay Area, Central Coast, and Southern California regions under No Action Alternative as compared to the Second Basis of Comparison. The decrease in surface water supplies could result in additional use of groundwater pumps and emissions of air pollutants and contaminants if the use of diesel engines is also increased.

16.5.3.1.3 Overall Study Area

Changes in GHG Emissions due to Changes in Energy Generation or Use

As described in Chapter 8, Energy, changes in CVP and SWP operations under the No Action Alternative as compared to the Second Basis of Comparison would result in a reduction of CVP and SWP water deliveries to areas located south of the Delta; and therefore, annual energy use for conveyance would decline. CVP annual net generation would be similar; and SWP net energy generation would increase which could result indirectly in less GHG emissions if the hydropower generation replaces fossil fuel generation.

In addition to changes in CVP and SWP energy generation and use and the associated GHG emissions, CVP and SWP operations under the No Action Alternative as compared to the Second Basis of Comparison could potentially increase use of energy by CVP and SWP water users to implement regional and local alternate water supplies, such as increased groundwater pumping and use of recycled water treatment plants and desalination water treatment plants. These facilities would require energy which could result in increased GHG emissions.

16.5.3.2 Alternative 1

Alternative 1 is identical to the Second Basis of Comparison. Alternative 1 is compared to the No Action Alternative and the Second Basis of Comparison. However, because CVP and SWP operations conditions under Alternative 1 are identical to conditions under the Second Basis of Comparison; Alternative 1 is only compared to the No Action Alternative.

16.5.3.2.1 Alternative 1 Compared to the No Action Alternative

Central Valley Region

Changes in Emissions of Criteria Air Pollutants and Precursors, and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants Related to Changes in Groundwater Pumping

Groundwater pumping in the San Joaquin Valley portion of the Central Valley Region would decrease by 8 percent under Alternative 1 as compared to the No Action Alternative. It is not known if the reduction in groundwater pumping would result in a reduction of the use of electricity or diesel to drive the pump engines. For this analysis, it is assumed that the decreased use of diesel engines would be proportional to the decreased use of groundwater. Therefore, under Alternative 1, there would be a potential decrease in emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants as compared to the No Action Alternative.

Effects Related to Cross Delta Water Transfers

Potential effects to air quality could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions would occur during implementation of cross Delta water transfers under Alternative 1 and the No Action Alternative, and that impacts on air quality would not be substantial due to implementation requirements of the transfer programs.

Under Alternative 1, water could be transferred throughout the year without an annual volumetric limit. Under the No Action Alternative, the timing of cross Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Overall, the potential for cross Delta water transfers would be increased under Alternative 1 as compared to the No Action Alternative.

San Francisco Bay Area, Central Coast, and Southern California Regions

Changes in Emissions of Criteria Air Pollutants and Precursors, and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants Related to Changes in Groundwater Pumping

It is anticipated that CVP and SWP water supplies would be increased by 11 percent and 21 percent, respectively, in the San Francisco Bay Area, Central Coast, and Southern California regions under Alternative 1 as compared to the No Action Alternative. The increase in surface water supplies could result in the reduction in use of groundwater pumps and emissions of air pollutants and contaminants if the use of diesel engines is also decreased.

Overall Study Area

Changes in GHG Emissions due to Changes in Energy Generation or Use

As described in Chapter 8, Energy, changes CVP and SWP operations under Alternative 1 as compared to the No Action Alternative would result in an increase of CVP and SWP water deliveries to areas located south of the Delta; and therefore, annual energy use for conveyance would increase. CVP annual net generation would be similar, and SWP annual net generation would be decrease over the long-term average conditions. This could result in increased GHG emissions if fossil fuel generation replaces hydropower generation.

In addition to changes in CVP and SWP energy generation and use, and the associated GHG emissions, CVP and SWP operations under Alternative 1 as compared to the No Action Alternative could potentially decrease the use of energy by CVP and SWP water users due to less need to implement regional and local alternative water supplies, such as increased groundwater pumping and use of recycled water treatment plants and desalination water treatment plants. As the need for alternative water supplies is decreased, the associated energy demand and indirect GHG emissions would also be decreased under Alternative 1 as compared to the No Action Alternative.

16.5.3.2.2 Alternative 1 Compared to the Second Basis of Comparison

Alternative 1 is identical to the Second Basis of Comparison.

16.5.3.3 Alternative 2

The CVP and SWP operations under Alternative 2 are identical to the CVP and SWP operations under the No Action Alternative, as described in Chapter 3, Description of Alternatives; therefore, Alternative 2 is only compared to the Second Basis of Comparison.

16.5.3.3.1 Alternative 2 Compared to the Second Basis of Comparison

The CVP and SWP operations under Alternative 2 are identical to the CVP and SWP operations under the No Action Alternative. Therefore, changes to air quality and GHG emission conditions under Alternatives 2 as compared to the Second Basis of Comparison would be the same as the impacts described in Section 16.5.3.1, No Action Alternative.

16.5.3.4 Alternative 3

As described in Chapter 3, Description of Alternatives, CVP and SWP operations under Alternative 3 are similar to the Second Basis of Comparison with modified Old and Middle River flow criteria and New Melones Reservoir operations. As described in Chapter 4, Approach to Environmental Analysis, Alternative 3 is compared to the No Action Alternative and the Second Basis of Comparison.

16.5.3.4.1 Alternative 3 Compared to the No Action Alternative

Central Valley Region

Changes in Emissions of Criteria Air Pollutants and Precursors, and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants Related to Changes in Groundwater Pumping

Groundwater pumping in the San Joaquin Valley portion of the Central Valley Region would decrease by 6 percent under Alternative 3 as compared to the No Action Alternative. It is not known if the reduction in groundwater pumping would result in a reduction of the use of electricity or diesel to drive the pump engines. For this analysis, it is assumed that the decreased use of diesel engines would be proportional to the decreased use of groundwater. Therefore, under Alternative 3, there would be a potential decrease in emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants as compared to the No Action Alternative.

Effects Related to Cross Delta Water Transfers

Potential effects to air quality could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions would occur during implementation of cross Delta water transfers under Alternative 3 and the No Action Alternative, and that impacts on air quality would not be substantial due to implementation requirements of the transfer programs.

Under Alternative 3, water could be transferred throughout the year without an annual volumetric limit. Under the No Action Alternative, the timing of cross Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Overall, the potential for cross Delta water transfers would be increased under Alternative 3 as compared to the No Action Alternative.

San Francisco Bay Area, Central Coast, and Southern California Regions

Changes in Emissions of Criteria Air Pollutants and Precursors, and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants Related to Changes in Groundwater Pumping

It is anticipated that CVP and SWP water supplies would be increased by 9 percent and 17 percent, respectively, in the San Francisco Bay Area, Central Coast, and Southern California regions under Alternative 3 as compared to the No Action Alternative. The increase in surface water supplies could result in the reduction in use of groundwater pumps and emissions of air pollutants and contaminants if the use of diesel engines is also decreased.

Overall Study Area

Changes in GHG Emissions due to Changes in Energy Generation or Use

As described in Chapter 8, Energy, changes in CVP and SWP operations under Alternative 3 as compared to the No Action Alternative would result in an increase of CVP and SWP water deliveries to areas located south of the Delta; and therefore, annual energy use for conveyance would increase. CVP annual net energy generation would be similar; and SWP annual net energy generation would be less which could result in increased GHG emissions if fossil fuel generation replaces hydropower generation.

In addition to changes in CVP and SWP energy generation and use, and the associated GHG emissions, CVP and SWP operations under Alternative 3 as compared to the No Action Alternative could potentially decrease the use of energy by CVP and SWP water users due to less need to implement regional and local alternative water supplies, such as increased groundwater pumping and use of recycled water treatment plants and desalination water treatment plants. As the need for alternative water supplies is decreased, the associated energy demand and GHG emissions would also be decreased under Alternative 3 as compared to the No Action Alternative.

16.5.3.4.2 Alternative 3 Compared to the Second Basis of Comparison

Central Valley Region

Changes in Emissions of Criteria Air Pollutants and Precursors, and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants Related to Changes in Groundwater Pumping

Groundwater pumping in the San Joaquin Valley portion of the Central Valley Region would be similar (within a 5 percent change) under Alternative 3 as compared to the Second Basis of Comparison. Therefore, the emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants would be similar under Alternative 3 as compared to the Second Basis of Comparison.

Effects Related to Cross Delta Water Transfers

Potential effects to air quality could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions would occur during implementation of cross Delta water transfers under Alternative 3 and the Second Basis of Comparison, and that impacts on air quality would not be substantial in the seller's service area due to implementation requirements of the transfer programs.

Under Alternative 3 and the Second Basis of Comparison, water could be transferred throughout the year without an annual volumetric limit. Overall, the potential for cross Delta water transfers would be similar under Alternative 3 and the Second Basis of Comparison.

San Francisco Bay Area, Central Coast, and Southern California Regions

Changes in Emissions of Criteria Air Pollutants and Precursors, and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants Related to Changes in Groundwater Pumping

It is anticipated that CVP and SWP water supplies and emissions from diesel engines used for groundwater pumping would be similar in the San Francisco Bay Area, Central Coast, and Southern California regions under Alternative 3 as compared to the Second Basis of Comparison.

Overall Study Area

Changes in GHG Emissions due to Changes in Energy Generation or Use

As described in Chapter 8, Energy, changes in CVP and SWP operations under Alternative 3 as compared to the Second Basis of Comparison would result in a decrease of CVP and SWP water deliveries to areas located south of the Delta; and therefore, annual energy use for conveyance would decrease. CVP annual net energy generation would be similar; and SWP annual net energy generation would be greater which could result in decreased GHG emissions if hydropower generation replaces fossil fuel generation.

In addition to changes in CVP and SWP energy generation and use, and the associated GHG emissions, CVP and SWP operations under Alternative 3 as compared to the Second Basis of Comparison could potentially increase the use of energy by CVP and SWP water users to implement regional and local alternative water supplies, such as increased groundwater pumping and use of recycled water treatment plants and desalination water treatment plants. These facilities would require energy which could indirectly result in increased GHG emissions.

16.5.3.5 Alternative 4

The air quality and GHG emissions under Alternative 4 would be identical to the air quality and GHG emissions under the Second Basis of Comparison; therefore, Alternative 4 is only compared to the No Action Alternative.

16.5.3.5.1 Alternative 4 Compared to the No Action Alternative

The CVP and SWP operations under Alternative 4 is identical to the CVP and SWP operations under the Second Basis of Comparison and Alternative 1. Therefore, changes in air quality and GHG emissions under Alternative 4 as compared to the No Action Alternative would be the same as the impacts described in Section 16.5.3.2.1, Alternative 1 Compared to the No Action Alternative.

16.5.3.6 Alternative 5

As described in Chapter 3, Description of Alternatives, CVP and SWP operations under Alternative 5 are similar to the No Action Alternative with modified Old and Middle River flow criteria and New Melones Reservoir operations. As described in Chapter 4, Approach to Environmental Analysis, Alternative 5 is compared to the No Action Alternative and the Second Basis of Comparison.

16.5.3.6.1 Alternative 5 Compared to the No Action Alternative

Central Valley Region

Changes in Emissions of Criteria Air Pollutants and Precursors, and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants Related to Changes in Groundwater Pumping

Groundwater pumping in the San Joaquin Valley portion of the Central Valley Region would be similar under Alternative 5 as compared to the No Action Alternative. Therefore, the emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants would be similar under Alternative 5 as compared to the No Action Alternative.

Effects Related to Cross Delta Water Transfers

Potential effects to air quality could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions would occur during implementation of cross Delta water transfers under Alternative 5 and the No Action Alternative, and that impacts on air quality would not be substantial in the seller's service area due to implementation requirements of the transfer programs.

Under Alternative 5 and the No Action Alternative, the timing of cross Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Overall, the potential for cross Delta water transfers would be similar under Alternative 5 and the No Action Alternative.

San Francisco Bay Area, Central Coast, and Southern California Regions

Changes in Emissions of Criteria Air Pollutants and Precursors, and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants Related to Changes in Groundwater Pumping

It is anticipated that CVP and SWP water supplies and emissions from diesel engines used for groundwater pumping would be similar in the San Francisco Bay Area, Central Coast, and Southern California regions under Alternative 5 as compared to the No Action Alternative.

Overall Study Area

Changes in GHG Emissions due to Changes in Energy Generation or Use

As described in Chapter 8, Energy, changes in CVP and SWP operations under Alternative 5 as compared to the No Action Alternative would result in similar CVP and SWP water deliveries to areas located south of the Delta except in April and May when exports would decline. Overall, annual CVP and SWP net energy generation would be similar under Alternative 5 and the No Action Alternative.

In addition to changes in CVP and SWP energy generation and use, and the associated GHG emissions, CVP and SWP operations under Alternative 5 as compared to the No Action Alternative could potentially increase the use of energy by CVP and SWP water users to implement regional and local alternative water supplies, such as increased groundwater pumping and use of recycled water treatment plants and desalination water treatment plants. These facilities would require energy which could indirectly result in increased GHG emissions.

16.5.3.6.2 Alternative 5 Compared to the Second Basis of Comparison

Central Valley Region

Changes in Emissions of Criteria Air Pollutants and Precursors, and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants Related to Changes in Groundwater Pumping

Groundwater pumping in the San Joaquin Valley portion of the Central Valley Region would increase by 8 percent under Alternative 5 as compared to the Second Basis of Comparison. It is not known if the additional groundwater pumping would rely upon electricity or diesel to drive the pump engines. Under the worst case analysis, it is assumed that the increased use of diesel engines would be proportional to the increased use of groundwater. Therefore, under Alternative 5, there would be a potential increase in emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants as compared to the Second Basis of Comparison.

Effects Related to Cross Delta Water Transfers

Potential effects to air quality could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions would occur during implementation of cross Delta water transfers under Alternative 5 and the Second Basis of Comparison, and that impacts on air quality would not be substantial in the seller’s service area due to implementation requirements of the transfer programs.

Under Alternative 5, the timing of cross Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Under the Second Basis of Comparison, water could be transferred throughout the year without an annual volumetric limit. Overall, the potential for cross Delta water transfers would be reduced under Alternative 5 as compared to the Second Basis of Comparison.

San Francisco Bay Area, Central Coast, and Southern California Regions

Changes in Emissions of Criteria Air Pollutants and Precursors, and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants Related to Changes in Groundwater Pumping

It is anticipated that CVP and SWP water supplies would be decreased by 10 percent and 18 percent, respectively, in the San Francisco Bay Area, Central Coast, and Southern California regions under Alternative 5 as compared to the Second Basis of Comparison. The decrease in surface water supplies could result in increased use of groundwater pumps and emissions of air pollutants and contaminants if the use of diesel engines is also increased.

Overall Study Area

Changes in GHG Emissions due to Changes in Energy Generation or Use

As described in Chapter 8, Energy, changes in CVP and SWP operations under Alternative 5 as compared to the Second Basis of Comparison would result in a decrease of CVP and SWP water deliveries to areas located south of the Delta; and therefore, annual energy use for conveyance would decrease. CVP annual net generation would be similar; and SWP net energy generation would increase which could result indirectly in less GHG emissions if the hydropower generation replaces fossil fuel generation.

In addition to changes in CVP and SWP energy generation and use, and the associated GHG emissions, CVP and SWP operations under Alternative 5 as compared to the Second Basis of Comparison could potentially increase the use of energy by CVP and SWP water users to implement regional and local alternative water supplies, such as increased groundwater pumping and use of recycled water treatment plants and desalination water treatment plants. These facilities would require energy which could indirectly result in increased GHG emissions.

16.5.3.7 Summary of Environmental Consequences

The results of the environmental consequences of implementation of Alternatives 1 through 5 as compared to the No Action Alternative and the Second Basis of Comparison are presented in Tables 16.5 and 16.6.

Table 16.5 Comparison of Alternatives 1 through 5 to No Action Alternative

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	Decrease potential for emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants by 8 percent in the Central Valley, 11 to 21 percent in the San Francisco Bay Area Region, and by 21 percent in the Central Coast and Southern California regions. Potentially, could indirectly result in an increase of GHG emissions due to a decrease in SWP net energy generation; however, GHG emissions could decrease due to a reduced need for additional energy for alternative water supplies. The overall changes in GHG emissions are not known at this time because the need for energy use by alternative water supplies is not known at this time.	None needed
Alternative 2	No effects on air quality.	None needed
Alternative 3	Decrease potential for emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants by 6 percent in the Central Valley, 9 to 17 percent in the San Francisco Bay Area Region, and by 17 percent in the Central Coast and Southern California regions. Potentially, could indirectly result in an increase of GHG emissions due to a decrease in SWP net energy generation; however, GHG emissions could decrease due to a reduced need for additional energy for alternative water supplies. The overall changes in GHG emissions are not known at this time because the need for energy use by alternative water supplies is not known at this time.	None needed
Alternative 4	Same effects as described for Alternative 1 compared to the No Action Alternative.	None needed

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 5	Similar potential for emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants in the Central Valley, San Francisco Bay Area, Central Coast, and Southern California regions. Potentially, could indirectly result in an increase of GHG emissions due to the need for additional energy for alternative water supplies. The overall changes in GHG emissions are not known at this time because the need for energy use by alternative water supplies is not known at this time.	None needed

Note: Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools, incremental differences of 5 percent or less between alternatives and the No Action Alternative are considered to be "similar."

1 **Table 16.6 Comparison of Alternatives 1 through 5 to Second Basis of Comparison**

Alternative	Potential Change	Consideration for Mitigation Measures
No Action Alternative	Increase potential for emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants by 8 percent in the Central Valley, 10 to 18 percent in the San Francisco Bay Area Region, and by 18 percent in the Central Coast and Southern California regions. Potentially, could indirectly result in a decrease of GHG emissions due to an increase in SWP net energy generation; however, GHG emissions could increase due to the need for additional energy for alternative water supplies. The overall changes in GHG emissions are not known at this time because the need for energy use by alternative water supplies is not known at this time.	Not considered for this comparison.
Alternative 1	No effects on air quality.	Not considered for this comparison.
Alternative 2	Same effects as described for No Action Alternative as compared to the Second Basis of Comparison.	Not considered for this comparison.

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 3	Similar potential for emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants in the Central Valley, San Francisco Bay Area, Central Coast, and Southern California regions. Potentially, could indirectly result in a decrease of GHG emissions due to an increase in SWP net energy generation; however, GHG emissions could increase due to the need for additional energy for alternative water supplies. The overall changes in GHG emissions are not known at this time because the need for energy use by alternative water supplies is not known at this time.	Not considered for this comparison.
Alternative 4	No effects on air quality.	Not considered for this comparison.
Alternative 5	Increase potential for emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants by 8 percent in the Central Valley, 10 to 18 percent in the San Francisco Bay Area Region, and by 18 percent in the Central Coast and Southern California regions. Potentially, could indirectly result in a decrease of GHG emissions due to an increase in SWP net energy generation; however, GHG emissions could increase due to the need for additional energy for alternative water supplies. The overall changes in GHG emissions are not known at this time because the need for energy use by alternative water supplies is not known at this time.	Not considered for this comparison.

Note: Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools, incremental differences of 5 percent or less between alternatives and the No Action Alternative are considered to be “similar.”

16.5.3.8 Potential Mitigation Measures

Mitigation measures are presented in this section to avoid, minimize, rectify, reduce, eliminate, or compensate for adverse environmental effects of Alternatives 1 through 5 as compared to the No Action Alternative. Mitigation measures were not included to address adverse impacts under the alternatives as compared to the Second Basis of Comparison because this analysis was included in this EIS for information purposes only.

Changes in CVP and SWP operations under Alternatives 1 through 5 as compared to the No Action Alternative would not result in changes in air quality. Therefore, there would be no adverse impacts to air quality; and no mitigation measures are required.

16.5.3.9 Cumulative Effects Analysis

As described in Chapter 3, the cumulative effects analysis considers projects, programs, and policies that are not speculative; and are based upon known or reasonably foreseeable long-range plans, regulations, operating agreements, or other information that establishes them as reasonably foreseeable.

The cumulative effects analysis considers potential incremental impacts of the alternatives when added to other past and present actions (as described in the Affected Environment section) and reasonably foreseeable future actions (as described in the No Action Alternative section plus cumulative effects) regardless of what agency (federal or non-federal) or person undertakes such actions (40 CFR 1508.7, 1508.25, and 43 CFR 46.115). The quantitative effects of these items are based upon the quantitative comparisons of Alternatives 1 through 5 to the No Action Alternative presented in previous sections of this chapter; and the qualitative cumulative effects of the alternatives are based upon the qualitative comparisons of Alternatives 1 through 5 to the No Action Alternative presented in previous sections of this chapter and the effects of the cumulative actions that are less certain than future actions under the No Action Alternative.

The cumulative effects analysis for Alternatives 1 through 5 for Air Quality issues are summarized in Table 16.7.

Table 16.7 Summary of Cumulative Effects on Air Quality with Implementation of Alternatives 1 through 5 as Compared to the No Action Alternative

Scenarios	Actions	Cumulative Effects of Actions
Past & Present, and Future Actions included in the No Action Alternative and in All Alternatives in Year 2030	Consistent with Affected Environment conditions plus: Actions in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives), including climate change and sea level rise Actions not included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives): • Implementation of Federal and state policies and programs, including Clean Water Act (e.g., Total Maximum Daily Loads); Safe Drinking Water Act; Clean Air Act; and flood management programs • General plans for 2030. • Trinity River Restoration Program. • Central Valley Project Improvement Act programs • Folsom Dam Water Control Manual Update • FERC Relicensing for the Middle Fork of the American River Project • San Joaquin River Restoration Program • Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects with completed environmental documents)	<u>These effects would be the same under all alternatives.</u> Climate change and sea level rise, development under the general plans, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce carryover storage in reservoirs and changes in stream flow patterns in a manner that could reduce hydroelectric generation in the summer and fall months which could result in increased use of fossil fuels and indirectly increase GHG emissions for fossil fuel generation and increased use of diesel engines for additional groundwater use. Reduced CVP and SWP water deliveries south of the Delta would reduce CVP and SWP electricity use for conveyance; and could reduce the need for electricity generation using fossil fuels and indirectly reduce GHG emissions. Future water supply projects are anticipated to both improve water supply reliability due to reduced surface water supplies and to accommodate planned growth in the general plans. It is anticipated that some of these projects could increase energy use, such as implementation of desalination projects. However, other projects, such as water recycling, would not substantially increase energy use because most of the energy use was previously required for wastewater treatment. It is anticipated that energy required for water treatment of alternative water supplies would be similar as treatment for CVP and SWP water supplies. Increased energy use could increase use of electricity generation by fossil fuels; which could increase air quality issues and indirectly increase GHG emissions. Most of these programs were initiated prior to implementation of the 2008 USFWS BO and 2009 NMFS BO which reduced CVP and SWP water supply reliability.

Scenarios	Actions	Cumulative Effects of Actions
Future Actions considered as Cumulative Effects Actions in All Alternatives in Year 2030	Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives): • Bay-Delta Water Quality Control Plan Update • FERC Relicensing Projects • Bay Delta Conservation Plan (including the California WaterFix alternative) • Shasta Lake Water Resources, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations • El Dorado Water and Power Authority Supplemental Water Rights Project • Sacramento River Water Reliability Project • Semitropic Water Storage District Delta Wetlands • North Bay Aqueduct Alternative Intake • Irrigated Lands Regulatory Program • San Luis Reservoir Low Point Improvement Project • *Westlands Water District v. United States Settlement* • Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects that did not have completed environmental documents during preparation of the EIS)	<u>These effects would be the same under all alternatives.</u> Most of the future reasonably foreseeable actions are anticipated to improve water supplies in California to reduce impacts due to climate change, sea level rise, increased water allocated to improve habitat conditions, and future growth. If CVP and SWP water supply reliability increases, energy use for conveyance of CVP and SWP water supplies also would increase. Some of the future reasonably foreseeable actions are anticipated to potentially reduce CVP and SWP water supply reliability (e.g., Water Quality Control Plan Update and FERC Relicensing Projects). Future water supply projects are anticipated to both improve water supply reliability due to reduced surface water supplies and to accommodate planned growth in the general plans. It is anticipated that some of these projects could increase energy use, such as implementation of desalination projects. However, other projects, such as water recycling, would not substantially increase energy use because most of the energy use was previously required for wastewater treatment. It is anticipated that energy required for water treatment of alternative water supplies would be similar as treatment for CVP and SWP water supplies. Increased use of groundwater pumps would increase energy use.

Scenarios	Actions	Cumulative Effects of Actions
No Action Alternative with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP	Implementation of No Action Alternative would result in changes stream flows and related changes in hydroelectric generation patterns, and reduced CVP and SWP water supplies as compared to conditions prior to the BOs. If CVP and SWP water supply reliability decreases, energy use for conveyance of CVP and SWP water supplies also would decrease and energy use for alternative water supplies could increase. Increased energy use could increase use of electricity generation by fossil fuels; which could increase air quality issues and indirectly increase GHG emissions.
Alternatives 1 and 4 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternatives 1 and 4 with reasonably foreseeable actions would result in changes in stream flows and related hydroelectric generation patterns, and increased CVP and SWP water supplies as compared to the No Action Alternative with the added actions. Increased CVP and SWP water supply reliability would increase energy use for conveyance of CVP and SWP water supplies; and it is anticipated that energy use for alternative water supplies would decrease as compared to the No Action Alternative with the added actions. Increased energy use for CVP and SWP conveyance could increase use of electricity generation by fossil fuels; which could increase air quality issues and indirectly increase GHG emissions. However, decreased energy use for alternative water supplies could decrease use of electricity generation by fossil fuels; which could decrease air quality issues and indirectly decrease GHG emissions as compared to for the No Action Alternative with the added actions.
Alternative 2 with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions No implementation of structural improvements or other actions that require further study to develop a more detailed action description.	Implementation of Alternative 2 with reasonably foreseeable actions for energy resources would be the same as for the No Action Alternative with the added actions.

Scenarios	Actions	Cumulative Effects of Actions
Alternative 3 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant) Slight increase in positive Old and Middle River flows in the winter and spring months	Implementation of Alternative 3 with reasonably foreseeable actions would result in changes in stream flows and related hydroelectric generation patterns, and increased CVP and SWP water supplies as compared to the No Action Alternative with the added actions. Increased CVP and SWP water supply reliability would increase energy use for conveyance of CVP and SWP water supplies; and it is anticipated that energy use for alternative water supplies would decrease as compared to the No Action Alternative with the added actions. Increased energy use for CVP and SWP conveyance could increase use of electricity generation by fossil fuels; which could increase air quality issues and indirectly increase GHG emissions. However, decreased energy use for alternative water supplies could decrease use of electricity generation by fossil fuels; which could decrease air quality issues and indirectly decrease GHG emissions as compared to for the No Action Alternative with the added actions.
Alternative 5 with Associated Cumulative Effects Actions in Year 20530	Full implementation of the 2008 USFWS BO and 2009 NMFS BO Positive Old and Middle River flows and increased Delta outflow in spring months	Implementation of Alternative 5 with reasonably foreseeable actions would result in similar net CVP and SWP hydroelectric generation, and reduced CVP and SWP water supplies as compared to the No Action Alternative with the added actions. It is anticipated that energy use for alternative water supplies would increase as compared to the No Action Alternative with cumulative effects which could increase air quality issues and indirectly increase GHG emissions as compared to for the No Action Alternative with the added actions.

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Chapter 17

Cultural Resources

17.1 Introduction

Cultural resources are defined as prehistoric and historic archaeological sites, architectural features (e.g., buildings, bridges, flumes, trestles, railroads), and traditional cultural properties. However, the focus of this chapter is more on cultural resources than historic properties.

This chapter describes the known existing cultural resources conditions in the study area and the potential changes that could occur as a result of implementing the alternatives evaluated in this Environmental Impact Statement (EIS). Implementation of the alternatives could affect cultural and historic resources through potential changes in the operation of the Central Valley Project (CVP) and State Water Project (SWP). Changes in CVP and SWP operations could increase the frequency and duration of low-elevation reservoir conditions that would increase the time of exposure of inundated cultural resources within reservoirs that store CVP and SWP water. Changes in CVP and SWP operations also could reduce water supply availability to agricultural lands, and those lands could be subject to land use changes that could increase disturbances of cultural resources if present.

17.2 Regulatory Environment and Compliance Requirements

Potential actions that could be implemented under the alternatives evaluated in this EIS could affect reservoirs, streams, and lands served by CVP and SWP water supplies located on lands with cultural resources. Actions implemented, funded, or approved by Federal and state agencies would need to be compliant with appropriate Federal and state agency policies and regulations, as summarized in Chapter 4, Approach to Environmental Analyses.

17.3 Affected Environment

This section describes the types of cultural resources that could be potentially affected by the implementation of the alternatives considered in this EIS. Changes in areas with cultural resources due to changes in CVP and SWP operations may occur at reservoirs that store CVP and SWP water and on lands that use CVP and SWP water supplies in the Trinity River, Central Valley, San Francisco Bay Area, and Central Coast and Southern California regions.

17.3.1 Prehistoric Context

17.3.1.1 Introduction to the Prehistoric Context

The study area has a long and complex cultural history with distinct regional patterns that extend back more than 11,000 years (Reclamation 1997). The first generally agreed upon evidence for the presence of prehistoric peoples in the study area is represented by the distinctive fluted spear points called Clovis points. These artifacts have been found on the margins of extinct lakes in the San Joaquin Valley. The Clovis points are found on the same surface with the bones of animals that are now extinct, such as mammoths, sloths, and camels. The subsequent period from about 10000 to 8000 BP (before present) was characterized by a small number of sites with stemmed spear points instead of fluted spear points. Approximately 8,000 years ago, many California cultures shifted the main focus of their subsistence strategies from hunting to seed gathering as evidenced by the increase in food-grinding implements found in archaeological sites dating to this period. In the last 3,000 years, the archaeological record becomes more complex as specialized adaptations to locally available resources were developed and populations expanded. Many sites dated to this time period contain mortars and pestles or are associated with bedrock mortars, implying that the occupants exploited acorns intensively. The range of subsistence resources that were used increased, exchange systems expanded, and social stratification and craft specialization occurred as indicated by well-made artifacts such as charm stones and beads, which were often found with burials.

17.3.1.2 Prehistory of the Trinity River Region

The Trinity River Region includes portions of Trinity County including Trinity Lake, Lewiston Reservoir, and Trinity River from Lewiston Reservoir to the Humboldt County boundary (near the eastern boundary of Hoopa Valley Indian Reservation); portions of Humboldt County including the Hoopa Valley Indian Reservation, Trinity River from the Humboldt County border to the Del Norte County border (near the confluence of the Trinity and Klamath rivers); and Del Norte County including the Lower Klamath River from the confluence with the Trinity River to the Pacific Ocean.

The area surrounding the present Trinity Lake and the Trinity River to its confluence with the Klamath River and along the Klamath River to the Pacific Ocean was inhabited by the Wintu, Chimariko, Yurok, and Hupa Indians at the time of Euroamerican contact.

17.3.1.3 Prehistory of the Central Valley Region

The Central Valley Region extends from above Shasta Lake to the Tehachapi Mountains and includes the Sacramento Valley, San Joaquin Valley, and the Delta and Suisun Marsh areas. The Sacramento Valley and San Joaquin Valley are divided into Eastern and Western subregions.

17.3.1.3.1 Prehistory of the Sacramento Valley

The western Sierra Nevada foothills appear to have been first used by Great Basin people around 8000 BP (Reclamation 1997). By approximately 4000 BP, people possibly from the Great Basin were seasonally hunting and gathering in the Sierra Nevada and the Sacramento Valley.

In the northern western portion of Sacramento Valley, between approximately 12,000 and 150 years ago (12000 to 100 BP), the prehistoric societies of northern California underwent a series of slow but significant changes in subsistence and economic orientation, population densities and distribution, and social organization. These changes are thought to reflect migrations of various peoples into the area and displacement of earlier populations (Jensen and Reed 1980; Farber 1985; Reclamation 1997). Early archaeological investigations within Nomlaki and Wintu ethnographic territory, particularly the present Redding area and adjacent tracts of the southern Klamath Mountains, appear to indicate that human occupation of this area began approximately 1050 to 950 BP.

Little is known of human occupation on the floor of the Sacramento Valley prior to 4500 BP (Reclamation 1997). Because of alluvial and colluvial deposition over the past 10,000 years, ancient cultural deposits have been deeply buried in many areas. Initially, humans appeared to adapt to lakes, marshes, and grasslands environments until approximately 8000 to 7000 BP (Placer County 2007). The earliest evidence of widespread villages and permanent occupation of the lower Sacramento Valley, Delta, and Suisun Marsh areas comes from several sites assigned to the Windmiller Pattern (previously, “Early Horizon”), dated circa 4500 to 2500 BP (Ragir 1972; Reclamation 1997; Reclamation et al. 2010).

From circa 2500 to 1500 BP in the Central Valley area, villages were characterized by deep midden deposits, suggesting intensified occupation and a broadened subsistence base (Reclamation 1997, 2005a; Reclamation et al. 2010; Beardsley 1948; Heizer and Fenenga 1939; Moratto 1984).

During the late prehistoric period from 1500 to 100 BP, development may have been initiated due to the southward expansion of Wintuan populations into the Sacramento Valley (Moratto 1984; Reclamation 1997; Reclamation et al. 2010). The period is characterized by intensified hunting, fishing, and gathering subsistence with larger communities, highly developed trade networks, elaborate ceremonial and mortuary practices, and social stratification.

17.3.1.3.2 Prehistory of the San Joaquin Valley

Evidence of prehistoric occupation of the central and southern Sierra Nevada foothills goes back to 9,500 years ago. The vast majority of investigated sites, however, are less than 500 years old, probably representing a relatively recent proliferation of settlements by Yokut Indians (Moratto 1984; Reclamation 1997). The chronological sequence developed in the south-central Sierra Nevada as a result of the Buchanan Reservoir project in present Madera County is still used as a general framework (Reclamation 1997). Similar findings were identified in major settlement sites along the San Joaquin River and in the present New Melones Reservoir area (Reclamation 2010; Reclamation and DWR 2011).

During the early Holocene period (10,000 to 12,000 years ago), peoples probably inhabited or passed through the San Joaquin Valley; however, few indications of this period have been discovered, probably due to burial beneath accumulated river sediment (Reclamation 1997, 2012). Examples of early Holocene cultural remains are known primarily from the Tulare Basin in the southern San Joaquin Valley. Evidence along the southern shoreline of the ancient Tulare Lake indicates that human presence may have occurred from 11000 BP (Reclamation and State Parks 2013).

From approximately 1650 to 950 BP, there is evidence that the people of the eastern San Joaquin Valley may have interacted with people in the Delta area (Reclamation 1997, 2012).

From approximately 450 to 100 BP, the people of the eastern San Joaquin Valley may have interacted with people in the Central Coast and Southern California areas. Material found in Pacheco to Panoche strata indicates a trade relationship with people of the Delta, Central Coast, and Southern California regions (Moratto 1984; Reclamation 1997, 2012).

17.3.1.4 Prehistory of the San Francisco Bay Area Region

The San Francisco Bay Area Region only includes portions of the Bay Area that could be affected through implementation of the alternatives considered in this EIS, which includes Contra Costa, Alameda, Santa Clara, and San Benito counties. The prehistory context is different throughout the San Francisco Bay Area Region. Human occupation in the northern valley regions of present San Benito County occurred as described above for the western San Joaquin Valley (San Benito County 2010).

Human occupation in the coastal regions of present Contra Costa and Alameda counties occurred as described above for the southern portion of the Sacramento Valley (Reclamation 1997; DWR 2008; Zone 7 2006). From 5000 to 2500 BP, dense settlements extended from the coastal marshes to interior grasslands and woodlands (Zone 7 2006). From about 2500 to 950 BP, coastal communities relied upon shellfish, and major shellmounds were created near these communities, including near the present Alameda County shorelines and some interior valleys.

Settlement of the interior valleys of the present Contra Costa, Alameda, and Santa Clara counties occurred during the past 12,000 years. From 6000 to 1700 BP, settlements occurred, as there was less emphasis on nomadic hunting for large animals and increased emphasis on the use of plant materials and hunting, fishing, and shellfish collection (Santa Clara County 2012; CCWD et al. 2009). The communities established economies and traded between the communities.

17.3.1.5 Prehistory of the Central Coast Region

The prehistory of the Central Coast Region for this EIS (present day San Luis Obispo and Santa Barbara counties) is poorly known but may have begun around 11000 BP and probably represents mobile hunter-gatherers (Reclamation 1997; San Luis Obispo County 2010; Santa Barbara 2010). Fishing, intensive shellfish collecting, and hunting began around 9000 BP. Use of milling stones and establishment of communities occurred after about 8500 BP. After about 5000 BP, there was greater reliance on hunting of land and sea mammals, gathering of shellfish, and use of mortars and pestles. Subsequently, larger settlements occurred for ethnographically known peoples, including the Chumash.

17.3.1.6 Prehistory of the Southern California Region

The Southern California Region includes the present Ventura, Los Angeles, Orange, San Diego, Riverside, and San Bernardino counties, which have substantially different prehistory characteristics.

In the coastal areas of the Southern California Region (present Ventura, Los Angeles, Orange, and San Diego counties), early habitation extends over 12,000 years ago (Ventura County 2005; Los Angeles 2005; San Diego County 2011b). Between 12000 and 7500 BP, the inhabitants were hunter-gatherer populations that used land and marine resources. The population along the northern coast of Southern California began expanding between 9000 and 8500 BP. Permanent coastal settlements expanded as plants, shellfish, and marine mammals became a large part of the subsistence (Glassow et al. 2007; Los Angeles 2005). From 5000 to 450 BP, the use of plant materials and exploitation of fish and sea mammals increased sedentism and socioeconomic interaction (Glassow 1999; Los Angeles 2005; San Diego County 2011b).

The interior area within the Southern California Region considered in this EIS includes portions of Riverside and San Bernardino counties that use SWP water supplies, including the Mojave Desert and the Peninsular Ranges.

Clovis (circa 12000 to 10000 BP) is the only cultural complex dating from the Pleistocene that can be consistently identified in the Mojave Desert (Sutton et al. 2007). The Clovis culture characteristics appear to be associated with Paleo-Indian groups as big game hunters. More recently, there have been indications that the people had greater cultural and economic diversity than previously recognized (CDFG 2009). Paleo-Indian groups were likely small, highly mobile populations living in small, temporary camps near permanent water sources (Sutton et al. 2007).

From 10000 and 8000 BP, communities were organized around relatively small social units (Sutton et al. 2007; Riverside County 2000). From 7000 to 4000 BP, hunting continued while foraging subsistence transformed during this period to more collection of plant and animal materials within adjacent ecological zones (CDFG 2009; Riverside County 2000; Sutton et al. 2007). Between 4000 and 1750 BP, permanent seasonally occupied settlements occurred in the lower valley with the use of oak woodlands and mesquite groves (Riverside County 2000; Sutton et al. 2007).

From 1750 to 850 BP, communities increased and trade between communities expanded (CDFG 2009; Gardner 2002, 2006; Riverside County 2000; Sutton et al. 2007; Sutton 1988, 1996; Warren and Crabtree 1986). During this period, the lower Coloradan culture became more prevalent along the shoreline of the Lake Cahuilla area (site of the present Salton Sea and Coachella Valley Water District) (Riverside County 2000). The lower Coloradans relied upon shellfish, fish, aquatic birds, marsh and riparian vegetation, and mammals. The culture may have been influenced by the Anasazi settlements of present Southern Nevada, including cultivation of corns, beans, and squash. The Anasazi people also occupied portions of present San Bernardino County where turquoise was mined. Extensive trading occurred between the people in the inland areas and the people along the coast.

After about 850 BP, populations appeared to decline, and several cultural complexes emerged (Sutton et al. 2007). Late Prehistoric occupation sites were based on hunting and gathering, especially of plant foods and small game (Riverside County 2000). Villages in Antelope Valley began to disappear in the later prehistoric times, probably due to the disappearance of lakes that were the headwaters of the Mojave River or changes in trade route locations (DWR 2009). Lake Cahuilla declined around 450 BP and the large populations dispersed to the Colorado River, western Peninsular Ranges in present western Riverside County, and the Pacific Ocean coast (Riverside County 2000).

17.3.2 Ethnographic Context

17.3.2.1 Introduction to Ethnographic Context

This section provides brief ethnographic sketches for each native cultural group whose traditional territories are within the study area. Each ethnographic sketch presents the territorial limits of each respective cultural group and then focuses mainly on those aspects of culture that are potentially represented in the archaeological record.

The study area encompasses lands occupied by more than 40 distinct Native American cultural groups. Although most California tribes shared similar elements of social organization and material culture, linguistic affiliation and territorial boundaries primarily distinguish them from each other. Before European settlement of California, an estimated 310,000 native Californians spoke dialects of as many as 80 mutually unintelligible languages representing six major North American language stocks (Cook 1978; Moratto 1984; Reclamation 1997; Shipley 1978).

17.3.2.2 Ethnography of the Trinity River Region

The Trinity River Region includes portions of Shasta, Trinity, Siskiyou, Humboldt, and Del Norte counties. This area is bounded by the Sacramento River on the east, the Pacific Ocean on the west, and the middle and upper Klamath Basin on the north. The ethnography of the Yurok, Hupa, Wintu, and Chimariko is described below.

17.3.2.2.1 Yurok

The Yurok inhabited California's northwestern coastline from Little River to Damnation Creek; along the Klamath River from the confluence with the Pacific Ocean up past the Klamath-Trinity confluence to Slate Creek; and approximately 6 miles along the Trinity River upstream of the confluence with the Klamath River (Pilling 1978; USFWS et al. 1999). The Yurok life, communities, society, and ceremonies are deeply connected with the Klamath River (DOI and CDFG 2012). Yurok culture and traditional stories describe that the Klamath River was created to facilitate the interaction with two neighboring people, the Hupa and the Karuk, and with the salmon that lived in the Klamath River. Both the Hupa and Karuk culture and traditional stories also describe this close interaction of the peoples, salmon, and Klamath River.

Yurok are recognized for their highly stylized art forms and their skills in making redwood canoes, weaving fine baskets, hunting, and especially riverine salmon fishing. The ancient traditions are continued through contemporary times (USFWS et al. 1999). The redwood canoes for ocean conditions can be 30 to 40 feet in length, designed to haul large amounts of fish and seal carcasses, and paddled by 5 to 20 paddlers (DOI and CDFG 2012). The canoes are used to gather food and materials, transport people and materials, and for ceremonial aspects of the Yurok culture. The Jump and Deerskin ceremonies are held in late fall to give thanks for abundant food supplies. The Deerskin Ceremony includes a Boat Ceremony in which the participants travel down the Klamath River to thank the river for continuing to flow and provide resources.

17.3.2.2.2 Hupa

The Hupa inhabited the area surrounding the lower reaches of the Trinity River from approximately Salyer to approximately 6 miles upstream from the confluence with the Klamath River (Wallace 1978a; USFWS et al. 1999). Hupa life is defined by extended families affiliated with villages.

The Hupa believe that the Klamath and Trinity rivers were created to provide interaction with other peoples (Yurok and Karuk) and with the salmon (DOI and CDFG 2012). Many of the Hupa ceremonies highlight their relationship with the rivers, including world renewal ceremonies and ceremonies for bountiful harvests. The world renewal ceremonies include the White Deerskin and Jump ceremonies to honor the earth and the creator for providing food and other resources. The ceremonies for bountiful harvest of fish and acorns include the First Salmon ceremony and the Acorn Feast.

17.3.2.2.3 Wintu

When the Europeans and Americans first explored California, most of the western side of the Sacramento Valley north of about Suisun Bay was inhabited by Wintun-speaking people (USFWS et al. 1999). Early in the anthropological study of the region, a linguistic and cultural distinction was recognized between the Wintun-speaking people in the southwestern Central Valley (the Patwin) and the people occupying the northwestern Central Valley and Trinity River Valley (LaPena 1978; USFWS et al. 1999).

17.3.2.2.4 Chimariko

The Chimariko lived in a 20-mile-long reach of the Trinity River from approximately Big Bar to the confluence with the South Fork (Silver 1978a; USFWS et al. 1999). Although the Chimariko language is now extinct, early ethnographers recorded some words, and the language is thought to be of Hokan stock.

17.3.2.3 Ethnography of the Central Valley Region

17.3.2.3.1 Ethnography of the Sacramento Valley

Maidu, Konkow, and Nisenan

Maidu (also known as northeastern Maidu), Konkow (also known as northwestern Maidu), and Nisenan (also known as southern Maidu) inhabited an area of California from Lassen Peak to the Cosumnes River, and from the Sacramento River to Honey Lake (Reclamation 1997; Shipley 1978). Northeastern Maidu territory extended from Lassen Peak on the west to Honey Lake on the east, Sierra Buttes on the south, and Eagle Lake on the north. The Konkow inhabited the region from the Lower Feather River in the north, to the Sutter Buttes in the south, and to the west beyond the Sacramento River. The Nisenan lived in the area east of the Sacramento River and along the Middle Fork Feather River, Bear River, American River, and Cosumnes River from the Sacramento River almost to Lake Tahoe (Riddell 1978; Wilson and Towne 1978; Reclamation 1997, 2005b).

Yana

The Yana of north-central California inhabited an area from Lassen Peak and the southern Cascade foothills on the east, Rock Creek on the south, Pit River on the north, and the eastern bank of the Sacramento River on the west. The western boundary is the most uncertain (J. Johnson 1978a; Reclamation 1997).

Achumawi, Atsugewi, and Shasta

The Achumawi and Atsugewi of northeastern California are two linguistically and culturally distinct but related groups (Reclamation 1997). The Achumawi and Atsugewi languages belong to the Palaihnihan family, or Hokan stock. The territory of the Achumawi extended generally to Mount Lassen, west to Mount Shasta, northeast to Goose Lake, and east to the Warner Range (Kroeber 1925; Olmsted and Stewart 1978; Garth 1978; Reclamation 1997). Overlapping this area to some extent, the Atsugewi territory ranged from Mount Lassen in the southwest, the Pit River in the north, and Horse Lake to the east.

The Shasta peoples were originally thought to be associated with the Achumawi and Atsugewi but then were considered as a separate group (Kroeber 1925; Reclamation 1997; Shipley 1978). The Shasta peoples inhabited the area from southern Oregon at the Rogue River, south to the present Cecilville, and the area between the Marble and Salmon mountains to Mount Shasta in the west and the

Cascade Range in the east. In California, the core areas of settlement were in Shasta Valley, Scotts Valley, and along the Klamath River from about Scotts River to the town of Hornbrook (Silver 1978b).

Plains Miwok

The Plains Miwok established villages along river courses in the foothills located east of Sacramento and the Delta (Reclamation 2005b).

Nomlaki

Two major divisions existed among the Nomlaki: the River and Hill Nomlaki (Goldschmidt 1978; DuBois 1935; Reclamation 1997). The River Nomlaki occupied the Sacramento River Valley in present eastern Tehama County. The Hill Nomlaki occupied the eastern side of the Coast Ranges in present Tehama and Glenn counties. The Nomlaki and Wintu conducted trading between the peoples (Goldschmidt 1978; DuBois 1935; Reclamation 1997).

Patwin

The Patwin lived along the western side of the Sacramento Valley from the present Princeton to Benicia, including Suisun Marsh (Kroeber 1925; Reclamation 1997; Reclamation et al. 2010). Within this large area, the Patwin have traditionally been divided into River, Hill, and Southern Patwin groups. Settlements generally were located on high ground along the Sacramento River or tributary streams, or in the eastern Coast Range valleys. The ethnographically recorded villages of Aguasto and Suisun were located near San Pablo and Suisun bays (P. Johnson 1978b; Reclamation 1997; Reclamation et al. 2010).

17.3.2.3.2 Ethnography of the San Joaquin Valley

Eastern Miwok

The Miwok cultures in present California include the Coast Miwok, Lake Miwok, and Eastern Miwok divisions. The Eastern Miwok included five separate groups (Bay, Plains, Northern Sierra, Central Sierra, and Southern Sierra) that inhabited the area from present Walnut Creek in Contra Costa County and the Delta, along the lower Mokelumne and Cosumnes rivers and along the Sacramento River from present Rio Vista to Freeport, the foothill and mountain areas of the upper Mokelumne River and Calaveras River watersheds, the upper Stanislaus River and Tuolumne River watersheds, and the upper Merced River and Chowchilla River watersheds, respectively (Levy 1978a; Reclamation 1997; Shipley 1978). No one Miwok tribal organization encompassed all the peoples speaking Miwokan languages, nor was there a single tribal organization that encompassed an entire division.

Yokuts

Yokuts are a large and diverse number of people in the San Joaquin Valley and Sierra Nevada foothills of central California, including the Southern San Joaquin Valley Yokuts, Northern San Joaquin Valley Yokuts, and Foothill Yokuts (Reclamation 1997; Reclamation et al. 2011a; SJRRP 2011). The three subdivisions of the Yokuts languages belong to the Yokutsan family, or Penutian stock (Shipley 1978).

The Southern Valley Yokuts inhabited the southern San Joaquin Valley from present Fresno to the Tehachapi Mountains (Wallace 1978b). The Northern Valley Yokuts inhabited the northern San Joaquin Valley from Bear Creek to the San Joaquin River near present Mendota, western San Joaquin Valley near present San Luis Reservoir, and eastern present Contra Costa and Alameda counties (ECCCHCPA et al. 2006; Wallace 1978c; Reclamation and State Parks 2012; Reclamation and DWR 2011). The Foothill Yokuts inhabited the western slopes of the Sierra Nevada foothills from the Fresno River to the Kern River (Spier 1978b; Reclamation and State Parks 2013). Yokuts were mobile hunters and gatherers with semipermanent villages and seasonal travel corridors to food sources.

The Yokuts probably traded with the Costanoan people from the coastal areas based upon the abalone and other mussel shells found in settlement sites (Reclamation and State Parks 2012).

Dumna and Kechayi

The Dumna and Kechayi lived along the San Joaquin River in the Sierra Nevada foothills near the present Millerton Lake (Reclamation and State Parks 2013).

17.3.2.4 Ethnography of the San Francisco Bay Area Region

Native inhabitants of the San Francisco Bay Area Region include the Miwok, Cholvon Northern Valley Yokuts, and the Costanoan Indians (Reclamation 1997; CCWD et al. 2009; ECCCHCPA et al. 2006; EBMUD 2009; Reclamation 2005b; Santa Clara County 2012; San Benito County 2013).

17.3.2.4.1 Miwok

In the San Francisco Bay Area Region, the Coast Miwok people lived along lower San Joaquin River and San Pablo Bay and in the interior of the present Contra Costa and Alameda counties (Reclamation 1997; ECCCHCPA et al. 2006; Kelly 1978). The Bay Miwok villages were located in the San Ramon Valley with other settlements on the western slopes of the Diablo Range. The Volvons, speakers of the Bay Miwok language, settled along Marsh Creek and Kellogg Creek on the northern side of the Diablo Range and near the present Los Vaqueros Reservoir (CCWD et al. 2009). The Miwok people may have held lands at the peak of Mount Diablo.

17.3.2.4.2 Costanoan

The Costanoans (also known as Ohlone) are a linguistically defined group with several autonomous tribelets that speak related languages (Levy 1978b; Reclamation 1997; EBMUD 2009; Zone 7 2006; Santa Clara County 2012). The Costanoans inhabited coastal shorelines along San Francisco, San Pablo, and Suisun Bay and along the Pacific Ocean Coast from the Golden Gate to Monterey Bay and interior valleys that extended approximately 60 miles inland, including areas within Santa Clara and San Benito counties (Reclamation 1997; ECCCHCPA et al. 2006; San Benito County 2010).

17.3.2.5 Ethnography of the Central Coast Region

The Central Coast Region considered in this EIS includes the coastal areas of present San Luis Obispo and Ventura counties. This area was home to the Salinan, Chumash, and Tataviam people.

The Salinan territory extends from about the present location of Soledad (Monterey County) to San Luis Obispo (Hester 1978). The Chumash are considered to have been one of the most elaborate cultures in California. The Chumash culture is characterized by large villages with social ranking, intensive trade, craft specialization, and well-developed art styles (Grant 1978b; Greenwood 1978; Kroeber 1925; Moratto 1984; Reclamation 1997; San Luis Obispo County 2010; Santa Barbara 2010; Santa Barbara County 2010). The Chumash inhabited the central coastal area of California from approximately present San Luis Obispo to Malibu Canyon and inland to western San Joaquin Valley.

17.3.2.6 Ethnography of the Southern California Region

The coastal portion of the Southern California Region considered in this EIS includes the present Ventura, Los Angeles, Orange, and San Diego counties. The interior portion of the Southern California Region includes the present western and central Riverside County and western San Bernardino County.

17.3.2.6.1 Prehistory of Southern California Region, Coastal Portion

The Chumash and Tataviam people lived in the present Ventura County and northern Los Angeles County areas. The ethnography of the Chumash people is similar to that described above for the Central Coast Region. The Tataviam people lived inland of the Chumash and Gabrielino on the upper reaches of the Santa Clara River drainage east of Piru Creek and extending over the Sawmill Mountains to the edge of the southwestern Antelope Valley (King and Blackburn 1978).

The Gabrielino and Juaneño people lived in the present Los Angeles and Orange counties areas. The Gabrielino (also known as Gabrielino Tongva or Gabrieleño) occupied the Southern California coast in the vicinity around Mission San Gabrielal areas. The Juaneño occupied the area around the mission (Bean and Smith 1978; Los Angeles 2005; Riverside County 2000). These people traded with other people in Southern California.

The Luiseño and Tipai-Ipai people lived in the present Orange and San Diego counties areas. The Luiseño occupied most of the San Luis Rey and Santa Margarita River drainages near San Luis Rey Mission (Bean and Shipek 1978). The Luiseño shared many cultural traits with the Gabrielino and Chumas people. The Tipai-Ipai (also known as Kumeyaay) occupied extreme Southern California and Northern Baja California in autonomous, seminomadic bands of patrilineal clans (Luomala 1978; San Diego County 2011b; CDFG 2009). The Ipai occupied the areas north of the San Diego River, and the Tipai occupied the area south of the San Diego River (San Diego County 2011b).

17.3.2.6.2 Prehistory of Southern California Region, Interior Portion

The Cahuilla, Serrano, Tubatalabal, Kawaiisu, and Quechan people lived in present Riverside, eastern Los Angeles, southeastern Kern, and western San Bernardino counties. The Tubatalabal also lived in the southeastern San Joaquin Valley in present southeastern Kern County.

Cahuilla

The Cahuilla lived inland within present Riverside County. Villages were located in canyons or on alluvial fans close to food and water sources. The Cahuilla interacted frequently with other people in Southern California (Bean 1978; Riverside County 2000).

Serrano

The Serrano lived in the San Bernardino Mountains within present northeastern Los Angeles County and southwestern San Bernardino County and in the northwestern valleys and mountains of Riverside County. Villages were located close to food and water sources along perennial streams and lakes. The Serrano interacted frequently with other people in Southern California (Riverside County 2000; DWR 2009).

Kawaiisu

The Kawaiisu occupied a mountainous area between the Mojave Desert and the southern San Joaquin Valley, mostly in Kern County, and the Tehachapi Valley (Zigmond 1986; California State Parks 2014). The Kawaiisu lived in permanent winter villages and traveled during the warmer months into the Mojave Desert and Antelope Valley. They traded and interacted with neighboring groups, including the Chumash, Yokuts, and Tubatalabal people.

Quechan

The Quechan were Yuman people that occupied areas along the Colorado River and adjacent valleys, including present Coachella and Imperial valleys (Riverside County 2000). The Quechan had a strong tribal identity and traveled extensively for trade.

17.3.3 Historical Context

The historical context presented in this section is focused on historical activities and resources that affected and/or were affected by implementation of water resource actions of CVP and SWP water users. Changes in CVP and SWP operations under implementation of alternatives considered in this EIS could not only affect CVP and SWP facilities. These changes also could affect regional and local water supplies, reservoirs, and associated land uses of those that use CVP and SWP water.

17.3.3.1 Introduction to Historical Context

Initial contact with Europeans and Americans occurred with Spanish missionaries and soldiers, who entered California from the south in 1769, eventually founding 21 missions along the California coast (Reclamation 1997). This period is characterized by the establishment of missions and military presidios, the development of large tracts of land owned by the missions, and subjugation of the local Indian population for labor. This way of life began to change in 1822 when Mexico became independent of Spain. The mission lands were divided by government grants into large ranchos often consisting of tens of thousands of acres. The owners of these large *estancias* built homes, often of adobe, and maintained large herds of cattle and horses.

During the Spanish and Mexican periods, explorers entered the region. Fort Ross on the Sonoma coast was established by the Russians from 1812 until 1841 to support hunting, fishing, and whaling businesses (Reclamation 1997). American explorer Jedediah Smith and Peter Skene Odgen, Chief Trader for the Hudson Bay Company, with other members of the Hudson Bay Company also came to California during this period.

In 1848, the Treaty of Guadalupe Hidalgo transferred the lands of California from the Mexican Republic to the United States and initiated what is called the American Period in California history (Reclamation 1997). During that same year, gold was discovered in the foothills of the Sierra Nevada, and thousands of hopeful miners as well as storekeepers, settlers, and farmers entered the region. Mining in the Trinity River Region was expanded for both gold and copper mines (Placer County 2007).

To support this growth, extensive transportation systems were created to support wagon routes, steamboats on the major rivers, and numerous railroads (Reclamation 1997). Many of the supply centers and shipment points along these transportation corridors developed into cities, towns, and settlements. Logging and ranching also expanded to meet the needs of the new settlers. American ranchers found Central California ideally suited for grazing large herds of stock. During the latter part of the 19th century, American ranchers amassed large tracts of former rancho land, and several great cattle empires were formed. As settlements grew, farming increased. A primary constraint to expansion of crop diversity and areas under cultivation was the lack of water. Irrigation was virtually unknown in California until the 1880s, when large-scale irrigation systems were developed to improve agriculture yields. With the development of irrigation and improved transportation, new crops were added to the grains obtained from dry farming, including vegetables, fruits, and nuts.

Irrigation capabilities further expanded in the 1950s and 1960s with the implementation of multiple water projects. The availability of water also expanded the agricultural and urban water supplies in the Central Valley, San Francisco Bay Area, Central Coast, and Southern California regions.

17.3.3.2 History of the Trinity River Region

Explorers from the Philippines and Europe may have visited and interacted with the Yurok people as early as the late 1700s. Peter Skene Odgen and Jedediah Smith initially visited the Lower and Middle Klamath River reaches in the 1820s. In 1828, Jedediah Smith and his party of explorers were the first white men known to have visited the Trinity River watershed (USFWS et al. 1999).

Although the area was first used extensively by trappers, gold was discovered on the Trinity River in 1848, and by the late 1840s, gold mining was a major activity along the Trinity River (Hoover et al. 1990; Del Norte County 2003; USFWS et al. 1999). Weaverville was the center of gold mining activity after 1849 with numerous mining camps and settlements along the Trinity River. Mining continued along the Trinity River through the early and mid-1900s with large-scale dragline and bucket dredging operations beginning in 1939. Logging has occurred since the 1880s and continues in the Trinity River Region. These activities resulted in significant changes to rivers and may have caused the destruction of many prehistoric or historic archaeological sites (Hoover et al. 1990).

Increased activities within the Trinity River Region led to conflicts between the new residents and the Yurok and Hupa people. On November 16, 1855, the Klamath Indian Reservation was established by Executive Order for lands from the mouth of the Klamath River to a location upstream of Tectah Creek that extended 1 mile wide on either side of the river for the approximately 20-mile reach (DOI and CDFG 2012). The Hoopa Valley Reservation was established in 1864 and expanded in 1891 to include lands from the mouth of the Klamath River to the Hoopa Valley that extended 1 mile wide on either side of the river including portions of the Klamath Indian Reservation. In 1988, the Hoopa-Yurok Settlement Act (Public Law 100-580) partitioned portions of the previously established reservations into the Yurok Indian Reservation and Hoopa Valley Reservation and established the Resighini Rancheria.

17.3.3.3 History of the Central Valley Region

17.3.3.3.1 History of the Sacramento Valley

Europeans, Americans, and Canadians may have initially entered the Sacramento Valley in the late 1700s and early 1800s as part of missionary or military expeditions (Reclamation 1997, 2005a; Reclamation et al. 2006; Placer County 2007). By 1776, Jose Canizares explored areas located south of the present Sacramento community, and in 1813, there was a major battle between the Spanish and the Miwok people near the confluence of the Cosumnes River along the Sacramento River. Fur trappers moved through this area from the 1820s to 1840s.

The first settlements in this area occurred in the 1830s and 1840s on Mexican Land Grants. The New Helvetica Land Grant, which included more than 40,000 acres in the Sacramento Valley, was awarded to John Sutter in 1841 (DSC 2011).

Following the discovery of gold on the New Helvetica Land Grant in 1848 near present-day Coloma, numerous mining-related settlements were established in areas with the Nisenan, Maidu, Konkow, and Atsugewi people in the eastern portion of the Sacramento Valley and in areas with the Nomlaki and Wintu people in the western Sacramento Valley. Many of the Native Americans died after exposure to diseases from the new settlers, including malaria. Numerous other Native American died during battles against the new settlers.

Mining activities in the northern Sacramento Valley foothills and mountains near present Redding primarily were related to gold and copper (Reclamation 2013a). Mining activities in the central Sierra Nevada foothills primarily were related to gold. In 1848, mining started along the Trinity River and upper Sacramento River tributaries, primarily for copper and gold (Reclamation 2013a; Reclamation et al. 2006). Smelters, mills, and communities grew rapidly near the mining areas, including the town of Keswick, and communities were established within and adjacent to the present day Folsom Lake. The development of hydraulic mining in 1851 required establishment of substantial water diversions, flumes, and ditches to convey the water and displacement of vast amounts of sediment into the streams and along the banks of the waterways.

Logging also was a dominant industry in the western Sacramento Valley since the 1850s (Reclamation 1997, 2013a). The logging industry grew as the railroads were extended. Establishment of logging in the Sierra Nevada foothills and mountains also led to development of water infrastructure to move and/or mill the logs. One of the first water system infrastructures developed for these purposes was the original Folsom Dam constructed in 1893 (Reclamation et al. 2006).

Agricultural activities were successful throughout the Sacramento Valley to serve the mining communities (Reclamation 1997). The completion of the first transcontinental railroad in 1869 increased the number of settlers and allowed transport of crops from the Sacramento Valley to Nevada, Utah, and subsequently to other areas of the nation (Reclamation 2005b). The expanded agricultural markets expanded due to the establishment and development of commercial crops, accessibility to markets, and new farming techniques and irrigation.

Construction of hydroelectric power and water storage facilities in the Sacramento Valley foothills started in the early 1900s to provide hydropower and water supplies to local and regional users, as well as export to other portions of the state using CVP, SWP, City and County of San Francisco, and East Bay Municipal Utility District facilities.

17.3.3.3.2 History of the San Joaquin Valley

The San Joaquin Valley area was not widely settled by Europeans or Mexicans when California lands were under Spanish rule (1769 to 1821) or Mexican rule (1821 to 1848). Numerous expeditions travelled through the San Joaquin Valley during this period but did not establish major settlements (Reclamation 2010). During the Spanish rule, several settlements occurred along Fresno Slough (Reclamation and State Parks 2012; Reclamation and DWR 2011). There were several settlements along the San Joaquin River and along the western boundary of the San Joaquin Valley during Mexican rule when ranches were established in the Coast Range foothills, including in Pacheco Pass and along Los Banos Creek.

In the latter half of the 19th century, agricultural settlements and mining camps were established in the San Joaquin Valley along the railroad corridors

(Reclamation 1997; Reclamation and DWR 2011). The town of Rootville, subsequently renamed Millerton in honor of Major Miller, was established near the present Millerton Lake with a military post, Camp Barbour (later named Fort Miller) to maintain order in the mining camps.

Initially, agricultural activities were related to ranching and dry farming. Livestock ranching expanded in the late 1860s (Reclamation et al. 2011b). With the increased availability of electric pumps, groundwater and surface water irrigation was used throughout the valley. Many irrigation districts were formed after the passage of the Wright Act in 1877 that provided methods to finance major irrigation projects. One of the first irrigation systems constructed in the eastern San Joaquin Valley was the “Main Canal” as part of the Miller and Lux’s San Joaquin and Kings River Canal and Irrigation Company (Reclamation and State Parks 2013).

Historic resources are related to the settlement of the valley and include homesteads, transportation infrastructure (such as ship landings, ferry ports, and bridges), food processing and other industrial facilities, residential properties, commercial establishments, mining features (in the eastern portion), and government facilities (Reclamation 1997, 2010; Reclamation and DWR 2011).

17.3.3.3.3 History of the Delta and Suisun Marsh

Communities were not established in the Delta and Suisun Marsh areas until the mid-1800s. There were numerous Spanish expeditions under Spanish rule. In the 1830s and 1840s, Mexico established land grants, including Rancho Suisun located west of present City of Fairfield (Reclamation et al. 2010).

Following the discovery of gold in the Sacramento Valley, settlements occurred in the Delta to provide support services and agricultural products for those traveling to the gold fields and the Sacramento and San Francisco areas. Passage of the Swamp and Overflow Act in 1850 led to the transfer of lands from the U.S. Government in the Delta to the State of California, which subsequently sold the land to individuals. The new settlers in the Delta constructed levees to protect the lands from periodic flooding and drained other lands to reduce the potential for mosquito-borne diseases. By the 1920s, numerous communities were established around food processing and packing houses that supported a wide range of crops such as asparagus, barley, celery, corn, winter grain, sugar beets, onions, and alfalfa for local dairy farms were introduced to the area (DSC 2011; Reclamation et al. 2010). By the 1950s, major food packers and processors moved from the Delta, and many communities became smaller. Recreational opportunities were established in the 1850s with duck hunting opportunities in the Suisun Marsh area.

17.3.3.4 History of the San Francisco Bay Area Region

In 1579, Sir Francis Drake and other Spanish explorers led expeditions into the San Francisco Bay Area. However, in general, the Spanish did not settle Northern California until the 1700s when other Europeans established trading settlements for fur, mining, and other products. Initially, the Spanish confined their settlement to the coastline to establish military bases, or presidios (Hoover et al. 1990). Father Junipero Serra and other Franciscans worked with the Spanish explorers to establish missions along the Alta California coastal areas between present Sonoma County (San Francisco Solano established in 1823) to present Ventura County (San Buenaventura established in 1782), including three missions in areas that use CVP and SWP water (Mission San Jose established in 1797, Mission Santa Clara established in 1777, and Mission San Juan Bautista established in 1797).

San Jose was one the first towns established in Alta California as Pueblo de San José de Guadalupe (Santa Clara County 2012). The Spanish government awarded land grants in the San Francisco Bay Area Region (DWR 2008; EBMUD 2009; Hoover et al. 1990; Reclamation 2005b; San Benito County 2010; Zone 7 2006). In 1821, Mexico won independence from Spain, began to establish more secular communities around the missions, and divided many of the ranchos into smaller pueblos (Santa Clara County 2012). These actions supported growth in the present California coastal areas.

Following California statehood in 1849, ranching and farming communities were established in the interior valleys of the San Francisco Bay Area Region (Santa Clara County 2012; CCWD et al. 2009; ECCCHCPA et al. 2006). Starting in the late 1800s, expansion of the railroads in the area and use of improved irrigation systems led to the expansion of agriculture throughout the area. In mid-1900s, industrial expansion occurred in Contra Costa, Alameda, and Santa Clara counties.

17.3.3.5 History of the Central Coast Region

In 1542, Portuguese explorer Juan Rodríguez Cabrillo entered Santa Barbara Harbor (Puerto de Santa Bárbara). In 1587, Pedro de Unamuno brought his ship into Morro Bay, explored inland to the present site of the City of San Luis Obispo, and claimed the area for Spain. In 1595, Sebastián Rodríguez Cermeño entered San Luis Obispo Bay (Hoover et al. 1990). The explorations laid the foundation for the founding of five missions in the Central Coast Region considered in this EIS. Ranchos were granted throughout the region in the 1830s and 1840s.

Following the California statehood, ranching and farming continued to be the main economic activity of the Central Coast Region to the present.

17.3.3.6 History of the Southern California Region

In 1540, Hernando de Alarcón explored the inland areas of the Southern California Region with an expedition that had explored the Colorado River. In 1542, Cabrillo apparently became the first European to sight the coast of Southern California, including the Los Angeles area and Santa Catalina Island, although he did not make landfall (Hoover et al. 1990).

In 1769, Gaspar de Portolá explored a trail by land from present San Diego through present San Diego, Orange, and Los Angeles counties (Hoover et al. 1990). He camped near the Los Angeles River and the Indian Village of Yang-Na (within the present City of Los Angeles). In 1772, Pedro Fages made an inland journey from present San Diego through western Riverside County to San Luis Obispo (Hoover et al. 1990; Riverside County 2000). In 1776, friar Francisco Garcés explored from present San Gabriel Valley to the Antelope Valley. More than 20 missions were established along the Southern California coastline (Los Angeles 2005). Pueblos were established near the missions, including the Pueblo of Los Angeles in 1781.

The first known discovery of gold in California was made between 1775 and 1780 in the Potholes district of southeastern California in present Imperial County (Clark 1970). Other placer deposits were found in 1828 at San Ysidro in present San Diego County, and in 1835 and 1842 at San Francisquito Canyon and Placerita Canyon, respectively, in present Los Angeles County (Clark 1970; Vredenburgh 1991). Some of the mines continued to produce gold through the early 1990s.

Following the end of Spanish Rule, the Mexican Government deeded the extensive land holdings to ranchos to develop ranches and orchards (Riverside County 2000). Oranges and lemons became major agricultural crops between the 1850s and 1880s, and railroads were built to transport the products.

Water supply systems were constructed to provide water to missions and pueblo villages. One of the first systems was the Zanja Madre that was constructed in 1781 to convey water to the pueblo in the present City of Los Angeles (Los Angeles 2005; DWR 2009). The system was expanded in the 1850s and 1860s to convey water to vineyards and fruit orchards. During the late 1800s and early 1900s, numerous dams and conveyance facilities were constructed in the area to support the communities and agriculture.

17.3.4 Known Cultural Resources

The following subsections describe known cultural resources in the counties within the study area as determined through review of reports prepared for other projects in the study area. No physical or record surveys were conducted for this EIS because no site-specific construction actions were considered in this EIS. The EIS evaluates alternatives to continue the coordinated long-term operation of the CVP and SWP. The resources described in this subsection indicate the types of resources that occur in areas served by CVP and SWP water and adjacent areas. Therefore, some of the known resources presented in this chapter are located in portions of the counties that are not within the CVP and SWP water service areas.

17.3.4.1 Known Cultural Resources of the Trinity River Region

Within Trinity County, a cultural resources records search of the Trinity River Region was conducted for the Trinity River Mainstem Fishery Restoration EIS/Environmental Impact Report (EIR) (USFWS et al. 1999). The area covered included 660 feet on either side of the Trinity River from Trinity Lake to the eastern boundary of Hoopa Valley Indian Reservation and the inundation areas of the Trinity Lake and Lewiston Reservoir. More than 150 recorded cultural resources were identified along the mainstem of Trinity River within Trinity County, including 20 types of prehistoric and historic sites. Among these were Native American villages, camps, and lithic scatters; historic Indian sites; mines; ditches; cabins; structures; a school; USFWS stations and campgrounds; cemeteries; a rock wall; trails; a wagon road; and a bridge. Fifty-one sites are inundated within Trinity Lake and Lewiston Reservoir. Few of these sites have been evaluated for eligibility to be included in the National Register of Historic Places (NRHP). With respect to more recent historic sites in Trinity County, none of the sites listed in the NRHP, California State Historical Landmarks, California Register of Historical Resources (CRHR), and/or Points of Interest is located within or along banks of the Trinity River (CSPOHP 2014a).

Within Humboldt County, numerous culturally sensitive areas are located along the Lower Klamath and Lower Trinity rivers. The culturally sensitive areas include the areas along the riverbanks associated with religious and/or resource-producing important sites, in addition to specific known cultural resources. Many cultural resource locations are in the Hoopa Valley Indian Reservation and Yurok Reservation, including villages, cemeteries, ceremonial and gathering areas, and along ridgeline corridors that were used for traveling between villages (Humboldt County 2012). With respect to more recent historic sites in Humboldt County, none of the sites listed in the NRHP, California State Historical Landmarks, CRHR, and/or Points of Interest is located within or along banks of the Trinity or Klamath rivers (CSPOHP 2014b).

Within Del Norte County, numerous culturally sensitive areas are located along the Lower Klamath River, including areas within the Yurok Reservation and the Resighini Rancheria along the southern shoreline of the mouth of the Klamath River at the Pacific Ocean (Del Norte County 2003). The mouth of the Klamath River is of great spiritual significance for the Yurok people (Yurok Tribe 2005). The Yurok Tribe has suggested that the entire Klamath River, including the Lower Klamath River, be designated as a Cultural Riverscape and be submitted for consideration as a NRHP (Yurok Tribe 2005). With respect to more recent historic sites in Del Norte County, none of the sites listed in the NRHP, California State Historical Landmarks, CRHR, and/or Points of Interest is located within or along banks of the Klamath River (CSPOHP 2014c).

17.3.4.2 Previously Recorded Cultural Resources in the Central Valley Region

The Central Valley Region is rich in both historic- and prehistoric-period resources (Reclamation 1997), including large, deep midden sites (which generally contains waste materials that indicate human inhabitation) that provide information on prehistoric culture extending over thousands of years.

As described above, implementation of the alternatives considered in this EIS could affect cultural resources at CVP and SWP reservoir facilities and in areas that use CVP and SWP water that could experience land uses because of changes in CVP and SWP water supply availability.

17.3.4.2.1 Cultural Resources at CVP and SWP Reservoir Facilities in the Sacramento Valley

Previous cultural resource studies were conducted at and/or near Shasta Lake, Lake Oroville, and Folsom Lake.

The studies near Shasta Lake surveyed approximately 8 percent of the study area and identified 261 cultural resources, including 190 prehistoric properties, 45 historic resources, and 26 properties with prehistoric and historic resources (Reclamation 2013a). The prehistoric sites include habitation sites, artifact and lithic scatters, caves used as shelter, and cemeteries. The historic sites included bridges, railways, a dam, buildings, ranches, orchards, mines, towns, and cemeteries. Several prehistoric and historic cemeteries located within the inundation area were moved prior to completion of the Shasta Lake complex. The Dog Creek Bridge is the only resource in this area that is listed on the NRHP. The Shasta and Keswick dams were determined to be NRHP-eligible.

The studies near Lake Oroville identified 261 cultural resources areas, including 234 prehistoric properties, 462 historic resources, and 91 properties with prehistoric and historic resources (DWR 2004, 2007). Within the Lake Oroville inundation area, 93 prehistoric properties and 19 historic sites were identified prior to the completion of the reservoir. The prehistoric sites include habitation sites, milling sites, quarries, artifact and lithic scatters, caves used as shelter, rock art, fishing and hunting grounds, battle sites, trails, and cemeteries. The historic sites included bridges, railways, a dam, buildings, ranches, orchards, mines, towns, and cemeteries.

Oroville Dam and peripheral dams, Thermalito Diversion Dam, Thermalito Forebay and Afterbay, Fish Barrier Dam, Hyatt Pumping-Generating Plant and Intake Structure, Thermalito Power Plant and Power Canal, Lake Oroville Visitor Center and Visitor Viewing Platform, and Feather River Fish Hatchery were determined to be NRHP-eligible.

The studies near Folsom Lake identified 185 prehistoric properties and 59 historic sites (Reclamation 2005b; Reclamation et al. 2006). The prehistoric sites include habitation sites, middens, groundstones, and artifact and lithic scatters. The historic sites included buildings, mining areas, and refuse dumps. Folsom Dam was determined to be NRHP-eligible.

17.3.4.2.2 Cultural Resources at CVP and SWP Reservoir and Pumping Plant Facilities in the San Joaquin Valley

Previous cultural resource studies were conducted at and/or near New Melones Reservoir, San Luis Reservoir, and Millerton Lake and San Joaquin River downstream of Friant Dam.

The studies near New Melones Reservoir surveyed approximately 78 percent of the study area and identified 725 cultural resources within the New Melones Reservoir area or within 0.25 mile of this area (Reclamation 2010). The prehistoric sites include habitation sites, artifact and lithic scatters, mortars, caves, rock art, and cemeteries. The historic sites included bridges, buildings, ranches, orchards, towns, water and power systems, transportation infrastructure, and cemeteries. Many of the sites are located within the inundation area. However, substantial surveys were conducted prior to construction of New Melones Reservoir in the 1980s.

The studies near San Luis Reservoir identified 51 prehistoric and historic cultural resources (Reclamation and State Parks 2012). The prehistoric sites include habitation sites and artifact and lithic scatters. The historic sites included bridges, water infrastructure, buildings, ranches, orchards, towns, and cemeteries. One of the major historic sites in this area is the remnant locations of Rancho San Luis Gonzaga. Many portions of the ranch are located within the inundation area. However, many of the structures were moved to a site near Pacheco Pass. The remaining portions of the ranch were deeded to the State of California in 1992 to become part of the Pacheco State Park. Rancho San Luis Gonzaga, a historic stock ranch landscape, has been designated by the state to be a Historic District/Cultural Landscape that is potentially NRHP-eligible and CRHR-eligible.

Recent studies along the San Joaquin River identified 19 prehistoric sites within the seasonal inundation area of Millerton Lake (Reclamation and DWR 2011; Reclamation and State Parks 2013). Additional sites are located within the area of the lake that is constantly inundated. Some of the known sites include the remains of Kuyu Illik; the Dumna “head” village; the Kechaye/”Dumna” village of Sanwo Kianu; remains of Fort Miller, Millerton, and Collins Sulphur Springs; and prehistoric sites with housepits, mortars, grinding sticks, and rock alignments (Reclamation and State Parks 2013).

Along the San Joaquin River downstream of Friant Dam (which forms Millerton Lake) to the confluence of the Merced River, 84 prehistoric sites, 18 historic sites, and 7 sites with both prehistoric and historic resources were identified as part of the San Joaquin River Restoration Program. The prehistoric sites include habitation sites, artifact and lithic scatters, and bedrock milling features. The historic sites included bridges, buildings, ranches, orchards, towns, water and power systems, and transportation infrastructure.

The Friant Dam, Friant-Kern Canal, associated features (berms, siphons, control structures, inlets, outlets, and check structures), approximately 40 bridges that cross the canal, and Little Dry Creek Wasteway Facility are considered historic resources (Reclamation and State Parks 2013; Reclamation et al. 2011b). The Friant Dam and Friant-Kern Canal was determined to be NRHP-eligible.

17.3.4.2.3 Cultural Resources in the areas that use CVP and SWP Water Supplies in the Central Valley

Numerous cultural and historical resources are in the Central Valley, as summarized in Table 17.1. Most of the cultural resources are located within areas that would not be affected by land use changes that could result from changes in CVP and SWP water supplies. The resources listed in Table 17.1 also include the sites described above near CVP and SWP facilities.

Table 17.1 Previously Recorded Cultural and Historical Resources of the Central Valley Region

County	Historic Site Types	Prehistoric Site Types
Butte	26 NRHP properties, 8 California Historical Landmarks, and 21 California Points of Historical Interest (Reclamation 1997; CSPOHP 2014e).	1,198 Known Prehistoric Site Types (Reclamation 1997).
Colusa	7 NRHP properties, 3 California Historical Landmarks, and 3 California Points of Historical Interest (Reclamation 1997; CSPOHP 2014g).	115 Known Prehistoric Site Types (Reclamation 1997).
El Dorado	18 NRHP properties, 30 California Historical Landmarks, 8 California Points of Historical Interest; numerous historic sites, such as mining features, building foundations, trash scatters, and bridges, were inundated by Folsom Lake (Reclamation 1997; CSPOHP 2014h).	595 Known Prehistoric Site Types (Reclamation 1997).
Fresno	38 NRHP properties, 8 California Historic Landmarks, and 13 of which are California Points of Historical Interest (Reclamation 1997; CSPOHP 2014i).	2,603 Known Prehistoric Site Types (Reclamation 1997).
Glenn	2 NRHP properties, 2 California Historical Landmarks, and 17 California Points of Historical Interest (Reclamation 1997; CSPOHP 2014j).	373 Known Prehistoric Site Types (Reclamation 1997).
Kern	20 NRHP properties, 47 California Historic Landmarks, and 11 California Points of Historical Interest (Reclamation 1997; CSPOHP 2014k).	3,850 Known Prehistoric and Historic Site Types (Reclamation 1997).
Kings	4 NRHP properties, 3 California Historic Landmarks; the San Luis Canal, the only CVP facility in Kings County, has no historic or architectural resources in its vicinity (Reclamation 1997; CSPOHP 2014l).	56 Known Prehistoric Site Types (Reclamation 1997).
Madera	2 NRHP property, 1 California Historic Landmarks, and 9 California Points of Historical Interest (Reclamation 1997; CSPOHP 2014n).	2,043 Known Prehistoric Site Types (Reclamation 1997).
Merced	14 NRHP properties, 5 California Historic Landmarks, 1 CRHR properties, and 8 California Points of Historical Interest (Reclamation 1997; CSPOHP 2014p).	316 Known Prehistoric Site Types (Reclamation 1997).

County	Historic Site Types	Prehistoric Site Types
Napa	76 NRHP properties, 17 California Historical Landmarks, and 13 California Points of Historical Interest (Reclamation 1997; CSPOHP 2014q).	700 Known Prehistoric Site Types (Reclamation 1997).
Placer	18 NRHP properties, 20 California Historical Landmarks, 21 California Points of Historical Interest; numerous historic sites, such as mining features, building foundations, trash scatters, and bridges, were inundated by Folsom Lake, which is a CVP facility (Reclamation 1997; CSPOHP 2014s).	627 Known Prehistoric Site Types (Reclamation 1997).
Plumas	6 NRHP properties, 13 California Historical Landmarks, and 5 California Points of Historical Interest (Reclamation 1997; CSPOHP 2014t).	1,639 prehistoric sites in Plumas County (Plumas County 2012).
Sacramento	90 NRHP properties, 56 California Historical Landmarks, 4 CRHR properties, 20 California Points of Historical Interest; numerous historic sites, such as mining features, building foundations, trash scatters, and bridges, were inundated by Folsom Lake; the Folsom Mining District surrounds Lake Natoma (Reclamation 1997; CSPOHP 2014u). There are over 40 historic sites along the Sacramento River between Sutter County boundary and Freeport (Reclamation 2005b); including Natomas Main Drainage Canal, Town of Freeport, Sacramento Weir, Yolo Bypass, homes and farms, and a church. There are 14 historic sites along the American River between Folsom Dam and the confluence with the Sacramento River (Reclamation 2005b).	407 Known Prehistoric Site Types (Reclamation 1997). There are 24 prehistoric sites along the Sacramento River between Sutter County boundary and Freeport (Reclamation 2005b). There are 22 prehistoric sites along the American River between Folsom Dam and the confluence with the Sacramento River (Reclamation 2005b).
San Joaquin	31 NRHP properties, 25 California Historic Landmarks, 3 CRHR properties, and 7 are California Points of Historical Interest (Reclamation 1997; CSPOHP 2014v).	189 Known Prehistoric Site Types (Reclamation 1997).

County	Historic Site Types	Prehistoric Site Types
Shasta	26 NRHP properties, 19 California Historical Landmarks, 1 CRHR properties, 15 California Points of Historical Interest (Reclamation 1997; CSPOHP 2014w). The Anderson-Cottonwood Irrigation District Diversion Dam has been determined to be eligible for NRHP listing (Reclamation 2013a).	1,419 Known Prehistoric Site Types. Many of these sites occur along the Sacramento River near Redding and between Battle Creek and Table Mountain (Reclamation 2013a).
Solano	23 NRHP properties, 14 California Historical Landmarks, and 9 California Points of Historical Interest (Reclamation 1997; CSPOHP 2014x).	300 Known Prehistoric Site Types (Reclamation 1997).
Stanislaus	21 NRHP properties, 5 California Historic Landmarks, and 7 are California Points of Historical Interest; the former right-of-way for the Patterson and Western Railroad, which was constructed in 1916, bisects the Delta-Mendota Canal (Reclamation 1997; CSPOHP 2014y).	280 Known Prehistoric Site Types (Reclamation 1997).
Sutter	7 NRHP properties, 2 California Historical Landmarks, and 22 California Points of Historical Interest (Reclamation 1997; CSPOHP 2014z).	62 Known Prehistoric Site Types (Reclamation 1997).
Tehama	10 NRHP properties, 3 California Historical Landmarks, and 1 California Point of Historical Interest (Reclamation 1997; CSPOHP 2014aa).	1,415 Known Prehistoric Site Types (Reclamation 1997).
Tulare	34 NRHP properties, 8 California Historic Landmarks, and no California Points of Historical Interest (Reclamation 1997; CSPOHP 2014ab).	1,857 Known Prehistoric Site Types (Reclamation 1997).
Yolo	21 NRHP properties, 2 California Historical Landmarks, 1 CRHR properties, and 8 California Points of Historical Interest (Reclamation 1997; CSPOHP 2014ad).	175 Known Prehistoric Site Types (Reclamation 1997). Includes possible fishing stations along Putah and Cache Creeks, the Sacramento, and ephemeral tributaries to these watercourses.
Yuba	10 NRHP properties, 6 California Historical Landmarks, and 14 California Points of Historical Interest (Reclamation 1997; CSPOHP 2014ae).	1,112 Known Prehistoric Site Types (Reclamation 1997).

17.3.4.3 Previously Recorded Cultural Resources in the San Francisco Bay Area Region

The San Francisco Bay Area Region includes Alameda, Contra Costa, Santa Clara, and San Benito counties. Much of this region is highly urbanized and that development has affected archaeological resources. Numerous cultural and historical resources are in the San Francisco Bay Area Region, as summarized in Table 17.2. Most of the cultural resources are located within areas that would not be affected by land use changes that could result from changes in CVP and SWP water supplies.

Table 17.2 Previously Recorded Cultural Resources of the San Francisco Bay Area Region

County	Historic Site Types	Prehistoric Site Types
Alameda	141 NRHP properties, 34 California Historical Landmarks, 2 CRHR properties, and 4 California Points of Historical Interest (CSPOHP 2014af).	No comprehensive inventory of prehistoric sites in Alameda County (Zone 7 2006).
Contra Costa	40 NRHP properties, 13 California Historical Landmarks, 1 CRHR property, and 12 California Points of Historical Interest (CSPOHP 2014ag).	No comprehensive inventory of prehistoric sites in Contra Costa County (Contra Costa County 2005). Up to 41 sites were identified in the Kellogg Creek Historic District near Los Vaqueros Reservoir (CCWD et al. 2009).
San Benito	12 NRHP properties, 5 California Historic Landmarks, and 2 California Points of Historical Interest (Reclamation 1997; CSPOHP 2014ah).	180 Known Prehistoric Site Types (Reclamation 1997).
Santa Clara	101 NRHP properties, 41 California Historical Landmarks, and 58 California Points of Historical Interest (CSPOHP 2014ai; Santa Clara County 1994).	Between 1912 and 1960, 43 sites were recorded in the Santa Clara Valley portion of Santa Clara County (Santa Clara 2012).

17.3.4.4 Previously Recorded Cultural Resources in the Central Coast and Southern California Regions

The Central Coast Region includes San Luis Obispo and Santa Barbara counties. Within the Central Coast Region, the SWP provides water supplies to portions of San Luis Obispo and Santa Barbara counties. Within the Southern California Region, the SWP provides water supplies to portions of Ventura, Los Angeles, Orange, Riverside, San Bernardino, and San Diego counties. Numerous cultural and historical resources are in the Central Coast and Southern California regions, as summarized in Table 17.3. Most of the cultural resources are located within areas that would not be affected by land use changes that could result from changes in SWP water supplies.

Table 17.3 Previously Recorded Cultural and Historical Resources of the Central Coast and Southern California Regions

County	Historic Site Types	Prehistoric Site Types
San Luis Obispo	34 NRHP properties, 2 California Historical Landmarks, and 4 California Points of Historical Interest (CSPOHP 2014ao).	The San Luis Obispo County General Plan discusses several hundred prehistoric resources throughout San Luis Obispo County related to the Chumash people (San Luis Obispo County 2010).
Santa Barbara	43 NRHP properties, 16 California Historical Landmarks, and 7 California Points of Historical Interest (CSPOHP 2014ap).	The 2010 Santa Barbara Conservation Element of the Comprehensive Plan noted prehistoric resources throughout Santa Barbara County related to the Chumash people (Santa Barbara County 2010).
Los Angeles	431 NRHP properties, 90 California Historical Landmarks, 6 CRHR property, and 65 California Points of Historical Interest (CSPOHP 2014aj).	Over 4,196 prehistoric sites in Los Angeles County (SCAG 2011).
Orange	108 NRHP properties, 24 California Historical Landmarks, and 20 California Points of Historical Interest (CSPOHP 2014ak).	Over 1,710 prehistoric sites in Orange County (SCAG 2011; Orange County 2005).
Riverside	52 NRHP properties, 23 California Historical Landmarks, and 72 California Points of Historical Interest (CSPOHP 2014al).	Over 19,858 prehistoric sites in Orange County (SCAG 2011). Some of the Cahuilla, Serrano, and Luiseño communities were inundated within Lake Perris (Reclamation and DWR 2003).
San Bernardino	56 NRHP properties, 39 California Historical Landmarks, 2 CRHR property, and 119 California Points of Historical Interest (CSPOHP 2014am).	Over 29,480 prehistoric sites in San Bernardino County, including the Calico “Early Man” Site (SCAG 2011).
San Diego	130 NRHP properties, 63 California Historical Landmarks, 3 CRHR property, and 16 California Points of Historical Interest (CSPOHP 2014an).	The San Diego County General Plan discussed that there are many prehistoric sites within San Diego County; however, the number and locations are not identified to protect the resources (San Diego County 2011a).

County	Historic Site Types	Prehistoric Site Types
Ventura	34 NRHP properties, 11 California Historical Landmarks, and 4 California Points of Historical Interest (CSPOHP 2014aq).	Over 1,806 prehistoric sites in San Bernardino County (SCAG 2011).

17.4 Impact Analysis

This section describes the potential mechanisms for change in cultural resources and analytical methods, results of the impact analysis, potential mitigation measures, and potential cumulative effects.

17.4.1 Potential Mechanisms for Change and Analytical Tools

As described in Chapter 4, Approach to Environmental Analysis, the environmental consequences assessment considers changes in cultural resources conditions related to changes in CVP and SWP operations under the alternatives as compared to the No Action Alternative and Second Basis of Comparison that could result in land disturbance or increased exposure of cultural resources sites.

17.4.1.1 Changes in the Potential for Land Disturbance

Under Alternatives 1 through 5, No Action Alternative, and Second Basis of Comparison, CVP and SWP water supplies would continue to be provided within the currently designated service areas. Implementation of the alternatives does not include expansion of designated service areas or increased water contract amounts. Land use in 2030 would be consistent with existing general plan projections under all alternatives and the Second Basis of Comparison. The CVP and SWP water contract amounts would be the same under all alternatives and the Second Basis of Comparison. The alternatives would not result in expansion of municipal or agricultural lands, or associated disturbances of cultural resources because of expansion of development or cultivated lands in addition to the conditions projected under existing general plans. Therefore, changes in CVP and SWP water supply availability that would result in changes in land use and associated potential for disturbance of cultural resources are not analyzed in this EIS.

17.4.1.2 Changes in Potential Exposure of Cultural Resources at Reservoirs that Store CVP and SWP Water

Changes in CVP and SWP operations under the alternatives as compared to the No Action Alternative and Second Basis of Comparison could result in increased periods of time when low water elevations occur in reservoirs that store CVP and SWP water, including the CVP and SWP reservoirs. The lowest reservoir elevations generally occur in September in dry and critical dry years, as described in Chapter 5, Surface Water Resources and Water Supplies. The minimum and maximum elevations of the reservoir surface water under Alternatives 1 through 5, No Action Alternative, and Second Basis of Comparison would be the same as under current conditions.

17.4.1.3 Effects Related to Cross Delta Water Transfers

Water transfer programs have been used to provide water to existing agricultural and municipal service areas when other water supplies are not available. It is anticipated that water transfers under all alternatives and the Second Basis of Comparison would continue in this manner to provide water supplies to land uses projected under existing general plans which would not result in expansion of municipal or agricultural lands, or associated disturbances of cultural resources because of expansion of development or cultivated lands in addition to conditions projected under existing general plans. Therefore, effects related to cross Delta water transfers and associated potential for disturbance of cultural resources are not analyzed in this EIS.

17.4.2 Conditions in Year 2030 without Implementation of Alternatives 1 through 5

The impact analysis in this EIS is based upon the comparison of the alternatives to the No Action Alternative and the Second Basis of Comparison in the Year 2030. Many of the changed conditions would occur in the same manner under both the No Action Alternative and the Second Basis of Comparison (e.g., climate change, sea level rise, general plan development, and implementation of reasonable and foreseeable projects). Because of these changes, especially climate change and sea level rise, it is anticipated that reservoir elevations at the end of September would be lower, flows patterns in the rivers downstream of the reservoirs would be different than under recent condition, and CVP and SWP water deliveries would be less than under recent condition, as described in Chapter 5, Surface Water Resources and Water Supplies. In all regions, the minimum reservoir elevations under the No Action Alternative and Second Basis of Comparison would be similar to minimum elevations during recent conditions.

17.4.3 Evaluation of Alternatives

As described in Chapter 4, Approach to Environmental Analysis, Alternatives 1 through 5 have been compared to the No Action Alternative, and the No Action Alternative and Alternatives 1 through 5 have been compared to the Second Basis of Comparison.

During review of the numerical modeling analyses used in this EIS, an error was determined in the CalSim II model assumptions related to the Stanislaus River operations for the Second Basis of Comparison, Alternative 1, and Alternative 4 model runs. Appendix 5C includes a comparison of the CalSim II model run results presented in this chapter and CalSim II model run results with the error corrected. Appendix 5C also includes a discussion of changes in the comparison of the following alternatives analyses.

- No Action Alternative compared to the Second Basis of Comparison
- Alternative 1 compared to the No Action Alternative

- Alternative 3 compared to the Second Basis of Comparison
- Alternative 5 compared to the Second Basis of Comparison

17.4.3.1 No Action Alternative

As described in Chapter 4, Approach to Environmental Analysis, the No Action Alternative is compared to the Second Basis of Comparison.

17.4.3.1.1 Potential Exposure of Cultural Resources at Reservoirs that Store CVP and SWP Water

As described above, the minimum reservoir elevations in all regions under the No Action Alternative and the Second Basis of Comparison would be within historic ranges and would not expose lands that are not currently exposed. Therefore, conditions of cultural resources would be similar under the No Action Alternative and Second Basis of Comparison.

17.4.3.2 Alternative 1

Alternative 1 is identical to the Second Basis of Comparison. Alternative 1 is compared to the No Action Alternative and the Second Basis of Comparison. However, because cultural resource conditions under Alternative 1 are identical to cultural resource conditions under the Second Basis of Comparison, Alternative 1 is only compared to the No Action Alternative.

17.4.3.2.1 Alternative 1 Compared to the No Action Alternative

Potential Exposure of Cultural Resources at Reservoirs that Store CVP and SWP Water

As described above, the minimum reservoir elevations in all regions under Alternative 1 as compared to the No Action Alternative would be within historic ranges and would not expose lands that are not currently exposed. Therefore, conditions of cultural resources would be similar under Alternative 1 and the No Action Alternative.

17.4.3.2.2 Alternative 1 Compared to the Second Basis of Comparison

Alternative 1 is identical to the Second Basis of Comparison.

17.4.3.3 Alternative 2

The cultural resources conditions under Alternative 2 would be identical to the conditions under the No Action Alternative; therefore, Alternative 2 is only compared to the Second Basis of Comparison.

17.4.3.3.1 Alternative 2 Compared to the Second Basis of Comparison

Changes to cultural resources conditions under Alternatives 2 as compared to the Second Basis of Comparison would be the same as the impacts described in Section 17.4.3.1, No Action Alternative.

17.4.3.4 Alternative 3

CVP and SWP operations under Alternative 3 are similar to the Second Basis of Comparison with modified Old and Middle River flow criteria and New Melones Reservoir operations.

17.4.3.4.1 Alternative 3 Compared to the No Action Alternative

Potential Exposure of Cultural Resources at Reservoirs that Store CVP and SWP Water

As described above, the minimum reservoir elevations in all regions under Alternative 3 as compared to the No Action Alternative would be within historic ranges and would not expose lands that are not currently exposed. Therefore, conditions of cultural resources would be similar under Alternative 3 as compared to the No Action Alternative.

17.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison

Potential Exposure of Cultural Resources at Reservoirs that Store CVP and SWP Water

As described above, the minimum reservoir elevations in all regions under Alternative 3 as compared to the Second Basis of Comparison would be within historic ranges and would not expose lands that are not currently exposed. Therefore, conditions of cultural resources would be similar under Alternative 3 and Second Basis of Comparison.

17.4.3.5 Alternative 4

The cultural resources conditions under Alternative 4 would be identical to the conditions under the Second Basis of Comparison. Therefore, Alternative 4 is only compared to the No Action Alternative.

17.4.3.5.1 Alternative 4 Compared to the No Action Alternative

Changes in cultural resources conditions under Alternative 4 as compared to the No Action Alternative would be the same as the impacts described in Section 17.4.3.2.1, Alternative 1 Compared to the No Action Alternative.

17.4.3.6 Alternative 5

The CVP and SWP operations under Alternative 5 are similar to the No Action Alternative with modified Old and Middle River flow criteria and New Melones Reservoir operations.

17.4.3.6.1 Alternative 5 Compared to the No Action Alternative

Potential Exposure of Cultural Resources at Reservoirs that Store CVP and SWP Water

As described above, the minimum reservoir elevations in all regions under Alternative 5 as compared to the No Action Alternative would be within historic ranges and would not expose lands that are not currently exposed. Therefore, conditions of cultural resources would be similar under Alternative 5 as compared to the No Action Alternative.

17.4.3.6.2 Alternative 5 Compared to the Second Basis of Comparison

Potential Exposure of Cultural Resources at Reservoirs that Store CVP and SWP Water

As described above, the minimum reservoir elevations in all regions under Alternative 5 as compared to the Second Basis of Comparison would be within historic ranges and would not expose lands that are not currently exposed. Therefore, conditions of cultural resources would be similar under Alternative 5 and Second Basis of Comparison.

17.4.3.7 Summary of Impact Analysis

The results of the impact analysis of implementation of Alternatives 1 through 5 as compared to the No Action Alternative and the Second Basis of Comparison are presented in Tables 17.4 and 17.5.

Table 17.4 Comparison of Alternatives 1 through 5 to No Action Alternative

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	No effects to cultural resources	None needed
Alternative 2	No effects to cultural resources	None needed
Alternative 3	No effects to cultural resources	None needed
Alternative 4	No effects to cultural resources	None needed
Alternative 5	No effects to cultural resources	None needed

Table 17.5 Comparison of No Action Alternative and Alternatives 1 through 5 to Second Basis of Comparison

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	No effects to cultural resources	None needed
Alternative 2	No effects to cultural resources	None needed
Alternative 3	No effects to cultural resources	None needed
Alternative 4	No effects to cultural resources	None needed
Alternative 5	No effects to cultural resources	None needed

17.4.3.8 Potential Mitigation Measures

Mitigation measures are presented in this section to avoid, minimize, rectify, reduce, eliminate, or compensate for adverse environmental effects of Alternatives 1 through 5, as compared to the No Action Alternative. Mitigation measures were not included to address adverse impacts under the alternatives as compared to the Second Basis of Comparison because this analysis was included in this EIS for information purposes only.

Implementation of Alternatives 1 through 5 as compared to the No Action Alternative would not result in increased potential exposure or disturbance of cultural resources. Therefore, there would be no adverse impacts to cultural resources because of implementation of the alternatives; and no mitigation measures are needed.

17.4.3.9 Cumulative Effects Analysis

As described in Chapter 3, the cumulative effects analysis considers projects, programs, and policies that are not speculative and are based upon known or reasonably foreseeable long-range plans, regulations, operating agreements, or other information that establishes them as reasonably foreseeable.

The cumulative effects analysis for Alternatives 1 through 5 for Cultural Resources are summarized in Table 17.6.

Table 17.6 Summary of Cumulative Effects on Cultural Resources with Implementation of Alternatives 1 through 5 as Compared to the No Action Alternative

Scenarios	Actions	Cumulative Effects of Actions
Past & Present, and Future Actions Included in All Alternatives in Year 2030	Consistent with Affected Environment conditions plus: Actions in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives), including climate change and sea level rise Actions not included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives): - Implementation of Federal and state policies and programs, including Clean Water Act (e.g., Total Maximum Daily Loads); Safe Drinking Water Act; Clean Air Act; and flood management programs - General plans for 2030. - Trinity River Restoration Program. - Central Valley Project Improvement Act programs - Iron Mountain Mine Superfund Site	<u>These effects would be the same under all alternatives.</u> Community development would occur in accordance with general plan projections for 2030. Development within the Delta would be subject to the requirements of the Delta Protection Commission and Delta Stewardship Council. Future development projects are anticipated to potentially effect cultural resources. However, development of these future programs would include preparation of environmental documentation that would identify methods to minimize adverse impacts to cultural resources. Restoration plans for the ongoing programs would be completed. Development along river corridors in the Central Valley. Future restoration projects are anticipated to potentially affect cultural resources. However, development of these future programs would include preparation of environmental documentation that would identify methods to

Scenarios	Actions	Cumulative Effects of Actions
	- Nimbus Fish Hatchery Fish Passage Project - Folsom Dam Water Control Manual Update - FERC Relicensing for the Middle Fork of the American River Project - Lower Mokelumne River Spawning Habitat Improvement Project - Dutch Slough Tidal Marsh Restoration - Suisun Marsh Habitat Management, Preservation, and Restoration Plan Implementation - Tidal Wetland Restoration: Yolo Ranch, Northern Liberty Island Fish Restoration Project, Prospect Island Restoration Project, and Calhoun Cut/Lindsey Slough Tidal Habitat Restoration Project - San Joaquin River Restoration Program - Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects with completed environmental documents)	minimize adverse impacts to cultural resources. Climate change and sea level rise, development under the general plans, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce availability of CVP and SWP water supplies as compared to past conditions. Future water supply projects are anticipated to both increase water supply reliability due to reduced surface water supplies and to accommodate planned growth in the general plans. Most of these programs were initiated prior to implementation of the 2008 USFWS BO and 2009 NMFS BO which reduced CVP and SWP water supply reliability. Future water supply projects are anticipated to potentially effect cultural resources. However, development of these future programs would include preparation of environmental documentation that would identify methods to minimize adverse impacts to cultural resources.
Future Actions considered as Cumulative Effects Actions in All Alternatives in Year 2030	Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives): - Bay-Delta Water Quality Control Plan Update - FERC Relicensing Projects - Bay Delta Conservation Plan (including the California WaterFix alternative) - Shasta Lake Water Resources, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations	<u>These effects would be the same under all alternatives.</u> Most of the future reasonably foreseeable actions are anticipated to reduce water supply impacts due to climate change, sea level rise, increased water allocated to improve habitat conditions, and future growth. Some of the reasonably foreseeable actions related to improved water quality and habitat conditions (e.g., Water Quality Control Plan Update and FERC Relicensing Projects), could in further

Scenarios	Actions	Cumulative Effects of Actions
	- El Dorado Water and Power Authority Supplemental Water Rights Project - Sacramento River Water Reliability Project - Semitropic Water Storage District Delta Wetlands - North Bay Aqueduct Alternative Intake - San Luis Reservoir Low Point Improvement Project - Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects that did not have completed environmental documents during preparation of the EIS)	reductions in CVP and SWP water deliveries. Future development of the cumulative projects are anticipated to potentially affect cultural resources. However, development of these future programs would include preparation of environmental documentation that would identify methods to minimize adverse impacts to cultural resources.
No Action Alternative with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO	Community development and restoration projects for the ongoing programs would be completed. Climate change and sea level rise, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce availability of CVP and SWP water supplies as compared to past conditions. Future water supply projects are anticipated to both increase water supply reliability due to reduced surface water supplies and to accommodate planned growth in the general plans. Future development projects are anticipated to potentially affect cultural resources. However, development of these future programs would include preparation of environmental documentation that would identify methods to minimize adverse impacts to cultural resources.

Scenarios	Actions	Cumulative Effects of Actions
Alternative 1 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternative 1 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 2 with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions No implementation of structural improvements or other actions that require further study to develop a more detailed action description.	Implementation of Alternative 2 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 3 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant) Slight increase in positive Old and Middle River flows in the winter and spring months	Implementation of Alternative 3 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 4 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternative 4 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 5 with Associated Cumulative Effects Actions in Year 20530	Full implementation of the 2008 USFWS BO and 2009 NMFS BO Positive Old and Middle River flows and increased Delta outflow in spring months	Implementation of Alternative 5 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.

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Chapter 18

Public Health

18.1 Introduction

This chapter describes public health hazards in the study area related to changes in the environment that could occur as a result of implementing the alternatives evaluated in this Environmental Impact Statement (EIS). Implementation of the alternatives considered in this EIS could affect public health through changes in available water supplies from the Central Valley Project (CVP) and State Water Project (SWP); changes in irrigated crop acreage related to potential changes in operation of the CVP and SWP; changes in wetlands acreage related to potential changes in ecosystem restoration; and changes in water quality related to potential changes in operation of the CVP and SWP.

Changes in available water supplies, agricultural resources, wetlands, and water quality are described in more detail in Chapter 5, Surface Water Resources and Water Supplies; Chapter 12, Agricultural Resources; and Chapter 6, Water Quality, respectively.

18.2 Regulatory Environment and Compliance Requirements

Potential actions that could be implemented under the alternatives evaluated in this EIS could affect public health throughout the study area. Some of the actions considered in the alternatives evaluated in this EIS could include facilities located on public agency lands; or actions implemented, funded, or approved by Federal and state agencies. These actions would need to be compliant with appropriate Federal and state agency policies and regulations, as summarized in Chapter 4, Approach to Environmental Analyses.

18.3 Affected Environment

This section describes the following public health factors that could be potentially affected by the implementation of the alternatives considered in this EIS.

- Changes in available water supplies.
- Increases in the potential for mosquito-borne diseases due to an increase in wetlands.
- Changes in the potential for Valley Fever from disturbed soils when irrigation water supplies change.
- Changes in the potential for bioaccumulation of mercury in fish and shellfish.

Changes in the potential of direct or indirect exposure to high water quality concentrations of various constituents also may occur due to implementation of the alternatives. These direct changes to water quality and the related changes to drinking water safety and consumption of fish or shellfish exposed to high concentrations of constituents of concern are described in Chapter 6, Water Quality.

Public health effects that could occur due to construction activities are not discussed in this chapter, including increased exposure to naturally occurring asbestos, methane production from disturbance of peat soils, disturbance of oil and gas production fields, use and transport of hazardous wastes, and changes in wastewater or stormwater discharges. Although several of the alternatives include assumptions of constructed facilities, those actions will require subsequent planning and environmental documentation prior to implementation. The subsequent environmental documentation and related permits will evaluate public health effects associated with construction and implementation of those facilities.

18.3.1 Public Health Issues Related to Available Water Supplies

Water supply availability can affect public health in several ways. Potential direct effects to public health are related to reduction of municipal water supplies. Potential indirect effects to public health are related to reduction of industrial and irrigation water supplies which could affect the ability to earn an income to fund food, shelter, and other critical factors necessary for public health. Effects related to loss of jobs.

Availability of water supplies substantially decreased for CVP and SWP water users during recent droughts in 1976-1977, 1987-1992, and 2012-2014. In addition, as described in Chapter 5, Surface Water Resources and Water Supplies, the frequency of substantially reduced water supplies provided by the CVP and SWP have increased since the 1976-1977 drought due to changes in regulations and increased water demands by users with higher priorities for water use.

During the 2014 drought, CVP and SWP water supply allocations have been reduced substantially to protect future water supplies and the ability to meet existing regulations, as described in Chapter 5, Surface Water Resources and Water Supplies. The allocations were modified throughout the 2013-2014 winter with the allocations that are the most stringent in the history of the CVP and/or SWP operations, as summarized below (Reclamation 2014a, 2014b; DWR 2013, 2014).

- CVP North of Delta Water Users.
  - Sacramento River Settlement Contractors – allocated 40 percent of total contracted water supply.
  - Sacramento Valley Refuges that use CVP water supplies – allocated 40 percent of total contracted water supply.

  - Agricultural Water Service Contractors – allocated 0 percent of total contracted water supply.
  - Municipal and Industrial Water Service Contractors – allocated 50 percent of historic water use.
- CVP In-Delta Water Service Contractor: Contra Costa Water District – allocated 50 percent of historic water use.
- CVP South of Delta Water Users.
  - San Joaquin River Exchange and Settlement Contractors – allocated 65 percent of total contracted water supply.
  - San Joaquin Valley Refuges that use CVP water supplies – allocated 65 percent of total contracted water supply.
  - Agricultural Water Service Contractors – allocated 0 percent of total contracted water supply.
  - Municipal and Industrial Water Service Contractors – allocated 50 percent of historic water use.
- CVP Friant Division Contractors – allocated 0 percent of total contracted water supply.
- CVP Eastside Water Service Contractors: Water supplies delivered from New Melones Reservoir – allocated 55 percent of total contracted water supply.
- SWP Water Service Contractors – 5 percent of total contracted water supply.

Another potential indirect effect to public health is related to reduction of stored water in the CVP and SWP reservoirs which could affect the ability to provide enough water for firefighting,

18.3.1.1 Public Health and Safety Related to Available Municipal and Industrial Water Supplies

The Department of the Interior, Bureau of Reclamation (Reclamation) current *Draft Municipal and Industrial Shortage Policy* (Reclamation 2005) describes that the CVP water service contractors should develop public health and safety volumes based California's public health and safety criteria or criteria developed in coordination with Reclamation. Currently, California does not have a uniform set of public health and safety criteria for municipal and industrial water supplies. At this time, most of the urban communities have not adopted specific public health and safety criteria. However, in some of the recently completed Urban Water Management Plans, criteria have been identified to protect public health and safety that range from 25 to 50 percent of the total water demand, as described in Chapter 5, Surface Water Resources and Water Supplies (CCWD 2011; City of Folsom 2011; Metropolitan 2010). The Urban Water Management Plans indicate that during the critical periods with reductions in water supplies, municipal and industrial water uses will be focused on inside water uses with little or no outside irrigation water.

At this time, no specific volumes have been identified for public health and safety quantities for the CVP and/or SWP water users. During the 2014 drought, the Department of Water Resources (DWR) and Reclamation identified 1,500 cubic feet per second as a minimum amount of CVP and SWP Delta exports for public health and safety uses for municipal and industrial water supplies. This amount is also defined by the limitations of the CVP and SWP conveyance facilities, as described in Chapter 5, Surface Water Resources and Water Supplies.

As described above, in 2014, CVP and SWP water supply allocations are at historically low values. However, it is difficult to identify local public health and safety issues, non-agricultural related industrial job losses, and economic losses associated with reductions in CVP and/or SWP water supplies. The potential economic losses, socioeconomic effects, and environmental justice effects are described in Chapter 19, Socioeconomics, and Chapter 21, Environmental Justice.

18.3.1.2 Public Health and Safety Related to Available Agricultural Water Supplies

Agricultural water suppliers have developed responses to the reductions in agricultural water supplies from the CVP and SWP, as described in Chapter 12, Agricultural Resources. Historically, the number of employment opportunities that rely directly or indirectly on the availability of CVP and/or SWP water supplies for irrigation have declined in the areas where the water supplies have declined, communities within the Central Valley Region and Southern California Region, as described in Chapter 19, Socioeconomics.

18.3.1.3 Public Health and Safety Related to Water Supply Availability for Wildland Firefighting

Complex terrain, Mediterranean climate, productive natural plant communities, and ample natural and aboriginal ignition sources has caused California to be a complex wildfire-prone and fire-adapted landscape. While natural wildfires support ecosystem health and are critical to maintaining the structure and function of ecosystems, wildfires pose a significant threat to life, public health, infrastructure, properties, and natural resources.

In accordance with Public Resources Code sections 4201 to 4204 and Government Code sections 51175 to 51189, the California Department of Forestry and Fire Prevention (CAL FIRE) has mapped areas of significant fire hazards based on fuels, terrain, weather, and other relevant factors. The zones are referred to as Fire Hazard Severity Zones and represent the risks associated with wildland fires. Under CAL FIRE regulations, areas within very high fire-hazard risk zones must comply with specific building and vegetation requirements intended to reduce property damage and loss of life within these areas.

According to CAL FIRE, there is an increasing trend of acres burned statewide, with particular increase in conifer vegetation types (CAL FIRE FRAP 2010). Statewide, there are 21.3 million acres of land designated as high priority landscape. The high priority landscape areas include locations with high value water supplies and high threats of fire and large communities which should be protected to prevent wildfire threats to maintain ecosystem health, water supplies, and large communities. These areas include the upper Trinity River watershed in the Trinity River Region; the upper Shasta Lake, Lake Oroville, Folsom Lake, New Melones Reservoir, and Millerton Lake watersheds in the Central Valley Region; and communities in throughout the Southern California Region. Areas designated as high priority landscape occur within 46 of 58 counties. Many rural counties have significant numbers of communities and acreage in medium priority landscape, including 508 communities with some high priority landscape areas.

CAL FIRE manages the State Responsibility Areas, and local fire districts manage Local Responsibility Areas. First responders are typically the local fire districts. The U.S. Forest Service provides wildland fire protection both independently and cooperatively with the California Department of Forestry and Fire Protection. In addition, the U.S. Department of the Interior National Park Service and Bureau of Land Management provide resource management and fire protection on portions of Federal lands.

Firefighting actions frequently involve use of water from reservoirs located close to wildland fires in the Trinity River, Central Valley, Central Coast, and Southern California regions, including reservoirs owned by Reclamation and DWR.

18.3.2 Public Health Issues Related to Mosquito-Borne Diseases

There are more than 50 species of mosquitos in California, including members of the four major genera: 24 species of *Aedes*, 5 species of *Anopheles*, 11 species of *Culex*, and 4 species of *Culiseta* (CDPH et al. 2012). Not all of these species are known to transmit mosquito-borne viruses, as described below. There are approximately 15 mosquito-borne viruses that occur in California; however, the most significant viruses that cause human disease are St. Louis encephalitis virus (SLEV), western equine encephalomyelitis (WEEV), and West Nile virus (WNV) (CDPH et al. 2014). No cases of SLEV or WEEV have been reported in humans over the past few years in California. Malaria also is a mosquito-borne disease that is caused by a parasite instead of a virus.

The *Culex tarsalis* has been identified as part of transmission of SLEV, WEEV, and WNV, especially in rural areas. The *Culex pipiens* and *Culex quinquefasciatus* have been identified as part of the transmission of WNV and SLEV. The *Culex stigmatosoma* has been identified as part of the transmission of WNV and SLEV, especially among birds. The *Aedes melanimon, Aedes vexans*, and *Culex erythrothorax* have been identified as species involved in transmitting the virus between birds and mammals or between mammals.

Mosquitoes, especially *Culex tarsalis*, live in every area of California, and can be a threat to the health of humans and domestic animals throughout the state. The mosquito life cycle requires water for the egg, larva, and pupa stages. Some of the species are more associated with irrigated agriculture, and others are more associated with urban communities (CDPH et al. 2014). Most of the diseases are not treatable and vaccines are not available for humans. Methods to prevent mosquitoes from becoming adults and methods to prevent mosquitos from biting humans are the only available and practical methods to protect public health.

California Health and Safety Code (Sections 2001 – 4(d); 2002; and 2060(b)) describes that landowners are legally responsible to eliminate public nuisances from their properties, including mosquito breeding habitat (CDPH 2008; CDPH et al. 2012). Federal, state, and local agencies supplement the preventive activities of individual landowners toward protecting humans and domestic animals from mosquito-borne diseases. The California Department of Public Health (CDPH) monitors mosquito populations throughout the state. In 1915, the state legislature enacted the Mosquito Abatement Act to allow local mosquito abatement special districts. The local mosquito and vector control districts monitor mosquito populations and take actions such as eliminating breeding sites, using biological control (predators such as mosquitofish), and using chemical control, to reduce mosquito population size (CDPH 2013a).

18.3.2.1 St. Louis Encephalitis Virus

The SLEV is a mosquito-borne virus that circulates among birds and is transmitted to humans via mosquito bites CALSURV 2013a; CDPH 2007). Human infection with SLE can cause mild to severe fever and headaches due to inflammation of the brain. In severe cases, the illness can cause disorientation and comas and possibly cause death. Elderly can become more severely ill than young children with SLEV as compared to WEEV.

Since the SLEV was first recognized in 1933 in St. Louis, Missouri, outbreaks have been reported throughout the United States, Canada, and northern Mexico, generally between August and October (CALSURV 2013a). In 1984 and 1989, 29 human cases were reported in the San Joaquin Valley of the Central Valley Region. During the same time periods, 26 human cases were reported in the Los Angeles area of the Southern California Region. The last human case reported in California occurred in 1997 in Los Angeles County.

18.3.2.2 Western Equine Encephalitis

The WEEV is another mosquito-borne virus that circulates among birds and is transmitted to horses and humans by mosquitoes (CDPH 2007). Symptoms are similar to SLEV. Infants and small children are most severely afflicted with WEEV as compared to SLEV. There is a vaccine for horses, but not for humans. Historically, substantial number of horses died due to this disease as well as humans. Recently, there has not been a recorded case of WEEV in humans in California (CDPH et al. 2014).

18.3.2.3 West Nile Virus

West Nile virus (WNV) can cause mild to severe illness in human, other mammals, and birds.

The virus circulates among birds and is transmitted to humans primarily by *Culex* mosquitoes (CDPH et al. 2014). The WNV was first detected in North America in New York in 1999, and has subsequently spread to 48 states, Canada, and Mexico.

The WNV first appeared in humans in California in 2002 with the identification of one human case (CALSURV 2013b). In 2003, three human cases and one equine case were reported with numerous verified findings of WNV activity among dead birds and mosquitoes. In 2004, the WNV was reported in 58 counties, with 779 human cases, including 29 WNV-associated deaths (CALSURV 2013b). From 2003 through 2013, there were 4,004 reported human cases of WNV with 145 deaths; 16,299 reported bird deaths; and 1,202 reported cases involving horses (CDPH 2014a). In 2007, 2008, and between 2010 and 2013, the majority of reported human cases occurred in the six counties in Southern California Region, with most of the cases reported in Los Angeles County. Between 2007 and 2013, numerous human cases were reported in Butte, Sutter, Sacramento, Stanislaus, Fresno, Tulare, and Kern counties in the Central Valley Region. During this same period, no human cases were reported in the Trinity River Region; Lassen, Plumas, and Nevada counties in the Central Valley Region; San Benito County in the San Francisco Bay Area Region; and San Luis Obispo County in the Central Coast Region.

In humans, WNV may not result in any symptoms or only mild viral symptoms, including mild fever, headache, body aches, skin rash, and swollen lymph glands. Symptoms in less than 1 percent of people that are infected can include headache, high fever, neck stiffness, stupor, disorientation, coma, tremors, convulsions, muscle weakness, and paralysis that are associated with meningitis or encephalitis.

18.3.2.4 Malaria

Malaria also is a mosquito-borne disease caused by a parasite that destroys the red blood cells of its host. People with malaria often experience fever, chills, and flu-like illness which can lead to death (CDPH et al. 2012). Malaria is no longer endemic in California, as well as the rest of the United States, due to intense mosquito control efforts and anti-malarial drugs. However, the disease is diagnosed every year, especially in people who have traveled outside the United States. In 2012, 92 human cases were reported in California (CDPH 2013). Of the 92 cases, 90 patients had traveled to countries characterized as endemic with malaria during the previous three years. The *Anopheles* mosquitoes can transmit the parasite to humans and are prevalent in California (CDPH et al. 2012).

18.3.3 Public Health Issues Related to Valley Fever

Valley fever is an illness that is caused by inhaling the spores of a fungus *Coccidioides immitis* (CDPH 2013c). This fungus lives in the top layers of some soils within 2 to 12 inches from the ground surface. When the soil is disturbed by digging, vehicles, cultivation, or wind, the fungal spores can be inhaled by persons within the area. Irrigated soils are less likely to contain the fungus than dry, previously undisturbed soils.

In most cases, symptoms in humans include mild cough and flu-like symptoms (CDPH 2013c). However, in about 40 percent of the reported cases, the illness can last for more than a month, make the person susceptible to pneumonia, and include cough, fever, chest pain, headache, muscle ache, rash, joint pain, and/or fatigue. In about 5 percent of the reported cases, the disease becomes "disseminated Valley Fever" and can cause meningitis and/or affect bones, joints, skin, or other organs. There are no vaccines to prevent Valley Fever.

The *Coccidioides immitis* is endemic in many areas of the southwestern United States, Mexico, Central America, and South America. In California, the fungus is found in many areas of the San Joaquin Valley and Southern California (CDPH 2011, 2014b). In California between 2001 and 2012, there were over 35,000 reported cases of Valley Fever. The number of incidences increased from 1,483 cases in 2001 to 4,094 cases in 2012. The highest number of cases reported during this period occurred in Kings, Kern, Fresno, Tulare, and Madera counties in the San Joaquin Valley within the Central Valley Region; San Luis Obispo County in the Central Coast Region; and Los Angeles County in the Southern California Region.

In general, the people who have the highest risk of exposure to the fungus include construction workers, archeologists, geologists, wildland fighters, military personnel, mining or gas/oil extraction workers, and agricultural workers in non-irrigated areas (CDPH 2013c). Other employees also may be at risk. For example, members of the cast and crew of a television film became ill with Valley Fever after working on an outdoor set in Ventura County (CDCP 2014).

In 2011, Fresno, Kern, Kings, San Joaquin, San Luis Obispo, and Tulare counties conducted an analysis of information related to Valley Fever incidences (Fresno County et al. 2011). The observations included:

- More incidences were reported in the western parts of Kern, Kings, Fresno, and San Joaquin counties than in other portions of the counties.
- More incidences were reported in northern San Luis Obispo County and southern Tulare County than other portions of the counties.
- In recent years, there was increased reporting of Valley Fever in the prison populations in Fresno and Kings counties. In Kern County, 8 percent of the reported cases between 2005 and 2008 were prison inmates. In Fresno County, incidences at Pleasant Valley State Prison were 43 percent of the total cases in the county between 2004 and 2010. In Kings County, incidences at state prisons were 58 percent of the total cases in the county between 2007 and 2010.

In 2012, the San Joaquin Valley Air Pollution Control District (SJVAPCD) evaluated causes for Valley Fever and options to reduce social and economic effects of Valley Fever in the San Joaquin Valley (SJVAPCD 2012). The analysis described that Valley Fever appears to be related to a fungus that forms in subsoil strata that are dry through a portion of the year. The analysis referred to other studies that correlated weather patterns with outbreaks of Valley Fever during dry periods following periods of heavy rainfall. The study also indicated that airborne *Coccidioides* spores do not generally come from irrigated agriculture. It appears that it is more likely that the spores are from non-irrigated lands, including undisturbed natural lands, undeveloped land, and grazing areas. The study indicated that additional monitoring or reduction of particulate matter of

10 microns, or PM_{10}, did not appear to be useful in reduction of the potential for Valley Fever. The study recommended additional funding to develop a vaccine for Valley Fever.

18.3.4 Public Health Issues Related to High Concentrations of Mercury in Fish and Shellfish

As described in Chapter 6, Water Quality, high concentrations of certain substances accumulate in fish and shellfish based upon the water quality. The California Environmental Protection Agency, Office of Environmental Health Hazard Assessment (OEHHA) evaluates concentrations of potentially toxic substances in edible tissues of fish and shellfish harvested in water bodies in California (OEHHA 2014a). Based upon the evaluation, general and specific safe eating guidelines are developed for the fish and shellfish, as summarized in Table 18.1. For the water bodies in the study area, the primary constituents that have triggered the development of safe eating guidelines are mercury, dieldrin, and/or polychlorinated biphenyl (PCB). Other constituents are present, including selenium; however, the concentrations do not exceed thresholds that would trigger safe eating guidelines. The OEHHA develops two separate guidelines: (1) Guidelines for Children from 1 to 17 years and Women from 18 to 45 years; and (2) Guidelines for Women over 45 years old and Men over 17 years old. The guidelines recommend the number of servings per week by fish or shellfish harvested from specific waters. A “serving size” is defined as “about the size and thickness of your hand” (OEHHA 2014a).

Table 18.1 Summary of Safe Eating Guidelines for Fish and Shellfish from Water Bodies in the Study Area Based on Mercury and PCB (servings per week)

Region	Water Body	Fish and Shellfish[a]	Guidelines for Children and Women up to 45 Years Old[b]	Guidelines for Men and Women over 45 Years Old[b]
Trinity River	Trinity Lake	Rainbow Trout, Brown Trout, White Catfish	2	5
		Largemouth Bass, Smallmouth Bass	Do not eat	1
	Lewiston Lake	Trout	5	7
Central Valley	Sacramento River and Northern Delta	American Shad, Chinook Salmon, Rainbow Trout, Steelhead Trout	2 to 3	7
		Clams	7	7
		Bluegill, other sunfish, carp or goldfish, catfish, crappie, Crayfish, Hardhead, Hitch, sucker	1	3

Region	Water Body	Fish and Shellfisha	Guidelines for Children and Women up to 45 Years Oldb	Guidelines for Men and Women over 45 Years Oldb
Central Valley (continued)		Bass, Pikeminnow, White Sturgeon	Do not eat	1
		Striped Bass	Do not eat	2
	Lake Oroville	Bluegill and Green Sunfish	2	5
		Carp, Coho salmon	1	2
		Largemouth Bass, Smallmouth Bass, Redeye, or Spotted Bass; Channel Catfish; White Catfish	Do not eat	1
	Lower Feather River	American Shad, Chinook Salmon, Steelhead Trout	2 to 3	7
		Carp, sucker	1	2
		Redear, other sunfish	1	3
		Black Bass, catfish, Pikeminnow, Striped Bass, White Sturgeon	Do not eat	1
	Englebright Lake	Rainbow Trout	2	7
		Bluegill, other sunfish	1	2
		Largemouth Bass, Smallmouth Bass, Spotted Bass	Do not eat	1
	Rollins Reservoir	Catfish	1	2
	Camp Far West Reservoir	Bluegill, other sunfish	1	3
		Largemouth Bass, Smallmouth Bass, Spotted Bass, catfish	Do not eat	1
	Folsom Lake	Bluegill, Green Sunfish, or other sunfish; Rout: 16 inches or less	2	5

Region	Water Body	Fish and Shellfisha	Guidelines for Children and Women up to 45 Years Oldb	Guidelines for Men and Women over 45 Years Oldb
Central Valley (continued)		Catfish; Chinook Salmon; Largemouth Bass, Smallmouth Bass, Spotted Bass, trout: over 16 inches	Do not eat	1
	Lake Natoma	Bluegill, Green Sunfish, or other sunfish; trout: 16 inches or less	2	5
		Chinook Salmon; Largemouth Bass, Smallmouth Bass, Spotted Bass, trout: over 16 inches	Do not eat	1
		Catfish	Do not eat	Do not eat
	Lower American River	American Shad, Chinook Salmon, steelhead trout	2 to 3	7
		Redear or other sunfish, sucker, white catfish	1	2
		Striped Bass	Do not eat	2
		Bass, Pikeminnow	Do not eat	1
	Lower Mokelumne River	American Shad, Chinook Salmon, steelhead trout	2 to 3	7
		Clams	7	7
		Bluegill or other sunfish, Crayfish, catfish	1	2
		Striped Bass	Do not eat	2
		Bass, Pikeminnow, White Sturgeon	Do not eat	1
	San Joaquin River (Friant Dam to Port of Stockton)	Chinook Salmon, steelhead trout	2	7
		Bluegill or other sunfish	2	5
		American Shad	3	7
		Carp, catfish, sucker	1	2

Region	Water Body	Fish and Shellfisha	Guidelines for Children and Women up to 45 Years Oldb	Guidelines for Men and Women over 45 Years Oldb
Central Valley (continued)		Striped Bass	Do not eat	2
		Bass, white sturgeon	Do not eat	1
	Central and South Delta	American Shad, Chinook Salmon, Bluegill or other sunfish, steelhead trout	2	7
		Catfish, Crayfish	2	5
		Clams	7	7
		Bass, carp, crappie, sucker	1	2
		Striped Bass	Do not eat	2
		White Sturgeon	Do not eat	1
San Francisco Bay Area	San Francisco Bay	Chinook Salmon	2	7
		Brown Rockfish, Red Rock Crab	2	5
		Jacksmelt	2	2
		California Halibut	1	2
		White Croaker	1	1
		Sharks, Striped Bass, White Sturgeon	Do not eat	1
		Surfperches	Do not eat	Do not eat
	San Pablo Reservoir	Crappie	2	5
		Trout	5	5
		Largemouth Bass, Smallmouth Bass, Spotted Bass	Do not eat	1
		Carp, catfish	Do not eat	Do not eat
	Lafayette Reservoir	Crappie	4	7
		Bass	1	2
		Carp or Goldfish	Do not eat	1

Region	Water Body	Fish and Shellfisha	Guidelines for Children and Women up to 45 Years Oldb	Guidelines for Men and Women over 45 Years Oldb
San Francisco Bay Area **(continued)**	Lake Chabot	Redear or other sunfish	2	4
		Channel Catfish	1	1
		Bass	Do not eat	1
		Carp	Do not eat	Do not eat
Southern California Region	Pyramid Lake	Rainbow Trout	7	7
		Channel Catfish	1	2
		Largemouth Bass, Smallmouth Bass	Do not eat	1
		Bullhead	Do not eat	Do not eat
	Silverwood Lake	Rainbow Trout	7	7
		Tule Perch	1	1
		Largemouth Bass, Bluegill, Channel Catfish	Do not eat	1
		Striped Bass, Blackfish, Tui Chub	Do not eat	Do not eat
Statewide	All Lakes and Reservoirs without Site-Specific Advice	Rainbow trout	2	6
		Bullhead, catfish, Bluegill or other sunfish, Brown Trout: 16 inches or less	1	2
		Bass, carp, Brown Trout: over 16 inches	Do not eat	1
	All Rivers, Estuaries, and Coastal Waters without Site-Specific Advice	American Shad, Chinook Salmon, steelhead trout	2 to 3	7

Region	Water Body	Fish and Shellfisha	Guidelines for Children and Women up to 45 Years Oldb	Guidelines for Men and Women over 45 Years Oldb
Statewide (continued)		Striped Bass	Do not eat	2
		White Sturgeon	Do not eat	1

Sources: OEHHA 2014b, 2014c, 2014d, 2014e, 2014f, 2014g, 2014h, 2014i, 2014j, 2014k, 2014l, 2014m, 2014n, 2014o, 2014p, 2014q, 2014r, 2014s, 2014t, 2014u, 2014v, 2014w

Notes:

a. All fish and shellfish names are as appears in the OEHHA guidelines.

b. The OEHHA guidelines refer to the total number of servings of fish per week for one water body, not just the total for a specific species. For example, OEHHA guidelines for Men eating fish from Trinity Lake would include no more than 5 servings of Rainbow Trout, Brown Trout, or White Catfish; OR 1 serving of Largemouth Bass or Smallmouth Bass.

Resident Delta fish accumulate mercury primarily through dietary exposure; larger, piscivorous (fish-eating) fish show the greatest levels of tissue mercury. In contrast to anadromous fish (migratory species), the resident fish experience constant exposure to local mercury sources. Resident species include larger fish with human health exposure (such as Largemouth Bass) and smaller, forage fish (such as Inland Silversides). Fish tissues are the ultimate route of exposure to mercury for humans who consume locally caught fish.

Historically, substantial levels of mercury contamination have occurred in fish throughout the Delta. Mercury concentrations in tissue of the larger piscivorous fish are lower in for fish in the central Delta as compared to fish from the Mokelumne, Cosumnes, Sacramento, and San Joaquin rivers (CVRWQCB 2010a, 2010b). Larger, piscivorous resident fish, in general, provide a good record of fish tissue mercury as a baseline condition for the Delta. Largemouth Bass were chosen because they are popular sport fish, top predators, live for several years, and tend to stay in the same area (exhibit high site fidelity). Consequently, they are excellent indicators of long-term average mercury exposure, risk, and spatial pattern for ecological and human health. Mercury in sport fish from the Delta region was reported for Largemouth Bass as a median tissue mercury concentration of 0.53 mg mercury per kilogram (Hg/kg) wet weight (Davis et al. 2003). Current fish tissue concentrations thus exceed both adopted regulatory standards and guidance from the U.S. Environmental Protection Agency (USEPA). In the 2010 Delta TMDL for methylmercury, the Central Valley Regional Water Quality Control Board (Central Valley RWQCB) established a fish tissue threshold (fillet concentrations, wet weight mercury) of 0.24 mg Hg/kg wet weight in trophic level 4 fish (adult, top predatory sport fish, such as Largemouth Bass) (Central Valley Water Board 2010a). These values are slightly lower than USEPA's national recommended water quality criterion for fish tissue of 0.3 mg Hg/kg wet weight for protection of human health and wildlife (USEPA

2001). Therefore, the Delta average for Largemouth Bass fillet concentrations in the study by Davis et al. exceeds both recommended safe consumption guidelines.

18.4 Impact Analysis

This section describes the potential mechanisms for change in conditions and analytical methods; results of impact analyses; potential mitigation measures; and cumulative effects.

18.4.1 Potential Mechanisms for Change and Analytical Methods

As described in Chapter 4, Approach to Environmental Analysis, the impact analysis considers changes in public health factors related to changes in CVP and SWP operations under the alternatives as compared to the No Action Alternative and Second Basis of Comparison.

Changes in CVP and SWP operations under the alternatives as compared to the No Action Alternative and Second Basis of Comparison could change public health factors affected by CVP and SWP operations.

18.4.1.1 Changes in Public Health Factors Related to Available CVP and SWP Agricultural Water Supplies

Changes in water supply availability to agricultural water users could result in reductions of irrigated acreage and related jobs. The availability of jobs can affect public health, as described in Section 18.3.2, Public Health Issues Related to Available Water Supplies. As described in Chapter 12, Agricultural Resources, agricultural acreage would be similar under Alternatives 1 through 5, No Action Alternative, and Second Basis of Comparison. Therefore, the change in public health conditions would be the same under all of the alternatives and the Second Basis of Comparison; and is not analyzed in this EIS.

18.4.1.2 Changes in Public Health Factors Related to Available Municipal Water Supplies

As described in Section 18.3.2, Public Health Issues Related to Available Water Supplies, water supply availability can affect public health related to direct use within the household and indirect effects related to adequate water supplies for industrial and commercial water users that provide employment. As described in Chapter 5, Surface Water Resources and Water Supplies, and Chapter 18, Socioeconomics, t municipal and industrial water users would rely upon alternate water supplies to meet water demands in 2030. Therefore, public health conditions related to availability of municipal and industrial water supplies would be the same under all of the alternatives and the Second Basis of Comparison; and is not analyzed in this EIS.

18.4.1.3 Changes in Public Health Factors Related to Wildland Firefighting and CVP and SWP Reservoir Storage

Stored water in water supply reservoirs is used for wildland firefighting in the California foothills and mountains, including water stored in CVP and SWP reservoirs. During drier periods, reduced storage levels could affect the availability of water for wildlife firefighting, as indicated in changes in CVP and SWP reservoir at the end of September in critical dry water years, as described in Chapter 5, Surface Water Resources and Water Supplies.

Reservoirs that store water in the San Francisco Bay Area, Central Coast, and Southern California regions are managed to store water supplies as part of short-term conveyance management or storage for regional and local water supplies using water from numerous sources and water for wildland firefighting is not known; and therefore, are not analyzed in this EIS.

18.4.1.4 Changes in Public Health Factors Related to Wetlands Restoration and Mosquito-Borne Diseases

Wetlands provide habitat for mosquito breeding, especially in tidally-influenced wetlands with slow moving water and floodplains after the majority of the water recedes. Management practices (e.g., designing wetlands to provide flushing flows, use of biological controls) can reduce the nuisance and public health aspects of mosquito populations. The extent of seasonal floodplains and tidally-influenced wetlands in Yolo Bypass, Cache Slough, and Suisun Marsh areas would increase in a similar manner under all of the alternatives and the Second Basis of Comparison, as described in Chapter 3, Description of Alternatives. Therefore, the potential for changes in public health conditions related to mosquito populations would be the same under all of the alternatives and the Second Basis of Comparison; and is not analyzed in this EIS.

18.4.1.5 Changes in Public Health Factors Related to Potential Valley Fever

As described above, recent studies have indicated that valley fever exposure appears to be related to cultivated lands, including lands that are idled due to agricultural practices or reduced water supply availability. Changes in CVP and SWP operations under the alternatives and the Second Basis of Comparison would not affect the extent of non-irrigated lands. Therefore, the potential for changes in public health conditions related to Valley Fever would be the same under all of the alternatives and the Second Basis of Comparison; and is not analyzed in this EIS.

18.4.1.6 Changes in Public Health Factors Related to Mercury in Fish used for Human Consumption

As described above, fish used for human consumption in the Delta have mercury levels that exceed OEHHA guidelines. Changes in CVP and SWP operations under the alternatives and the Second Basis of Comparison would change the accumulated mercury concentrations in fish in the Delta. As described in Chapter 6, Surface Water Quality, the bioavailability and toxicity of mercury is enhanced through the natural, bacterial conversion of mercury to methylmercury in marshlands or wetlands. These stagnant locations with reduced oxygen concentrations promote chemical reduction processes that make methylation possible. The methylmercury model is based upon the Total Maximum Daily Load translation equation for mercury developed by the Central Valley Regional

Water Quality Control Board. The model estimates fish tissue concentrations from waterborne concentrations of mercury in the Delta and evaluates the potential to cause exceedances of water quality or tissue benchmarks. The tissue concentrations associated with the Alternatives 1 through 5 were compared to the No Action Alternative and the Second Basis of Comparison.

18.4.2 Conditions in Year 2030 without Implementation of Alternatives 1 through 5

This EIS includes two bases of comparison, as described in Chapter 3, Description of Alternatives: the No Action Alternative and the Second Basis of Comparison. Both of these bases are evaluated at 2030 conditions. Changes that would occur over the next 15 years without implementation of the alternatives are not analyzed in this EIS. However, the changes to public health that are assumed to occur by 2030 under the No Action Alternative and the Second Basis of Comparison are summarized in this section. Many of the changed conditions would occur in the same manner under both the No Action Alternative and the Second Basis of Comparison.

18.4.2.1 Common Changes in Conditions under the No Action Alternative and Second Basis of Comparison

Conditions in 2030 would be different than existing conditions due to:

- Climate change and sea level rise
- General plan development throughout California, including increased water demands in portions of Sacramento Valley
- Implementation of reasonable and foreseeable water resources management projects to provide water supplies

It is anticipated that climate change would result in more short-duration high-rainfall events and less snowpack in the winter and early spring months. The reservoirs would be full more frequently by the end of April or May by 2030 than in recent historical conditions. However, as the water is released in the spring, there would be less snowpack to refill the reservoirs. This condition would reduce reservoir storage and available water supplies to downstream uses in the summer. The reduced end of September storage also would reduce the ability to release stored water to downstream regional reservoirs. These conditions would occur for all reservoirs in the California foothills and mountains, including non-CVP and SWP reservoirs.

These changes would result in a decline of the long-term average CVP and SWP water supply deliveries by 2030 as compared to recent historical long-term average deliveries under the No Action Alternative and the Second Basis of Comparison. However, the CVP and SWP water deliveries would be less under the No Action Alternative as compared to the Second Basis of Comparison, as described in Chapter 5, Surface Water Resources and Water Supplies. Due to climate change and related lower snowfall, end of September low reservoir storage would be lower in critical dry years by 2030 as compared to recent historical conditions in Shasta Lake, Lake Oroville, Folsom Lake, New Melones Reservoir, and San Luis Reservoir. Therefore, the potential for reduced reservoir water supplies for wildland firefighting would be greater under the No Action Alternative and Second Basis of Comparison as compared to recent historical conditions.

Under the No Action Alternative and the Second Basis of Comparison, land uses in 2030 would occur in accordance with adopted general plans.

The No Action Alternative and the Second Basis of Comparison assumes completion of water resources management and environmental restoration projects that would have occurred without implementation of Alternatives 1 through 5, including regional and local recycling projects, surface water and groundwater storage projects, conveyance improvement projects, and desalination projects, as described in Chapter 3, Description of Alternatives. The No Action Alternative and the Second Basis of Comparison also assumes implementation of actions included in the 2008 U.S. Fish and Wildlife Service (USFWS) Biological Opinion (BO) and 2009 National Marine Fisheries Service (NMFS) BO that would have been implemented without the BOs by 2030, as described in Chapter 3, Description of Alternatives.

Under the No Action Alternative and Second Basis of Comparison, it is anticipated that mercury concentrations in fish tissue within the Delta will be either similar or greater than recent historical conditions. Phase 1 of the Delta Mercury Program mandated by the Central Valley RWQCB is currently being completed to protect people eating one meal per week of larger fish from the Delta, including Largemouth Bass. Phase 1 is focused on studies and pilot projects to develop and evaluate management practices to control methylmercury from mercury sources in the Delta and Yolo Bypass; and to reduce total mercury loading to the San Francisco Bay. Following completion of Phase 1 in 2019, Phase 2 will be implemented through 2030. Phase 2 will focus on methylmercury control programs and reduction programs for total inorganic mercury. Due to the extent of these studies, it is not anticipated that changes in methylmercury or total mercury concentrations in fish tissue will be reduced by 2030. Future mercury reduction and control programs will reduce mercury sources and related fish tissue concentrations; however, that will occur after 2030.

18.4.3 Evaluation of Alternatives

As described in Chapter 4, Approach to Environmental Analysis, Alternatives 1 through 5 have been compared to the No Action Alternative; and the No Action Alternative and Alternatives 1 through 5 have been compared to the Second Basis of Comparison.

During review of the numerical modeling analyses used in this EIS, an error was determined in the CalSim II model assumptions related to the Stanislaus River operations for the Second Basis of Comparison, Alternative 1, and Alternative 4 model runs. Appendix 5C includes a comparison of the CalSim II model run results presented in this chapter and CalSim II model run results with the error corrected. Appendix 5C also includes a discussion of changes in the comparison of groundwater conditions for the following alternative analyses.

- No Action Alternative compared to the Second Basis of Comparison
- Alternative 1 compared to the No Action Alternative
- Alternative 3 compared to the Second Basis of Comparison
- Alternative 5 compared to the Second Basis of Comparison

18.4.3.1 No Action Alternative

The No Action Alternative is compared to the Second Basis of Comparison.

18.4.3.1.1 Trinity River Region

Changes in Public Health Factors Related to Wildland Firefighting and CVP and SWP Reservoir Storage

Changes in CVP water supplies and operations under the No Action Alternative as compared to the Second Basis of Comparison would result in similar end of September reservoir elevations in critical dry years (changes within 5 percent) at Trinity Lake, as described in Chapter 5, Surface Water Resources and Water Supplies. Therefore, the potential for water availability for wildland firefighting would be similar under the No Action Alternative as compared to the Second Basis of Comparison.

18.4.3.1.2 Central Valley Region

Changes in Public Health Factors Related to Wildland Firefighting and CVP and SWP Reservoir Storage

Changes in CVP water supplies and operations under the No Action Alternative as compared to the Second Basis of Comparison would result in similar end of September reservoir elevations in critical dry years (changes within 5 percent) at Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir, as described in Chapter 5, Surface Water Resources and Water Supplies. Therefore, the potential for water availability for wildland firefighting would be similar under the No Action Alternative as compared to the Second Basis of Comparison.

End of September surface water elevations at San Luis Reservoir in critical dry years would be 6 percent lower under the No Action Alternative as compared to the Second Basis of Comparison. Therefore, the potential for water availability for wildland firefighting would be reduced at San Luis Reservoir under the No Action Alternative as compared to the Second Basis of Comparison.

Changes in Public Health Factors Related to Mercury in Fish used for Human Consumption

Mercury concentrations in Largemouth Bass would be similar (within 5 percent change) in most locations in the Delta, except for Rock Slough, San Joaquin River near Antioch, and Montezuma Slough in Suisun Marsh. In these areas, the mercury concentrations would increase by 7 percent over long-term conditions under the No Action Alternative as compared to the Second Basis of Comparison.

Under dry and critical dry years, mercury concentrations would increase by 7 to 8 percent at Rock Slough, intakes of the Banks and Jones pumping plants, and Victoria Canal. All values exceed the threshold of 0.24 mg/kg ww for mercury.

18.4.3.2 Alternative 1

Alternative 1 is identical to the Second Basis of Comparison. Alternative 1 is compared to the No Action Alternative and the Second Basis of Comparison. However, because CVP and SWP operations under Alternative 1 are identical to conditions under the Second Basis of Comparison; Alternative 1 is only compared to the No Action Alternative.

18.4.3.2.1 Alternative 1 Compared to the No Action Alternative

Trinity River Region

Changes in Public Health Factors Related to Wildland Firefighting and CVP and SWP Reservoir Storage

Changes in CVP water supplies and operations under Alternative 1 as compared to the No Action Alternative would result in similar end of September reservoir elevations in critical dry years at Trinity Lake, as described in Chapter 5, Surface Water Resources and Water Supplies. Therefore, the potential for water availability for wildland firefighting would be similar under Alternative 1 as compared to the No Action Alternative.

Central Valley Region

Changes in Public Health Factors Related to Wildland Firefighting and CVP and SWP Reservoir Storage

Changes in CVP water supplies and operations under Alternative 1 as compared to the No Action Alternative would result in similar end of September reservoir elevations in critical dry years at Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir, as described in Chapter 5, Surface Water Resources and Water Supplies. Therefore, the potential for water availability for wildland firefighting would be similar under Alternative 1 as compared to the No Action Alternative.

End of September surface water elevations at San Luis Reservoir in critical dry years would be 7 percent higher under Alternative 1 as compared to the No Action Alternative. Therefore, the potential for water availability for wildland firefighting would be increased at San Luis Reservoir under Alternative 1 as compared to the No Action Alternative.

Changes in Public Health Factors Related to Mercury in Fish used for Human Consumption

Mercury concentrations in Largemouth Bass would be similar in most locations in the Delta, except for Rock Slough, San Joaquin River near Antioch, and Montezuma Slough in Suisun Marsh. In these areas, the mercury concentrations would decrease by 6 percent over the long-term conditions under Alternative 1 as compared to the No Action Alternative. Under dry and critical dry years, mercury concentrations would decrease by 6 to 8 percent at Rock Slough, intakes of the

Banks and Jones pumping plants, and Victoria Canal. All values exceed the threshold of 0.24 mg/kg ww for mercury.

18.4.3.2.2 Alternative 1 Compared to the Second Basis of Comparison

Alternative 1 is identical to the Second Basis of Comparison.

18.4.3.3 Alternative 2

The CVP and SWP operations under Alternative 2 are identical to the CVP and SWP operations under the No Action Alternative; therefore, Alternative 2 is only compared to the Second Basis of Comparison.

18.4.3.3.1 Alternative 2 Compared to the Second Basis of Comparison

The CVP and SWP operations under Alternative 2 are identical to the CVP and SWP operations under the No Action Alternative. Therefore, changes to public health conditions under Alternatives 2 as compared to the Second Basis of Comparison would be the same as the impacts described in Section 18.4.3.1, No Action Alternative.

18.4.3.4 Alternative 3

As described in Chapter 3, Description of Alternatives, CVP and SWP operations under Alternative 3 are similar to the Second Basis of Comparison with modified Old and Middle River flow criteria and New Melones Reservoir operations. As described in Chapter 4, Approach to Environmental Analysis, Alternative 3 is compared to the No Action Alternative and the Second Basis of Comparison.

18.4.3.4.1 Alternative 3 Compared to the No Action Alternative

Trinity River Region

Changes in Public Health Factors Related to Wildland Firefighting and CVP and SWP Reservoir Storage

Changes in CVP water supplies and operations under Alternative 3 as compared to the No Action Alternative would result in similar end of September reservoir elevations in critical dry years at Trinity Lake, as described in Chapter 5, Surface Water Resources and Water Supplies. Therefore, the potential for water availability for wildland firefighting would be similar under Alternative 3 as compared to the No Action Alternative.

Central Valley Region

Changes in Public Health Factors Related to Wildland Firefighting and CVP and SWP Reservoir Storage

Changes in CVP water supplies and operations under Alternative 3 as compared to the No Action Alternative would result in similar end of September reservoir elevations in critical dry years at Shasta Lake, Lake Oroville, Folsom Lake, New Melones Reservoir, and San Luis Reservoir, as described in Chapter 5, Surface Water Resources and Water Supplies. Therefore, the potential for water availability for wildland firefighting would be similar under Alternative 3 as compared to the No Action Alternative.

Changes in Public Health Factors Related to Mercury in Fish used for Human Consumption

Mercury concentrations in Largemouth Bass would be similar (within 5 percent change) in most locations in the Delta, except for San Joaquin River near Antioch and Montezuma Slough in Suisun Marsh. In these areas, the mercury concentrations would decrease by 6 percent over the long-term conditions under Alternative 3 as compared to the No Action Alternative. Mercury concentrations under the dry and critical dry years would be similar throughout the Delta. All values exceed the threshold of 0.24 mg/kg ww for mercury.

18.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison

Trinity River Region

Changes in Public Health Factors Related to Wildland Firefighting and CVP and SWP Reservoir Storage

Changes in CVP water supplies and operations under Alternative 3 as compared to the Second Basis of Comparison would result in similar end of September reservoir elevations in critical dry years at Trinity Lake, as described in Chapter 5, Surface Water Resources and Water Supplies. Therefore, the potential for water availability for wildland firefighting would be similar under Alternative 3 as compared to the Second Basis of Comparison.

Central Valley Region

Changes in Public Health Factors Related to Wildland Firefighting and CVP and SWP Reservoir Storage

Changes in CVP water supplies and operations under Alternative 3 as compared to the Second Basis of Comparison would result in similar end of September reservoir elevations in critical dry years at Shasta Lake, Lake Oroville, Folsom Lake, New Melones Reservoir, and San Luis Reservoir, as described in Chapter 5, Surface Water Resources and Water Supplies. Therefore, the potential for water availability for wildland firefighting would be similar under Alternative 3 as compared to the Second Basis of Comparison.

Changes in Public Health Factors Related to Mercury in Fish used for Human Consumption

Mercury concentrations in Largemouth Bass would be similar throughout the Delta under Alternative 3 as compared to the Second Basis of Comparison, as summarized in Chapter 6, Surface Water Quality. All values exceed the threshold of 0.24 mg/kg ww for mercury.

18.4.3.5 Alternative 4

The public health conditions under Alternative 4 would be identical to the conditions under the Second Basis of Comparison; therefore, Alternative 4 is only compared to the No Action Alternative.

18.4.3.5.1 Alternative 4 Compared to the No Action Alternative

The CVP and SWP operations under Alternative 4 are identical to the CVP and SWP operations under the Second Basis of Comparison and Alternative 1. Therefore, changes in public health conditions under Alternative 4 as compared to the No Action Alternative would be the same as the impacts described in Section 12.4.4.2.1, Alternative 1 Compared to the No Action Alternative.

18.4.3.6 Alternative 5

As described in Chapter 3, Description of Alternatives, CVP and SWP operations under Alternative 5 are similar to the No Action Alternative with modified Old and Middle River flow criteria and New Melones Reservoir operations. As described in Chapter 4, Approach to Environmental Analysis, Alternative 5 is compared to the No Action Alternative and the Second Basis of Comparison.

18.4.3.6.1 Alternative 5 Compared to the No Action Alternative

Trinity River Region

Changes in Public Health Factors Related to Wildland Firefighting and CVP and SWP Reservoir Storage

Changes in CVP water supplies and operations under Alternative 5 as compared to the No Action Alternative would result in similar end of September reservoir elevations in critical dry years at Trinity Lake, as described in Chapter 5, Surface Water Resources and Water Supplies. Therefore, the potential for water availability for wildland firefighting would be similar under Alternative 5 as compared to the No Action Alternative.

Central Valley Region

Changes in Public Health Factors Related to Wildland Firefighting and CVP and SWP Reservoir Storage

Changes in CVP water supplies and operations under Alternative 5 as compared to the No Action Alternative would result in similar end of September reservoir elevations in critical dry years at Shasta Lake, Lake Oroville, Folsom Lake, New Melones Reservoir, and San Luis Reservoir, as described in Chapter 5, Surface Water Resources and Water Supplies. Therefore, the potential for water availability for wildland firefighting would be similar under Alternative 5 as compared to the No Action Alternative.

Changes in Public Health Factors Related to Mercury in Fish used for Human Consumption

Mercury concentrations in Largemouth Bass would be similar throughout the Delta under Alternative 5 as compared to the No Action Alternative, as summarized in Chapter 6, Surface Water Quality. All values exceed the threshold of 0.24 mg/kg ww for mercury.

18.4.3.6.2 Alternative 5 Compared to the Second Basis of Comparison

Trinity River Region

Changes in Public Health Factors Related to Wildland Firefighting and CVP and SWP Reservoir Storage

Changes in CVP water supplies and operations under Alternative 5 as compared to the Second Basis of Comparison would result in similar end of September reservoir elevations in critical dry years at Trinity Lake, as described in Chapter 5, Surface Water Resources and Water Supplies. Therefore, the potential for water availability for wildland firefighting would be similar under Alternative 5 as compared to the Second Basis of Comparison.

Central Valley Region

Changes in Public Health Factors Related to Wildland Firefighting and CVP and SWP Reservoir Storage

Changes in CVP water supplies and operations under Alternative 5 as compared to the Second Basis of Comparison would result in similar end of September reservoir elevations in critical dry years at Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir, as described in Chapter 5, Surface Water Resources and Water Supplies. Therefore, the potential for water availability for wildland firefighting would be similar under Alternative 5 as compared to the Second Basis of Comparison.

End of September surface water elevations at San Luis Reservoir in critical dry years would be 9 percent lower under Alternative 5 as compared to the Second Basis of Comparison. Therefore, the potential for water availability for wildland firefighting would be reduced at San Luis Reservoir under Alternative 5 as compared to the Second Basis of Comparison.

Changes in Public Health Factors Related to Mercury in Fish used for Human Consumption

Mercury concentrations in Largemouth Bass would be similar in most locations in the Delta, except for Rock Slough, San Joaquin River near Antioch, and Montezuma Slough in Suisun Marsh. In these areas, the mercury concentrations would increase by 7 to 8 percent over long-term conditions under Alternative 5 as compared to the Second Basis of Comparison. During dry and critical dry years, mercury concentrations also would increase by 7 percent at intakes to Banks Pumping Plant and Jones Pumping Plant; and 13 percent at Rock Slough. All values exceed the threshold of 0.24 mg/kg ww for mercury.

18.4.3.7 Summary of Environmental Consequences

The results of the environmental consequences of implementation of Alternatives 1 through 5 as compared to the No Action Alternative and the Second Basis of Comparison are presented in Tables 18.2 and 18.3, respectively.

Table 18.2 Comparison of Alternatives 1 through 5 to No Action Alternative

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	Similar water supply availability for wildland firefighting at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir; and a 7 percent increase at San Luis Reservoir. Similar mercury concentrations in Largemouth Bass in the most of the Delta; and a 6 percent decrease near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough over the long-term conditions.	None needed
Alternative 2	No effects on public health issues.	None needed
Alternative 3	Similar water supply availability for wildland firefighting at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, New Melones Reservoir, and San Luis Reservoir. Similar mercury concentrations in Largemouth Bass in the most of the Delta; and a 6 percent decrease near San Joaquin River at Antioch and Montezuma Slough over the long-term conditions.	None needed
Alternative 4	Same effects as described for Alternative 1 compared to the No Action Alternative.	None needed
Alternative 5	Similar water supply availability for wildland firefighting at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, New Melones Reservoir, and San Luis Reservoir. Similar mercury concentrations in Largemouth Bass throughout the Delta.	None needed

Note: Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools, incremental differences of 5 percent or less between alternatives and the Second Basis of Comparison are considered to be “similar.”

Table 18.3 Comparison of No Action Alternative and Alternatives 1 through 5 to Second Basis of Comparison

Alternative	Potential Change	Consideration for Mitigation Measures
No Action Alternative	Similar water supply availability for wildland firefighting at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir; and a 6 percent decrease at San Luis Reservoir. Similar mercury concentrations in Largemouth Bass in the most of the Delta; and a 7 percent increase near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough over the long-term conditions.	Not considered for this comparison.
Alternative 1	No effects on public health issues.	Not considered for this comparison.
Alternative 2	Same effects as described for No Action Alternative as compared to the Second Basis of Comparison.	Not considered for this comparison.
Alternative 3	Similar water supply availability for wildland firefighting at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, New Melones Reservoir, and San Luis Reservoir. Similar mercury concentrations in Largemouth Bass throughout the Delta.	Not considered for this comparison.
Alternative 4	No effects on public health issues.	Not considered for this comparison.
Alternative 5	Similar water supply availability for wildland firefighting at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir; and a 9 percent decrease at San Luis Reservoir. Similar mercury concentrations in Largemouth Bass in the most of the Delta; and a 7 percent increase near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough over the long-term conditions.	Not considered for this comparison.

Note: Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools, incremental differences of 5 percent or less between alternatives and the Second Basis of Comparison are considered to be “similar.”

18.4.3.8 Potential Mitigation Measures

Mitigation measures are presented in this section to avoid, minimize, rectify, reduce, eliminate, or compensate for adverse environmental effects of Alternatives 1 through 5 as compared to the No Action Alternative. Mitigation measures were not included to address adverse impacts under the alternatives as compared to the Second Basis of Comparison because this analysis was included in this EIS for information purposes only.

Changes in CVP and SWP operations under Alternatives 1 through 5 as compared to the No Action Alternative would not result in changes in public health factors. Therefore, there would be no adverse impacts to public health factors; and no mitigation measures are required.

18.4.3.9 Cumulative Effects Analysis

As described in Chapter 3, the cumulative effects analysis considers projects, programs, and policies that are not speculative; and are based upon known or reasonably foreseeable long-range plans, regulations, operating agreements, or other information that establishes them as reasonably foreseeable.

The cumulative effects analyses for Alternatives 1 through 5 for Public Health are summarized in Table 18.4.

Table 18.4 Summary of Cumulative Effects on Public Health with Implementation of Alternatives 1 through 5 as Compared to the No Action Alternative

Scenarios	Actions	Cumulative Effects of Actions
Past & Present, and Future Actions included in the No Action Alternative in All Alternatives in Year 2030	Consistent with Affected Environment conditions plus: Actions in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives), including climate change and sea level rise Actions not included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives): - Implementation of Federal and state policies and programs, including Clean Water Act (e.g., Total Maximum Daily Loads); Safe Drinking Water Act; Clean Air Act; and flood management programs - General plans for 2030. - Trinity River Restoration Program. - Central Valley Project Improvement Act programs	These effects would be the same under all alternatives. Climate change and sea level rise, development under the general plans, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce end of September storage in CVP and SWP reservoirs. Mercury concentrations in fish tissue within the Delta will be either similar or greater than recent historical conditions because Phases 1 and 2 of the Delta Mercury Program would be completed by 2030, as mandated by the Central Valley RWQCB, including methylmercury control programs and reduction programs for total inorganic mercury. Due to the extent of these programs, it is anticipated that the programs would be initiated; however, future reductions in mercury sources and related reductions of mercury and

Scenarios	Actions	Cumulative Effects of Actions
	- Folsom Dam Water Control Manual Update - FERC Relicensing for the Middle Fork of the American River Project - Lower Mokelumne River Spawning Habitat Improvement Project - Dutch Slough Tidal Marsh Restoration - Suisun Marsh Habitat Management, Preservation, and Restoration Plan Implementation - Tidal Wetland Restoration: Yolo Ranch, Northern Liberty Island Fish Restoration Project, Prospect Island Restoration Project, and Calhoun Cut/Lindsey Slough Tidal Habitat Restoration Project - San Joaquin River Restoration Program - Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects with completed environmental documents)	methylmercury concentrations in fish tissue would actually occur after 2030.
Future Actions considered as Cumulative Effects Actions in All Alternatives in Year 2030	Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives): - Bay-Delta Water Quality Control Plan Update - FERC Relicensing Projects - Bay Delta Conservation Plan (including the California WaterFix alternative) - Shasta Lake Water Resources, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations - El Dorado Water and Power Authority Supplemental Water Rights Project - Sacramento River Water Reliability Project - Semitropic Water Storage District Delta Wetlands	These effects would be the same under all alternatives. Reasonably foreseeable storage projects would increase reservoir storage at Shasta Lake and Los Vaqueros Reservoir, and provide new reservoir storage at North-of-the-Delta Offstream Storage, Upper San Joaquin River Basin Storage, and Delta Wetlands.

Scenarios	Actions	Cumulative Effects of Actions
	- North Bay Aqueduct Alternative Intake - San Luis Reservoir Low Point Improvement Project - Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects that did not have completed environmental documents during preparation of the EIS)	
No Action Alternative with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO	Climate change and sea level rise, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce end of September CVP and SWP reservoir storage as compared to past conditions. Mercury and methylmercury concentrations in fish tissue would be similar or greater than past conditions.
Alternative 1 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternative 1 with future reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 2 with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions No implementation of structural improvements or other actions that require further study to develop a more detailed action description.	Implementation of Alternative 2 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 3 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant) Slight increase in positive Old and Middle River flows in the winter and spring months	Implementation of Alternative 3 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.

Scenarios	Actions	Cumulative Effects of Actions
Alternative 4 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternative 4 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 5 with Associated Cumulative Effects Actions in Year 20530	Full implementation of the 2008 USFWS BO and 2009 NMFS BO Positive Old and Middle River flows and increased Delta outflow in spring months	Implementation of Alternative 5 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.

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Chapter 19

Socioeconomics

19.1 Introduction

This Chapter describes socioeconomic conditions in the Study Area; and potential changes that could occur as a result of implementing the alternatives evaluated in this Environmental Impact Statement (EIS). Implementation of the alternatives could affect socioeconomic conditions through potential changes in operation of the Central Valley Project (CVP) and State Water Project (SWP) that would change CVP and SWP water supply availability to agricultural water users and municipal and industrial (M&I) water users. Changes in CVP and SWP operations also would result in changes to recreational resources at reservoirs that store CVP and SWP water.

Changes in agricultural production, including costs to provide Alternative water supplies when CVP and SWP water supplies are not available, are presented in Chapter 12, Agricultural Resources. Changes in reservoir recreational opportunities that would occur due to reduction in reservoir storage elevations are presented in Chapter 15, Recreational Resources. The results of these analyses are summarized in Section 19.4, Environmental Consequences, of this Chapter and considered in the determination of regional socioeconomics effects.

19.2 Regulatory Environment and Compliance Requirements

Potential actions that could be implemented under the alternatives evaluated in this EIS could affect socioeconomic conditions in portions of the Study Area affected by or served by CVP and SWP water supplies. Actions located on public agency lands; or implemented, funded, or approved by Federal and state agencies would need to be compliant with appropriate Federal and state agency policies and regulations, as summarized in Chapter 4, Approach to Environmental Analyses.

19.3 Affected Environment

This section describes socioeconomic conditions that could be potentially affected by implementation of the alternatives considered in this EIS. The socioeconomic conditions described in this Chapter are related to population, employment, income, and taxes.

Housing information is not described in this Chapter because implementation of the No Action Alternative, Second Basis of Comparison, and Alternatives 1 through 5 would not result in changes to land use that would displace or relocate housing stocks. Land use would be the same under the No Action Alternative, Second Basis of Comparison, and Alternatives 1 through 5, as described in Chapter 13, Land Use. The only changes in land use between recent historical conditions and conditions in 2030 for the No Action Alternative, Second Basis of Comparison, and Alternatives 1 through 5 would occur due to ecosystem restoration on agricultural lands, open space, and public lands that do not support housing units.

19.3.1 Characterization of Socioeconomic Conditions

Characterization of the socioeconomic conditions within the Study Area is based upon publically available data sources. The data sources used include the U.S. Census Bureau, U.S. Bureau of Economic Analysis, U.S. Bureau of Labor Statistics, California Department of Finance, California Employment Development Department, and California Board of Equalization. The data were summarized and used to compare historical and current trends in the socioeconomic conditions in the Study Area.

Population and income data used to characterize the socioeconomic conditions are reported from 2000 to 2012 by the California Department of Finance.

The employment data presented in this Chapter are reported from 2001 to 2008 and from 2008 to 2012 (the latest values from consistent data sources). The first period from 2001 to 2008 represents a period of time prior to implementation of the 2008 U.S. Fish and Wildlife Service (USFWS) Biological Opinion (BO) and the 2009 National Marine Fisheries Service (NMFS) BO. The second period from 2008 to 2012 represents a period of time following implementation of the 2008 USFWS BO and 2009 NMFS BO.

There are two estimates of employment that are typically used to describe employment. The civilian labor force employment data compiled by the Bureau of Labor Statistics reflect the employment status of individuals that are covered by unemployment insurance by “place of residence,” and includes the self-employed, employees on unpaid leave of absence, unpaid family workers, and household workers. These data do not include sole proprietors, some self-employed, and some farm workers and domestic workers. Employment by industry data compiled by the Bureau of Economic Analysis, including farm employment, reflect jobs by “place of work” and include sole proprietors and active partners, self-employed, farm workers, and domestic workers. Individuals with more than one job are counted only once in civilian labor force data and counted in each job in the employment by industry data. Therefore, the employment by industry data are greater than the civilian labor force data.

19.3.2 Trinity River Region

The Trinity River Region includes the area in Trinity County along the Trinity River from Trinity Lake to the confluence with the Klamath River; and in Humboldt and Del Norte counties along the lower Klamath River from the confluence with the Trinity River to the Pacific Ocean. Tribal lands along the Trinity or lower Klamath River within the Trinity River Region include the

Hoopa Valley Indian Reservation, Yurok Indian Reservation, and Resighini Rancheria.

Trinity County includes extensive trails, lakes, and the Trinity River Scenic Byway, providing several venues for outdoor enthusiasts and travelers. The recreation and tourism industries are major contributors to the local economy of Trinity County (EDD 2013).

Humboldt County is the largest and most populous of the north coast counties. Its 2012 population of 134,728 ranked 35th among the 58 counties in California (EDD 2014a). Humboldt County encompasses 2.3 million acres, 80 percent of which is forestlands, protected redwoods and recreation areas (Humboldt County 2014). Humboldt County is the leading timber producing county in the state (CDFA 2014). As described in Chapter 13, Land Use, the portion of Humboldt County in the Trinity River Region evaluated in this EIS is located along the Trinity and Klamath rivers. This portion of the county includes the communities of Willow Creek and Orleans within Humboldt County; Hoopa in the Hoopa Valley Indian Reservation; and the communities of Weitchpec, Cappell, Pecwan, and Johnson's in the Yurok Tribe Indian Reservation (Humboldt County 2012).

Del Norte County is the northernmost county in California. The county includes Redwood National Park and other state parks making tourism a natural industry in the county (EDD 2014b). As described in Chapter 13, Land Use, the portion of Del Norte County in the Trinity River Region evaluated in this EIS is located along the lower Klamath River. Most of this area is located within the Yurok Indian Reservation, and includes the communities of Requa and Klamath (Del Norte County 2003).

19.3.2.1 Population

Population in the Trinity River Region, by county and for the region as a whole, is presented in Table 19.1. The population of Trinity River Region has increased, although at a small average annual growth rate for the period shown.

Table 19.1 Population Characteristics in Trinity River Region

Area	Population 2000	Population 2012	Average Annual Growth Rate (percent) 2000-2012
Trinity County	13,022	13,471	0.3
Humboldt County	126,518	134,728	0.5
Del Norte County	27,507	28,527	0.3
Total Trinity River Region	167,047	176,726	0.5
STATE OF CALIFORNIA	**33,873,086**	**37,427,946**	**0.9**

Sources: DOF 2013a, 2013b, 2014

Tribal enrollment for the Hoopa Valley Tribe, Yurok Tribe, Karuk Tribe, and Resighini Rancheria as reported by the Bureau of Indian Affairs is presented in Table 19.2. These values do not necessarily include all members that live within the area, and should be considered as representative of trends. Values were only available for the years of 2001, 2003, 2005, and 2013.

Table 19.2 Tribal Enrollment in Trinity River Region

Tribe	2001	2003	2005	2013
Hoopa Valley Tribe	1,893	1,893	1,893	1,719[a]
Yurok Tribe	4,466	4,466	4,912	Not available
Karuk Tribe	3,165	3,165	3,427	Not available
Resighini Rancheria	90	175	111	Not available
TOTAL	**9,614**	**9,699**	**10,343**	**–**

Sources: BIA 2003, 2006, 2008, 2014

Note:
a. Value is reported as population, not enrollment, for Hoopa Valley Tribe in 2013.

19.3.2.2 Employment

Civilian labor force characteristics for the Trinity River Region are presented in Table 19.3. The civilian labor force (composed of employment and unemployment) in the Trinity River Region increased between 2001 and 2008 and between 2008 and 2012 (BLS 2014).

Table 19.3 Civilian Labor Force and Unemployment Rates in Trinity River Region

	Civilian Labor Force (subject to unemployment insurance)			Unemployment Rate (percent)		
Area	**2001**	**2008**	**2012**	**2001**	**2008**	**2012**
Trinity County	5,394	4,855	5,019	9.3	12.7	15.8
Humboldt County	60,443	60,039	60,144	6.0	7.2	10.5
Del Norte County	10,221	11,376	11,381	8.0	8.8	13.4
Total Trinity River Region	76,058	76,270	76,544	6.5	7.8	11.2
STATE OF CALIFORNIA	**17,152,106**	**18,392,000**	**18,494,881**	**5.4**	**7.2**	**10.5**

Source: BLS 2014

Available labor force and unemployment rates for members of the tribes in the Trinity River Region are presented in Table 19.4. These individuals may or may not be included in the values presented in Table 19.3 because different sources are used for each table.

Table 19.4 Available Labor Force and Unemployment Rates Related to the Tribes in Trinity River Region

	Civilian Labor Force				Unemployment Rate (percent)			
Area	**2001**	**2003**	**2005**	**2013**	**2001**	**2003**	**2005**	**2013**
Hoopa Valley Tribe	1,043	1,043	1,043	NA	40	40	40	42
Yurok Tribe	2,151	2,151	1,096	NA	74	74	74	38
Karuk Tribe	3,307	3,307	915	NA	14	14	63	29
Resighini Rancheria	37	44	45	NA	57	59	60	NA

Sources: BIA 2003, 2006, 2008, 2014

Note:
NA = Not Available

Total employment and the farm employment in 2001, 2008 and 2012 in the Trinity River Region counties are presented in Table 19.5. The Trinity River Region farm employment represents less than 1 percent of farm employment in the state and the lowest amount of farm employment in counties within the Study Area, as indicated in Figure 19.1.

Table 19.5 Employment in Trinity River Region

Area	Total Employment			Farm Employment[a]		
	2001	2008	2012	2001	2008	2012
Trinity County	4,878	4,930	4,788	155	161	165
Humboldt County	68,596	71,552	68,861	1,662	1,383	1,227
Del Norte County	10,266	11,531	10,720	384	309	231
Total Trinity River Region	83,740	88,013	84,369	2,201	1,853	1,623
STATE OF CALIFORNIA	**19,411,367**	**20,820,306**	**20,653,860**	**479,283**	**438,013**	**443,764**

Source: BEA 2014a.

Note:
a. Farm employment includes employment numbers in forestry, fishing, and related activities.

19.3.2.3 Income

Per capita personal income for the Trinity River Region counties for 2000, 2008, and 2012 is presented in Table 19.6. Humboldt County had the highest per capita income, and Del Norte County had the lowest.

Table 19.6 Per Capita Personal Income in Trinity River Region

Area	Per Capita Personal Income			Average Annual Growth Rate (percent)	
	2000	2008	2012	2000-2008	2008-2012
Trinity County	$20,489	$28,861	$34,027	4.4	4.2
Humboldt County	$23,980	$32,859	$35,681	4.0	2.1
Del Norte County	$18,563	$26,420	$30,016	4.5	3.2
Total Trinity River Region	$22,818	$31,497	$34,647	4.1	2.4
STATE OF CALIFORNIA	**$33,404**	**$44,003**	**$43,647**	**3.5**	**1.4**

Source: BEA 2014e

19.3.2.4 Local Government Finances

The sales tax rates, as of April 1, 2014, were 7.5 percent in all three counties in the Trinity River Region (BOE 2014). Total annual taxable sales within the Trinity River Region in 2000, 2008, and 2012 are presented in Table 19.7. The region’s total taxable sales represents less than one tenth of one percent of total annual state taxable sales.

Table 19.7 Total Taxable Sales in Trinity River Region

Area	Total Taxable Sales (millions)			Average Annual Growth Rate (percent)	
	2000	2008	2012	2000-2008	2008-2012
Trinity County	$61	$74	$87	2.6	3.9
Humboldt County	$1,293	$1,693	$1,768	3.4	1.1
Del Norte County	$176	$232	$226	3.5	-0.6
Total Trinity River Region	$1,530	$1,999	$2,081	3.4	1.0
STATE OF CALIFORNIA	**$441,854**	**$531,654**	**$407,714**	**2.3**	**-6.4**

Sources: BOE 2000, 2008, 2012

Total property tax charges (secured and unsecured) within the Trinity River Region in Fiscal Year 2011-2012 were $160.2 million (California State Controller 2012). The Humboldt County share of the total property tax revenues was the largest at $126 million. The Del Norte and Trinity counties contributions to the total were $19 million and $13 million, respectively.

19.3.3 Central Valley Region

The Central Valley Region extends from above Shasta Lake to the Tehachapi Mountains, and includes the Sacramento Valley, San Joaquin Valley, and Delta and Suisun Marsh subregions.

19.3.3.1 Sacramento Valley

The Sacramento Valley includes the counties of Shasta, Plumas, Tehama, Glenn, Colusa, Butte, Sutter, Yuba, Nevada, Placer, and El Dorado counties. Sacramento, Yolo, and Solano counties also are located within the Sacramento Valley; however, these counties are discussed below as part of the Delta and Suisun Marsh subsection. Other counties in Sacramento Valley are not anticipated to be affected by changes in CVP and SWP operations, and are not discussed here, including: Alpine, Sierra, Lassen, and Amador counties.

The Sacramento Valley includes major agricultural counties, including Glenn, Colusa, Sutter and Placer counties, as described in Chapter 12, Agricultural Resources. The region also includes some of the leading major timber producing counties of the state. Shasta County is the second and Plumas County is the fifth among the leading timber producing counties in the state.

19.3.3.1.1 Population

Population characteristics in the Sacramento Valley portion of the Central Valley Region are presented in Table 19.8. Among the counties evaluated in the Sacramento Valley portion of the Central Valley Region, Placer County had the highest average annual population growth rate between 2000 and 2012; and Plumas County was the only county with a reduction in population.

Table 19.8 Population Characteristics in Central Valley Region – Sacramento Valley

Area	Population		Average Annual Growth Rate (percent)
	2000	2012	2000-2012
Shasta County	163,256	177,516	0.8
Plumas County	20,824	19,901	-0.4
Tehama County	56,039	62,985	1.1
Glenn County	26,453	28,105	0.6
Colusa County	18,804	21,552	1.2
Butte County	203,171	220,465	0.7
Yuba County	60,219	72,642	1.6
Nevada County	92,033	97,366	0.5
Sutter County	78,930	94,620	1.7
Placer County	248,399	351,463	3.2
El Dorado County	156,299	180,483	1.3
Sacramento Valley Subtotal	1,124,427	1,333,615	1.4
Total Central Valley Region	6,214,316	7,408,750	1.5
STATE OF CALIFORNIA	**33,873,086**	**37,668,804**	**0.9**

Sources: DOF 2013a, 2013b, 2014

19.3.3.1.2 Employment

Civilian labor force characteristics for the counties in the Sacramento Valley portion of the Central Valley Region are presented in Table 19.9. The civilian labor force increased between 2001 and 2012. The data for 2008 represents the employment situation immediately following the recent economic recession that started in 2007. The average unemployment rate in the civilian labor force increased from 2001 to 2012. The average unemployment rate in the Sacramento Valley portion of the Central Valley Region between 2001 and 2012 has been higher than the state unemployment rate; and lower than for the counties in the Central Valley Region.

Table 19.9 Civilian Labor Force and Unemployment Rates in Central Valley Region – Sacramento Valley

Area	Civilian Labor Force (subject to unemployment insurance)			Unemployment Rate (percent)		
	2001	**2008**	**2012**	**2001**	**2008**	**2012**
Shasta County	77,647	82,675	81,245	6.3	10.0	13.4
Plumas County	9,958	9,824	9,478	7.6	10.5	14.7
Tehama County	24,574	25,185	25,251	6.5	9.2	13.9
Glenn County	11,239	12,196	12,841	8.8	10.4	14.7
Colusa County	9,130	10,505	11,860	12.8	13.7	20.0
Butte County	95,216	102,952	102,063	6.6	8.4	12.2
Yuba County	24,862	27,729	27,772	8.5	11.8	16.9
Nevada County	46,947	50,428	50,742	4.4	6.5	9.4
Sutter County	38,457	41,100	42,810	9.7	12.3	17.6
Placer County	139,106	177,243	178,818	4.0	6.4	9.4
El Dorado County	84,064	90,732	90,525	4.3	6.9	10.4
Sacramento Valley Subtotal	561,200	630,569	633,405	5.8	8.3	12.0
Total Central Valley Region	3,519,870	3,885,435	3,990,083	6.8	8.7	12.6
STATE OF CALIFORNIA	**17,152,106**	**18,392,000**	**18,494,881**	**4.9**	**7.2**	**10.5**

Source: BLS 2014

Total employment and farm employment in 2001, 2008, and 2012 in the Sacramento Valley portion of the Central Valley Region are presented in Table 19.10. The contribution of farm employment to the total employment in the Sacramento Valley portion of the Central Valley Region declined between 2001 and 2008 and increased slightly by 2012.

Table 19.10 Employment in Central Valley Region – Sacramento Valley

Area	Total Employment			Farm Employment		
	2001	**2008**	**2012**	**2001**	**2008**	**2012**
Shasta County	85,937	91,883	86,696	1,821	1,781	1,751
Plumas County	10,813	10,524	9,493	288	140	138
Tehama County	23,760	24,284	22,669	2,716	2,332	3,042
Glenn County	11,526	11,987	11,856	2,873	1,927	2,049
Colusa County	9,770	10,863	11,266	2,943	1,954	1,831
Butte County	99,757	105,703	101,805	5,293	4,618	4,527
Yuba County	26,162	26,473	26,861	2,494	1,722	1,623
Nevada County	51,323	57,968	55,898	1,161	1,153	1,089
Sutter County	39,489	43,764	43,329	5,454	4,165	4,427
Placer County	158,070	192,171	188,729	2,064	1,925	1,844
El Dorado County	78,052	95,608	90,435	1,937	1,849	1,737
Sacramento Valley Subtotal	594,659	671,228	649,037	29,044	23,566	24,058
Total Central Valley Region	3,616,241	3,997,557	3,923,230	256,672	226,321	230,832
STATE OF CALIFORNIA	**19,411,367**	**20,820,306**	**20,653,860**	**479,283**	**438,013**	**443,764**

Source: BEA 2014a

Note:
Farm employment includes employment numbers in forestry, fishing, and related activities.

The annual farm employment for the Sacramento Valley portion of the Central Valley Region declined in 2004 and remained relatively stable through 2012, as shown in Figure 19.2. The overall trend in farm employment is influenced by the farm employment trends in Butte, Sutter, Tehama, Colusa, and Glenn counties, as shown in Figure 19.3. The decrease in farm employment is related to the reduction in cultivated acreage during this period, as described in Chapter 12, Agricultural Resources.

The farm employment numbers presented in Table 19.10 include only workers directly involved in farming, forestry, and fishing activities. However, farming is one of the most important basic industries in the Central Valley Region; and supports many other businesses including farm inputs (e.g., fertilizer, seed, machinery, and fuel) and processing of food and fiber grown on farms. As a result, employment both directly on farm and indirectly dependent on farming is higher than the values displayed in Table 19.10.

19.3.3.1.3 Income

The average per capita personal incomes for the counties in the Sacramento Valley portion of the Central Valley Region are presented in Table 19.11. Per capita personal incomes increased by an average annual rate of between 3 and 6 percent from 2000 to 2008. Following the economic downturn that started in 2007, the average annual growth in per capita personal income slowed between 2008 and 2012, except in Tehama County.

Table 19.11 Per Capita Personal Income in Central Valley Region – Sacramento Valley

	Per Capita Personal Income			Average Annual Growth Rate (percent)	
Area	**2000**	**2008**	**2012**	**2000-2008**	**2008-2012**
Shasta County	$25,385	$34,995	$37,593	4.1	1.8
Plumas County	$26,415	$38,401	$43,085	4.8	2.9
Tehama County	$19,461	$25,805	$30,094	3.6	3.9
Glenn County	$20,210	$32,054	$38,568	5.9	4.7
Colusa County	$24,656	$39,568	$45,800	6.1	3.7
Butte County	$23,143	$32,379	$35,696	4.3	2.5
Yuba County	$19,537	$27,655	$32,835	4.4	4.4
Nevada County	$32,253	$44,960	$47,924	4.2	1.6
Sutter County	$25,581	$33,117	$36,243	3.3	2.3
Placer County	$38,034	$49,436	$52,544	3.3	1.5
El Dorado County	$37,397	$50,052	$54,533	3.7	2.2
Average in Sacramento Valley Counties	$29,317	$40,177	$43,873	4.0	2.2
Central Valley Region	$28,163	$37,207	$40,619	3.5	2.2
STATE OF CALIFORNIA	**$33,404**	**$44,003**	**$46,477**	**3.5**	**1.4**

Source: BEA 2014e

19.3.3.1.4 Local Government Finances

As of April 1, 2014, the county sales tax rates in the counties within the Sacramento Valley portion of the Central Valley Region was 7.5 percent for all counties except Nevada County (BOE 2014). The Nevada County sales tax rate was 7.625 percent. These rates include the state, county, local and district taxes.

The total annual taxable sales in the Sacramento Valley portion of the Central Valley Region in 2000, 2008, and 2012 are presented in Table 19.12. The total taxable sales represent about 3 percent of total annual state taxable sales. The lower rates of growth for the period 2008 to 2012 may be attributable to the effects of the recession that started in 2007 and a decline in employment, as discussed above.

Table 19.12 Total Taxable Sales in Central Valley Region – Sacramento Valley

Area	Total Taxable Sales (millions)			Average Annual Growth Rate	
	2000	2008	2012	2000-2008	2008-2012
Shasta County	$2,055	$2,641	$2,642	3.2	0.0
Plumas County	$187	$222	$197	2.1	-2.9
Tehama County	$470	$684	$748	4.8	2.3
Glenn County	$231	$318	$327	4.1	0.7
Colusa County	$223	$329	$337	5.0	0.6
Butte County	$2,039	$2,678	$2,714	3.5	0.3
Yuba County	$392	$515	$486	3.5	-1.4
Nevada County	$997	$1,187	$1,105	2.2	-1.8
Sutter County	$1,021	$1,287	$1,367	2.9	1.5
Placer County	$4,742	$6,635	$7,066	4.3	1.6
El Dorado County	$1,324	$1,788	$1,740	3.8	-0.7
Sacramento Valley Subtotal	$13,680	$18,283	$18,729	3.7	0.6
Central Valley Region	$83,363	$109,401	$114,959	3.5	1.2
STATE OF CALIFORNIA	**$441,854**	**$531,654**	**$407,714**	**2.3**	**-6.4**

Sources: BOE 2000, 2008, 2012

Combined (secured and unsecured) property tax revenues in each of the counties in the Sacramento Valley portion of the Central Valley Region for Fiscal Year 2011-2012 are presented in Table 19.13. Total property tax revenues from these counties accounted for about 3 percent of the total state property tax revenues.

Table 19.13 Property Tax Revenues, Fiscal Year 2011-2012, in Central Valley Region – Sacramento Valley

Area	Property Tax Revenues (millions)
Shasta County	$168
Plumas County	$41
Tehama County	$48
Glenn County	$30
Colusa County	$36
Butte County	$203
Yuba County	$62
Nevada County	$183
Sutter County	$103
Placer County	$692
El Dorado County	$300
Sacramento Valley Subtotal	$1,866
Central Valley Region	$9,874
STATE OF CALIFORNIA	**$55,459**

Source: California State Controller 2012

19.3.3.2 San Joaquin Valley

The San Joaquin Valley includes the counties of Stanislaus, Merced, Madera, Fresno, Kings, Tulare, and Kern counties. San Joaquin County also is located within the San Joaquin Valley; however, this county is discussed below as part of the Delta and Suisun Marsh subsection. Other counties in the San Joaquin Valley are not anticipated to be affected by changes in CVP and SWP operations, and are not discussed here, including: Calaveras, Mariposa, and Tuolumne counties.

The San Joaquin Valley includes the major agricultural counties, of Fresno, Kern, Kings and Tulare, as described in Chapter 12, Agricultural Resources.

19.3.3.2.1 Population

Population characteristics in the San Joaquin Valley portion of the Central Valley Region are presented in Table 19.14. Among the counties in the San Joaquin Valley portion of the Central Valley Region, Kern County had the highest average annual population growth rate between 2000 and 2012; and Stanislaus and Kings counties had the lowest growth rate.

Table 19.14 Population Characteristics in Central Valley – San Joaquin Valley

Area	Population		Average Annual Growth Rate (percent)
	2000	2012	2000-2012
Stanislaus County	446,997	519,339	1.3
Madera County	123,109	152,325	1.8
Merced County	210,554	260,029	1.8
Fresno County	799,407	943,493	1.4
Tulare County	368,021	451,540	1.7
Kings County	129,461	151,774	1.3
Kern County	661,653	849,977	2.1
San Joaquin Valley Subtotal	2,739,202	3,328,477	1.6
Total Central Valley Region	6,062,064	7,238,742	1.5
STATE OF CALIFORNIA	**33,873,086**	**37,668,804**	**0.9**

Sources: DOF 2013a, 2013b, 2014

19.3.3.2.2 Employment

Civilian labor force characteristics for the counties in the San Joaquin Valley portion of the Central Valley Region are presented in Table 19.15. The civilian labor force increased between 2001 and 2012. The data for 2008 represents the employment situation immediately following the recession that started in 2007. The average unemployment rate in the civilian labor force increased from 2001 to 2012. The average unemployment rates for the San Joaquin Valley portion of the Central Valley Region between 2001 and 2012 have been higher than for the entire Central Valley Region and the state.

Table 19.15 Civilian Labor Force and Unemployment Rates in Central Valley Region – San Joaquin Valley

Area	Civilian Labor Force (subject to unemployment insurance)			Unemployment Rate (percent)		
	2001	**2008**	**2012**	**2001**	**2008**	**2012**
Stanislaus County	214,292	231,965	239,461	8.3	11.0	15.2
Madera County	53,956	65,100	68,167	9.6	9.4	13.6
Merced County	91,825	102,251	111,322	10.1	12.5	17.0
Fresno County	389,805	430,163	442,453	10.7	10.5	15.2
Tulare County	175,357	199,124	207,634	11.4	10.8	15.8
Kings County	50,233	58,801	60,886	10.7	10.5	15.3
Kern County	297,982	359,573	396,657	8.6	9.8	13.3
San Joaquin Valley Subtotal	1,273,450	1,446,977	1,526,580	9.8	10.5	14.9
Total Central Valley Region	3,448,061	3,807,278	3,911,569	6.8	8.7	12.6
STATE OF CALIFORNIA	**17,152,106**	**18,392,000**	**18,494,881**	**4.9**	**7.2**	**10.5**

Source: BLS 2014

Total employment and farm employment in 2001, 2008 and 2012 in the San Joaquin Valley portion of the Central Valley Region are presented in Table 19.16. The contribution of farm employment to the total employment declined between 2001 and 2008, and then increased slightly in 2012, except in Tulare County. In Tulare County, farm employment increased between 2001 and 2008 and decreased between 2008 and 2012.

Table 19.16 Employment in Central Valley Region – San Joaquin Valley

Area	Total Employment			Farm Employment		
	2001	**2008**	**2012**	**2001**	**2008**	**2012**
Stanislaus County	208,016	221,632	214,446	18,708	16,000	15,784
Madera County	50,975	59,354	59,027	6,296	4,750	5,186
Merced County	82,803	92,891	93,766	14,147	12,029	8,075
Fresno County	401,025	446,939	437,934	56,655	50,798	51,277
Tulare County	168,523	191,195	186,875	42,851	38,080	36,369
Kings County	48,960	57,513	55,008	4,705	4,061	6,620
Kern County	311,946	369,152	386,642	46,307	47,661	52,583
San Joaquin Valley Subtotal	1,272,248	1,438,676	1,433,698	189,669	173,379	175,894
Total Central Valley Region	3,616,241	3,997,557	3,923,230	256,672	226,321	230,832
STATE OF CALIFORNIA	**19,411,367**	**20,820,306**	**20,653,860**	**479,283**	**438,013**	**443,764**

Source: BEA 2014a

Note:
Farm employment includes employment numbers in forestry, fishing, and related activities.

Annual farm employment for the San Joaquin Valley portion of the Central Valley Region declined in 2004 and continued to fluctuate through 2012, as shown in Figure 19.2. Farm employment in the San Joaquin Valley portion of the Central Valley Region represents a major portion of the overall farm employment in the Central Valley.

Within the counties in the San Joaquin Valley portion of the Central Valley Region, farm employment declined between 2003 and 2006 and remained about the same between 2007 and 2012. The overall trend in farm employment is influenced by the farm employment trends in Fresno, Kern, and Tulare counties, as shown in Figure 19.4. The decrease in farm employment is related to the reduction in cultivated acreage during this period, as described in Chapter 12, Agricultural Resources.

The farm employment numbers presented in Table 19.16 include only workers directly involved in farming, forestry, and fishing activities. However, farming is one of the most important basic industries in the Central Valley; and supports many other businesses including farm inputs (e.g., fertilizer, seed, machinery, and fuel) and processing of food and fiber grown on farms. As a result, employment both directly on farm and indirectly dependent on farming is higher than the values displayed in Table 19.16.

Total farm-dependent employment is not reported in the U.S. Bureau of Economic Analysis or the U.S. Bureau of Labor Statistics; however, the employment values can be estimated by studies of local economies. A study of the local economy in four counties of the San Joaquin Valley found that, for every on-farm job, about two and one-half additional jobs are supported because of inputs purchased for farming operations (NEA 1997). This estimate includes the associated effects of workers on those farms and businesses spending their incomes on other purchases; however, the estimated values do not include employment in the processing sector. Another study indicated that the employment multiplier of the agricultural production and processing industry is 1.92, or that for every 100 agricultural production and processing jobs in the San Joaquin Valley, 92 other jobs were created in the San Joaquin Valley (UCAIC 2009).

San Joaquin Valley employment also includes employment associated with adult prison facilities. The San Joaquin Valley portion of the Central Valley Region includes eight (or about 24 percent) of the 33 adult prison facilities operated by the California Department of Corrections and Rehabilitation. These prisons are home to about a quarter of the total prison population in the state and employ about a quarter of the total prison staff in the state. Employment for these prisons is summarized in Table 19.17.

Table 19.17 California State Prisons in Central Valley Region - San Joaquin Valley

Prison Facility	Location	Staff
Central California Women's Facility	Chowchilla, Madera County	1,064
Valley State Prison	Chowchilla, Madera County	1,021
Pleasant Valley State Prison	Coalinga, Fresno County	1,357
Avenal State Prison	Avenal, Kings County	1,475
California State Prison	Corcoran, Kings County	2,003
Wasco State Prison	Wasco, Kern County	1,523
North Kern State Prison	Delano, Kern County	1,393
Kern Valley State Prison	Delano, Kern County	1,545

Sources: CDCR 2014a, 2014b, 2014c, 2014d, 2014e, 2014f, 2014g, 2014h

Federal prisons are located at Atwater in Merced County, Mendota in Fresno County, and Taft in Kern County within the San Joaquin Valley portion of the Central Valley Region (BOP 2014).

19.3.3.2.3 Income

The average per capita personal income in the San Joaquin Valley portion of the Central Valley Region was lower than that for the entire Central Valley Region, as presented in Table 19.18. The average per capita personal income in the San Joaquin Valley portion of the Central Valley Region was a little more than two-thirds of the average per capita personal income in the Central Valley Region and the state. With the exception of Stanislaus County, most counties in the San Joaquin Valley portion of the Central Valley Region had higher annual average growth in per capita personal income between 2000 and 2008 than the entire Central Valley Region and the state.

Table 19.18 Per Capita Personal Income in Central Valley Region – San Joaquin Valley

	Per Capita Personal Income			Average Annual Growth Rate (percent)	
Area	2000	2008	2012	2000-2008	2008-2012
Stanislaus County	$24,284	$31,093	$34,138	3.1	2.4
Madera County	$18,983	$26,693	$31,169	4.4	4.0
Merced County	$19,976	$26,963	$30,630	3.8	3.2
Fresno County	$23,001	$30,977	$34,074	3.8	2.4
Tulare County	$20,070	$28,035	$31,307	4.3	2.8
Kings County	$16,912	$26,339	$31,835	5.7	4.9
Kern County	$21,507	$29,527	$34,453	4.0	3.9
Average in San Joaquin Valley Counties	$21,755	$29,505	$33,303	3.9	3.1
Central Valley Region	$28,183	$37,198	$40,601	3.5	2.2
STATE OF CALIFORNIA	**$33,404**	**$44,003**	**$46,477**	**3.5**	**1.4**

Source: BEA 2014e

19.3.3.2.4 Local Government Finances

As of April 1, 2014, the county sales tax rates in the counties within the San Joaquin Valley portion of the Central Valley ranged from 7.5 percent in Merced, Kern, and Kings counties to 8.225 percent in Fresno County (BOE 2014).

The total annual taxable sales for the counties in the San Joaquin Valley portion of the Central Valley Region in 2000, 2008, and 2012 are presented in Table 19.19. The contribution of the area to California total annual taxable sales increased between 2000 and 2012. The lower rates of growth for the period 2008 to 2012 may be attributable to the effects of the recession that started in 2007 and a decline in employment, as discussed above.

Table 19.19 Total Taxable Sales in Central Valley Region – San Joaquin Valley

Area	Total Taxable Sales (millions)			Average Annual Growth Rate (percent)	
	2000	2008	2012	2000-2008	2008-2012
Stanislaus County	$5,195	$6,729	$7,178	3.3	1.6
Madera County	$881	$1,327	$1,356	5.2	0.5
Merced County	$1,740	$2,388	$2,512	4.0	1.3
Fresno County	$8,472	$11,729	$12,021	4.2	0.6
Tulare County	$3,222	$4,755	$5,499	5.0	3.7
Kings County	$888	$1,389	$1,386	5.8	-0.1
Kern County	$6,938	$12,086	$14,666	7.2	5.0
Total San Joaquin Valley	$27,337	$40,403	$44,619	5.0	2.5
Central Valley Region	$81,975	$107,699	$113,368	3.5	1.3
STATE OF CALIFORNIA	**$441,854**	**$531,654**	**$407,714**	**2.3**	**-6.4**

Sources: BOE 2000, 2008, 2012

The combined (secured and unsecured) property tax revenues in each of the counties in the San Joaquin Valley portion of the Central Valley Region for Fiscal Year 2011-2012 are presented in Table 19.20. Total property tax revenues from these counties accounted for about 6 percent of the total state property tax revenues.

Table 19.20 Property Tax Revenues, Fiscal Year 2011-2012, in Central Valley Region – San Joaquin Valley

Area	Property Tax Revenues (millions)
Stanislaus County	$426
Madera County	$128
Merced County	$197
Fresno County	$755
Tulare County	$327
Kings County	$104
Kern County	$1,102
San Joaquin Valley Subtotal	$3,039
Central Valley Region	$9,874
STATE OF CALIFORNIA	**$55,459**

Source: California State Controller 2012

19.3.3.3 Delta and Suisun Marsh

The Delta and Suisun Marsh portion of the Central Valley Region includes Sacramento, Yolo, Solano, San Joaquin, and Contra Costa counties. These counties include some of the leading agricultural areas in the state. In addition to agriculture, this area includes important transportation infrastructures including inland shipping ports (Port of West Sacramento and Port of Stockton); major employment centers (cities of Sacramento, West Sacramento, Fairfield, Stockton, and Concord); and water-based recreation activities (e.g., boating, fishing, and water skiing).

19.3.3.3.1 Population

Population characteristics in the counties of the Delta and Suisun Marsh portion of the Central Valley Region are presented in Table 19.21. San Joaquin County had the highest average annual population growth rate between 2000 and 2012, and Solano County had the lowest growth rate.

Table 19.21 Population Characteristics in Central Valley Region – Delta and Suisun Marsh

Area	Population		Average Annual Growth Rate (percent)
	2000	2012	2000-2012
Sacramento County	1,223,499	1,433,525	1.3
Yolo County	168,660	204,349	1.6
Solano County	394,930	415,787	0.4
San Joaquin County	563,598	692,997	1.7
Contra Costa County	948,816	1,066,602	1.0
Delta and Suisun Marsh Subtotal	3,299,503	3,813,260	1.2
Total Central Valley Region	6,062,064	7,238,742	1.5
STATE OF CALIFORNIA	**33,873,086**	**37,668,804**	**0.9**

Sources: DOF 2013a, 2013b, 2014

19.3.3.3.2 Employment

Civilian labor force characteristics for the Sacramento, Yolo, Solano, San Joaquin, and Contra Costa counties are presented in Table 19.22. The civilian labor force in these counties increased between 2001 and 2012. The data for 2008 represents the employment situation immediately following the recession in 2007.

Table 19.22 Civilian Labor Force and Unemployment Rates in Central Valley Region – Delta and Suisun Marsh

Area	Civilian Labor Force (subject to unemployment insurance)			Unemployment Rate (percent)		
	2001	2008	2012	2001	2008	2012
Sacramento County	624,693	680,373	680,349	4.5	7.2	10.6
Yolo County	88,331	98,438	98,475	5.1	7.4	11.5
Solano County	197,178	211,369	217,024	4.6	6.8	10.1
San Joaquin County	266,288	293,190	298,468	7.5	10.4	15.2
Contra Costa County	508,730	524,519	535,782	4.1	6.2	9.0
Delta and Suisun Marsh Subtotal	1,685,220	1,807,889	1,830,098	4.9	7.4	10.8
Total Central Valley Region	3,448,061	3,807,278	3,911,569	6.8	8.7	12.6
STATE OF CALIFORNIA	**17,152,106**	**18,392,000**	**18,494,881**	**4.9**	**7.2**	**10.5**

Source: BLS 2014

Total employment and farm employment in 2001, 2008, and 2012 in the Sacramento, Yolo, Solano, San Joaquin, and Contra Costa counties are presented in Table 19.23. The contribution of farm employment to the total employment declined slightly between 2001 and 2008, and then increased slightly between 2008 and 2012.

Table 19.23 Employment in Central Valley Region – Delta and Suisun Marsh

Area	Total Employment			Farm Employment		
	2001	2008	2012	2001	2008	2012
Sacramento County	739,256	806,976	784,386	5,176	4,019	3,924
Yolo County	110,902	122,054	117,609	5,244	5,364	5,745
Solano County	162,874	174,565	169,096	3,321	2,144	2,116
San Joaquin County	260,809	286,171	277,260	21,088	16,939	17,496
Contra Costa County	475,493	497,887	492,144	3,130	910	1,599
Delta and Suisun Marsh Subtotal	1,749,334	1,887,653	1,840,495	37,959	29,376	30,880
Total Central Valley Region	3,616,241	3,997,557	3,923,230	256,672	226,321	230,832
STATE OF CALIFORNIA	**19,411,367**	**20,820,306**	**20,653,860**	**479,283**	**438,013**	**443,764**

Source: BEA 2014a

Note:
Farm employment includes employment numbers in forestry, fishing, and related activities.

Annual farm employment for the Sacramento, Yolo, Solano, San Joaquin, and Contra Costa counties declined in 2004, slightly increased in 2006, and continued to fluctuate through 2012, as shown in Figure 19.5. Within these counties, farm employment started to decline in 2004 and began to increase slightly in 2006, as shown in Figure 19.5. The overall trend in farm employment in the Delta and Suisun Marsh portion of the Central Valley Region is influenced by the farm employment trends in San Joaquin County. The decrease in farm employment is related to the reduction in cultivated acreage during this period, as described in Chapter 12, Agricultural Resources.

The farm employment numbers presented in Table 19.23 include only workers directly involved in farming, forestry, and fishing activities. However, farming is one of the most important basic industries in many counties in the Central Valley Region; and supports many other businesses including farm inputs (e.g., fertilizer, seed, machinery, and fuel) and processing of food and fiber grown on farms. As a result, employment both directly on farm and indirectly dependent on farming is higher than the values displayed in Table 19.23.

19.3.3.3.3 Income

The average per capita personal income in the Sacramento, Yolo, Solano, San Joaquin, and Contra Costa counties was about 15 percent higher than the average per capita personal income in the entire Central Valley Region, as presented in Table 19.24. San Joaquin and Contra Costa counties experienced the lowest average annual growth rates in per capita personal income between 2000 and 2008. Between 2008 and 2012, Yolo County was the only county with a slightly higher average annual growth rate as compared to the entire Central Valley Region.

Table 19.24 Per Capita Personal Income in Central Valley Region – Delta and Suisun Marsh

Area	Per Capita Personal Income			Average Annual Growth Rate (percent)	
	2000	2008	2012	2000-2008	2008-2012
Sacramento County	$29,406	$38,782	$41,837	3.5	1.9
Yolo County	$27,093	$37,488	$41,811	4.1	2.8
Solano County	$28,373	$39,178	$42,354	4.1	2.0
San Joaquin County	$25,147	$31,250	$33,024	2.8	1.4
Contra Costa County	$45,576	$58,547	$61,638	3.2	1.3
Average in Delta and Suisun Marsh Counties	$33,079	$42,861	$45,829	3.3	1.7
Central Valley Region	$28,183	$37,198	$40,601	3.5	2.2
STATE OF CALIFORNIA	**$33,404**	**$44,003**	**$46,477**	**3.5**	**1.4**

Source: BEA 2014e

19.3.3.3.4 Local Government Finances

As of April 1, 2014, the county sales tax rates in the Sacramento, Yolo, Solano, San Joaquin, and Contra Costa counties ranged between 7.5 percent in Yolo to 8 percent in San Joaquin (BOE 2014).

Total annual taxable sales for Sacramento, Yolo, Solano, San Joaquin, and Contra Costa counties in 2000, 2008, and 2012 are presented in Table 19.25. Between 2000 and 2008 Yolo, Solano, and San Joaquin counties experienced average annual growth in total taxable sales that were higher than the entire Central Valley Region and the state. Between 2008 and 2012, Sacramento County experienced negative average annual growth in total taxable sales.

Table 19.25 Total Taxable Sales in Central Valley Region – Delta and Suisun Marsh

Area	Total Taxable Sales (millions)			Average Annual Growth Rate (percent)	
	2000	2008	2012	2000-2008	2008-2012
Sacramento County	$16,594	$19,332	$19,090	1.9	-0.3
Yolo County	$2,416	$3,347	$3,475	4.2	0.9
Solano County	$4,424	$6,033	$6,038	4.0	0.0
San Joaquin County	$6,582	$8,696	$9,011	3.5	0.9
Contra Costa County	$12,331	$13,308	$13,997	1.0	1.3
Delta and Suisun Marsh Counties	$42,347	$50,715	$51,611	2.3	0.4
Central Valley Region	$81,975	$107,699	$113,368	3.5	1.3
STATE OF CALIFORNIA	**$441,854**	**$531,654**	**$407,714**	**2.3**	**-6.4**

Sources: BOE 2000, 2008, 2012

The combined (secured and unsecured) property tax revenues in Sacramento, Yolo, Solano, San Joaquin, and Contra Costa counties for Fiscal Year 2011-2012 are presented in Table 19.26. Total property tax revenues from these counties accounted for about 9 percent of the total state property tax revenues.

Table 19.26 Property Tax Revenues, Fiscal Year 2011-2012, in Central Valley Region – Delta and Suisun Marsh

Area	Property Tax Revenues (millions)
Sacramento County	$1,539
Yolo County	$270
Solano County	$497
San Joaquin County	$684
Contra Costa County	$1,979
Delta and Suisun Marsh Counties	$4,969
Central Valley Region	$9,874
STATE OF CALIFORNIA	**$55,459**

Source: California State Controller 2012

19.3.4 San Francisco Bay Area Region

The San Francisco Bay Area Region includes portions of Napa, Alameda, Santa Clara, and San Benito counties that are within the CVP and SWP service areas. Contra Costa County also is part of the San Francisco Bay Area Region. However, for this chapter, Contra Costa County is discussed under Section 19.3.4.3, Delta and Suisun Marsh.

19.3.4.1 Population

Population characteristics in the San Francisco Bay Area Region are presented in Table 19.27. The population of the San Francisco Bay Area Region grew slightly less than a quarter million, or at an average annual growth rate of less than one half of one percent between 2000 and 2012.

Table 19.27 Population Characteristics in San Francisco Bay Area Region

Area	Population		Average Annual Growth Rate (percent)
	2000	2012	2000-2012
Alameda County	1,443,939	1,530,176	0.5
Santa Clara County	1,682,585	1,813,696	0.6
San Benito County	53,234	56,137	0.4
Napa County	124,279	137,731	0.9
Total San Francisco Bay Area Region	3,304,037	3,537,740	0.6
STATE OF CALIFORNIA	**33,873,086**	**37,668,804**	**0.9**

Sources: DOF 2013a, 2013b, 2014

19.3.4.2 Employment

Civilian labor force characteristics for the counties in the San Francisco Bay Area Region are presented in Table 19.28. The civilian labor force in the counties within the San Francisco Bay Area Region declined between 2001 and 2008, and then increased between 2008 and 2012. The data for 2008 represents the employment situation immediately following the onset of the recession in 2007.

Table 19.28 Civilian Labor Force and Unemployment Rates in San Francisco Bay Area Region

Area	Civilian Labor Force (subject to unemployment insurance)			Unemployment Rate (percent)		
	2001	2008	2012	2001	2008	2012
Alameda County	778,472	757,566	775,855	4.8	6.2	9.0
Santa Clara County	939,501	870,251	910,983	5.1	6.0	8.4
San Benito County	27,461	24,870	26,611	6.3	9.6	13.9
Napa County	70,447	75,670	77,843	3.6	5.1	7.8
Total San Francisco Bay Area Region	1,815,881	1,728,357	1,791,292	4.9	6.1	8.7
STATE OF CALIFORNIA	**17,152,106**	**18,392,000**	**18,494,881**	**4.9**	**7.2**	**10.5**

Source: BLS 2014

Total employment and farm employment in 2001, 2008 and 2012 in the San Francisco Bay Area Region are presented in Table 19.29. The contribution of farm employment to total employment in the San Francisco Bay Area Region declined slightly between 2001 and 2008, and remained relatively stable between 2008 and 2012.

Table 19.29 Employment in San Francisco Bay Area Region

Area	Total Employment			Farm Employment		
	2001	2008	2012	2001	2008	2012
Alameda County	886,316	906,403	894,625	1,704	1,475	1,291
Santa Clara County	1,226,987	1,176,129	1,187,799	5,969	4,436	2,643
San Benito County	21,722	21,827	21,116	1,969	1,244	1,073
Napa County	84,369	91,837	93,050	4,835	5,730	3,148
Total San Francisco Bay Area Region	2,219,394	2,196,196	2,196,590	14,477	12,885	8,155
STATE OF CALIFORNIA	**19,411,367**	**20,820,306**	**20,653,860**	**479,283**	**438,013**	**443,764**

Source: BEA 2014a

Note:

Farm employment includes employment numbers in forestry, fishing, and related activities.

As shown in Table 19.29, overall farm employment has declined by 45 percent between 2001 and 2012, as presented in Figure 19.1. The decrease in farm employment is related to the reduction in cultivated acreage during this period, as described in Chapter 12, Agricultural Resources.

19.3.4.3 Income

The average per capita personal incomes for the counties in the San Francisco Bay Area Region are presented in Table 19.30. Among the four counties in this region, San Benito County had the lowest per capita personal income. Santa Clara County had the lowest average annual per capita growth rate between 2000 and 2008. All counties experienced smaller average annual per capita growth rates between 2008 and 2012 compared to the 2000 to 2008 period.

Table 19.30 Per Capita Personal Income in San Francisco Bay Area Region

Area	Per Capita Personal Income			Average Annual Growth Rate (percent)	
	2000	**2008**	**2012**	**2000-2008**	**2008-2012**
Alameda County	$39,613	$50,302	$54,683	3.0	2.1
Santa Clara County	$55,588	$59,927	$66,535	0.9	2.6
San Benito County	$29,608	$36,100	$38,030	2.5	1.3
Napa County	$38,854	$51,712	$54,807	3.6	1.5
Total San Francisco Bay Area Region	$47,546	$55,050	$60,493	1.8	2.4
STATE OF CALIFORNIA	**$33,404**	**$44,003**	**$46,477**	**3.5**	**1.4**

Source: BEA 2014e

19.3.4.4 Local Government Finances

As of April 1, 2014, the county sales tax rates in the San Francisco Bay Area region ranged between 7.5 percent in San Benito and 9.0 percent in Alameda (BOE 2014).

Total annual taxable sales for the counties in the San Francisco Bay Area Region in 2000, 2008, and 2012 are presented in Table 19.31. Between 2000 and 2008 all counties in the region, except Santa Clara County, experienced small increases in average annual growth in total taxable sales. All counties experienced increasing growth rates between 2008 and 2012. Santa Clara County had the highest annual average growth rate in total taxable sales among all the counties in the region during this period.

Table 19.31 Total Taxable Sales in San Francisco Bay Area Region

Area	Total Taxable Sales (Millions)			Average Annual Growth Rate (percent)	
	2000	2008	2012	2000-2008	2008-2012
Alameda County	$23,764	$23,863	$25,182	0.1	1.4
Santa Clara County	$37,304	$32,274	$36,220	-1.8	2.9
San Benito County	$476	$505	$530	0.7	1.2
Napa County	$1,908	$2,549	$2,719	3.7	1.6
Total San Francisco Bay Area Region	$63,451	$59,191	$64,651	-0.9	2.2
STATE OF CALIFORNIA	**$441,854**	**$531,654**	**$407,714**	**2.3**	**-6.4**

Sources: BOE 2000, 2008, 2012

The combined (secured and unsecured) property tax revenues in each of the counties in the San Francisco Bay Area Region for Fiscal Year 2011-2012 are presented in Table 19.32. Total property tax revenues in the four counties accounted for about 13 percent of the total state property tax revenues.

Table 19.32 Property Tax Revenues, Fiscal Year 2011-2012, in San Francisco Bay Area Region

Area	Property Tax Revenues (millions)
Alameda County	$2,830
Santa Clara County	$3,973
San Benito County	$68
Napa County	$327
Total San Francisco Bay Area Region	$7,198
STATE OF CALIFORNIA	**$55,459**

Source: California State Controller 2014

19.3.5 Central Coast Region

The Central Coast Region includes portions of San Luis Obispo and Santa Barbara counties served by the SWP. San Luis Obispo and Santa Barbara counties are among the top 15 counties in total agricultural production in the state.

19.3.5.1 Population

Population characteristics in the Central Coast Region are presented in Table 19.33. The population of the Central Coast Region grew by an average annual growth rate of about one half of one percent between 2000 and 2012.

Table 19.33 Population Characteristics in Central Coast Region

Area	Population		Average Annual Growth Rate (percent)
	2000	2012	2000-2012
San Luis Obispo County	246,681	271,502	0.8
Santa Barbara County	399,347	426,351	0.5
Total Central Coast Region	646,028	697,853	0.6
STATE OF CALIFORNIA	**33,873,086**	**37,668,804**	**0.9**

Sources: DOF 2013a, 2013b, 2014

19.3.5.2 Employment

Civilian labor force characteristics for the counties in the Central Coast Region are presented in Table 19.34. The civilian labor force in the Central Coast Region increased between 2000 and 2012.

Table 19.34 Civilian Labor Force and Unemployment Rates in Central Coast Region

	Civilian Labor Force (subject to unemployment insurance)			Unemployment Rate (percent)		
Area	2001	2008	2012	2001	2008	2012
San Luis Obispo County	126,176	136,615	138,650	4.0	5.7	9.3
Santa Barbara County	203,039	218,429	225,635	4.4	5.4	8.8
Total Central Coast Region	329,215	355,044	364,285	4.3	5.6	5.9
STATE OF CALIFORNIA	**17,152,106**	**18,392,000**	**18,494,881**	**4.9**	**7.2**	**10.5**

Source: BLS 2014

Total employment and farm employment in 2001, 2008, and 2012 in the Central Coast Region are presented in Table 19.35. Farm employment accounted for less than ten percent of total employment during this period.

Table 19.35 Employment in Central Coast Region

	Total Employment			Farm Employment		
Area	2001	2008	2012	2001	2008	2012
San Luis Obispo County	140,320	155,093	156,757	7,775	6,866	7,374
Santa Barbara County	243,955	260,056	257,841	15,228	16,483	18,075
Total Central Coast Region	384,275	415,149	414,598	23,003	23,349	25,449
STATE OF CALIFORNIA	**19,411,367**	**20,820,306**	**20,653,860**	**479,283**	**438,013**	**443,764**

Source: BEA 2014a
Note: Farm employment includes employment numbers in forestry, fishing, and related activities.

The farm employment numbers presented in Table 19.35 include only workers directly involved in farming, forestry, and fishing activities. However, farming is one of the most important basic industries in many counties in the Central Coast Region; and supports many other businesses including farm inputs (e.g., fertilizer, seed, machinery, and fuel) and processing of food and fiber grown on farms. As a result, employment both directly on farm and indirectly dependent on farming is higher than the values displayed in Table 19.35.

19.3.5.3 Income

Per capita personal incomes for the counties in the Central Coast Region are lower than those for the state. Both San Luis Obispo and Santa Barbara had average annual per capita personal income growth rates between 2000 and 2008 that were among the highest in the state. Per capita personal income for each of the two counties in the Central Coast Region in 2000, 2008 and 2012 are presented in Table 19.36.

Table 19.36 Per Capita Personal Income in Central Coast Region

	Per Capita Personal Income			Average Annual Growth Rate (percent)	
Area	2000	2008	2012	2000-2008	2008-2012
San Luis Obispo County	$28,671	$40,204	$43,698	4.3	2.1
Santa Barbara County	$33,317	$45,997	$47,862	4.1	1.0
Central Coast Region	$31,540	$43,735	$46,241	4.2	1.4
STATE OF CALIFORNIA	**$33,404**	**$44,003**	**$46,477**	**3.5**	**1.4**

Source: BEA 2014e

19.3.5.4 Local Government Finances

As of April 1, 2014, the county sales tax rates in the San Luis Obispo and Santa Barbara counties were 7.5 percent and 8.0 percent, respectively (BOE 2014).

Total annual taxable sales for San Luis Obispo and Santa Barbara counties in the Central Coast Region in 2000, 2008, and 2012 are presented in Table 19.37. The Central Coast Region's average annual growth in total taxable sales were higher than for the state.

Table 19.37 Total Taxable Sales in Central Coast Region

	Total Taxable Sales (Millions)			Average Annual Growth Rate (percent)	
Area	2000	2008	2012	2000-2008	2008-2012
San Luis Obispo County	$2,925	$3,974	$5,026	3.9	6.0
Santa Barbara County	$4,823	$5,884	$6,051	2.5	0.7
Central Coast Region	$7,748	$9,858	$11,077	3.1	3.0
STATE OF CALIFORNIA	**$441,854**	**$531,654**	**$407,714**	**2.3**	**-6.4**

Sources: BOE 2000, 2008, 2012

The combined (secured and unsecured) property tax revenues in the Central Coast Region for Fiscal Year 2011-2012 are presented in Table 19.38. Total property tax revenues in the two counties accounted for about 2 percent of the total state property tax revenues.

Table 19.38 Property Tax Revenues, Fiscal Year 2011-2012, in Central Coast Region

Area	Property Tax Revenues (millions)
San Luis Obispo County	$443
Santa Barbara County	$695
Central Coast Region	$1,138
STATE OF CALIFORNIA	**$55,459**

Source: California State Controller 2014

19.3.6 Southern California Region

The Southern California Region includes portions of Ventura, Los Angeles, Orange, San Diego, Riverside, and San Bernardino counties served by the SWP.

19.3.6.1 Population

Population characteristics in Southern California Region are presented in Table 19.39. Among the counties in the Southern California Region, Riverside County had the highest average annual population growth rate, and Los Angeles County had the lowest average annual population growth rate between 2000 and 2012.

Table 19.39 Population Characteristics in Southern California Region

	Population		Average Annual Growth Rate (percent)
Area	2000	2012	2000-2012
Ventura County	753,197	829,065	0.8
Los Angeles County	9,519,330	9,889,520	0.3
Orange County	2,846,289	3,057,879	0.6
San Diego County	2,813,833	3,128,734	0.9
Riverside County	1,545,387	2,234,193	3.1
San Bernardino County	1,710,139	2,059,699	1.6
Total Southern California Region	19,188,175	21,199,090	0.8
STATE OF CALIFORNIA	**33,873,086**	**37,668,804**	**0.9**

Sources: DOF 2013a, 2013b, 2014

19.3.6.2 Employment

Civilian labor force characteristics for the counties in the Southern California Region are presented in Table 19.40. The civilian labor force in the Southern California Region increased between 2001 and 2012. The average unemployment rates for the Southern California Region have been lower than for the state.

Table 19.40 Civilian Labor Force and Unemployment Rates in Southern California Region

Area	Civilian Labor Force (subject to unemployment insurance)			Unemployment Rate (percent)		
	2001	2008	2012	2001	2008	2012
Ventura County	399,325	429,444	440,649	4.8	6.3	9.0
Los Angeles County	4,752,839	4,934,756	4,879,674	5.7	7.5	10.9
Orange County	1,513,234	1,618,079	1,618,677	4.0	5.3	7.6
San Diego County	1,409,726	1,548,233	1,599,133	4.2	6.0	8.9
Riverside County	711,134	912,717	944,458	5.5	8.5	12.2
San Bernardino County	763,221	863,293	860,895	5.1	8.0	12.0
Total Southern California Region	9,549,479	10,306,522	10,343,486	5.1	7.0	10.2
STATE OF CALIFORNIA	**17,152,106**	**18,392,000**	**18,494,881**	**4.9**	**7.2**	**10.5**

Source: BLS 2014

Total employment and farm employment in 2001, 2008, and 2012 in the Southern California Region are presented in Table 19.41. Farm employment accounted for less than one percent of total employment.

Table 19.41 Employment in Southern California Region

Area	Total Employment			Farm Employment[1]		
	2001	2008	2012	2001	2008	2012
Ventura County	399,928	436,031	431,196	21,329	23,430	24,826
Los Angeles County	5,440,785	5,695,501	5,669,105	11,082	8,709	7,589
Orange County	1,845,392	1,999,036	1,963,080	7,888	4,713	3,183
San Diego County	1,723,801	1,901,598	1,887,077	17,871	15,718	14,778
Riverside County	677,214	866,247	864,308	20,892	15,669	15,024
San Bernardino County	730,150	881,700	864,432	6,050	3,931	3,688
Total Southern California Region	10,817,270	11,780,113	11,679,198	85,112	72,170	69,088
STATE OF CALIFORNIA	**19,411,367**	**20,820,306**	**20,653,860**	**479,283**	**438,013**	**443,764**

Source: BEA 2014a

Note:

Farm employment includes employment numbers in forestry, fishing, and related activities.

19.3.6.3 Income

Among the six counties in this region, San Bernardino County had the lowest per capita personal income in 2000 and 2008, as presented in Table 19.42. In 2012, Riverside County had the lowest per capita personal income.

Table 19.42 Per Capita Personal Income in Southern California Region

Area	Per Capita Personal Income			Average Annual Growth Rate (percent)	
	2000	2008	2012	2000-2008	2008-2012
Ventura County	$34,296	$46,634	$48,837	3.9	1.2
Los Angeles County	$29,878	$42,881	$44,474	4.6	0.9
Orange County	$38,357	$49,436	$52,342	3.2	1.4
San Diego County	$33,779	$47,197	$49,719	4.3	1.3
Riverside County	$24,528	$30,842	$31,742	2.9	0.7
San Bernardino County	$22,624	$30,220	$32,072	3.7	1.5
Total Southern California Region	$30,801	$41,078	$44,004	3.7	1.7
STATE OF CALIFORNIA	**$33,404**	**$44,003**	**$46,477**	**3.5**	**1.4**

Source: BEA 2014e

19.3.6.4 Local Government Finances

As of April 1, 2014, the county sales tax rates in the Southern California Region ranged from 7.5 percent in Ventura County to 9.0 percent in Los Angeles County (BOE 2014).

Total annual taxable sales for the counties in the Southern California Region in 2000, 2008, and 2012 are presented in Table 19.43. The counties in this region have had higher average annual growth rates in total taxable retail sales compared to the state. Between 2000 and 2008, Riverside and San Bernardino led the region with higher average annual growth rates. However, between 2008 and 2012, the two counties experienced declining growth rates.

Table 19.43 Total Taxable Sales in Southern California Region

Area	Total Taxable Sales (millions)			Average Annual Growth Rate (percent)	
	2000	2008	2012	2000-2008	2008-2012
Ventura County	$9,096	$11,322	$11,958	2.8	1.4
Los Angeles County	$106,674	$131,882	$135,296	2.7	0.6
Orange County	$44,462	$53,607	$55,231	2.4	0.7
San Diego County	$36,245	$45,329	$47,947	2.8	1.4
Riverside County	$16,979	$26,004	$28,096	5.5	2.0
San Bernardino County	$18,885	$27,778	$29,532	4.9	1.5
Total Southern California Region	$232,342	$295,921	$308,059	3.1	1.0
STATE OF CALIFORNIA	**$441,854**	**$531,654**	**$407,714**	**2.3**	**-6.4**

Sources: BOE 2000, 2008, 2012

The combined (secured and unsecured) property tax revenues in the Southern California Region for Fiscal Year 2011-2012 are presented in Table 19.44. Total property tax revenues accounted for about 55 percent of the total state property tax revenues.

Table 19.44 Property Tax Revenues, Fiscal Year 2011-2012, in Southern California Region

Area	Property Tax Revenues (millions)
Ventura County	$1,230
Los Angeles County	$14,191
Orange County	$5,046
San Diego County	$4,646
Riverside County	$2,812
San Bernardino County	$2,132
Southern California Region	$30,057
STATE OF CALIFORNIA	**$55,459**

Source: California State Controller 2012

19.3.7 Ocean Salmon Fishery

The ocean salmon fishery along the southern Oregon and northern California coast are affected by the population of salmon that rely upon the northern California rivers, including the Sacramento and San Joaquin rivers. Changes in CVP and SWP water operations would affect the flow patterns and water quality of the Sacramento and San Joaquin rivers; and the survivability of the salmon that use those rivers for habitat, as described in Chapter 9, Fish and Aquatic Resources. This section discusses the economic contributions of the Pacific Coast salmon fishery.

Management of the California ocean salmon fishery is a combined effort of the California Department of Fish and Wildlife (CDFW) and the Pacific Fishery Management Council (PFMC), a regional council of the National Oceanic and Atmospheric Administration. The California Department of Fish and Wildlife manages salmon harvest from the shoreline to three nautical miles off the California coast. From three nautical miles to two hundred nautical miles offshore is managed by the PFMC. The PFMC is responsible for developing the Pacific Coast Salmon Fishery Management Plan (FMP) that guides management of the ocean commercial and recreational fishery in California, Oregon, and Washington (PFMC 2014a). The annual ocean salmon fishery regulations promote the maximum amount of harvest while ensuring that suitable population levels are maintained (NOAA 2014).

19.3.7.1 Commercial Ocean Fisheries for Salmon along the Southern Oregon and Northern California Coasts

The commercial ocean salmon fishery plays a large role in the overall California commercial ocean industry, as shown in Table 19.45. The total harvest value for Chinook salmon ranked fourth among all commercially harvested ocean species in 2012. The harvest value rank of Chinook salmon in California between 2001 and 2012 as compared to the other commercially harvested ocean species are presented in Table 19.46.

Table 19.45 Top Ten Species by Total Value for Commercially Harvested Ocean Species in California in 2012

Rank	Species	Total Value
1	Dungeness Crab	$85,643,530
2	California Market Squid	$63,883,456
3	California Spiny Lobster	$13,706,721
4	**Chinook Salmon**	**$12,841,853**
5	Sablefish	$8,987,599
6	Pacific Oyster	$8,736,923
7	Sea Urchins	$8,320,111
8	Spot Shrimp	$4,462,204
9	Pacific Sardine	$4,248,504
10	Kumamoto Oyster	$3,170,760

Sources: NMFS 2014a, 2014b, 2014c, 2014d, 2014e, 2014f, 2014g, 2014h, 2014i, 2014j

Table 19.46 Chinook Salmon Total Harvest Value Ranking as compared to Other Commercially Harvested Ocean Species in California

Year	Total Value of Chinook Salmon Landings	Rank
2001	$4,760,786	7
2002	$7,610,882	4
2003	$12,153,111	3
2004	$17,770,036	3
2005	$12,804,188	3
2006	$5,260,526	4
2007	$7,835,240	4
2008	Season Closed	
2009	Season Closed	
2010	$1,214,959	19
2011	$5,096,433	7
2012	$12,841,853	4

Source: NMFS 2014k

Annual revenues from commercial ocean salmon fishery in California have fluctuated with changes in salmon prices and total landings. The dollar per dressed pound for Chinook salmon paid to the commercial operator can change within a season, across seasons, and at different ports, as presented in Table 19.47. Prices for Chinook salmon have increased over the past years; however, the costs for fuel, labor, and equipment maintenance also have increased.

Table 19.47 Average Annual Commercial Chinook Salmon Prices

Year	Average Annual California Price (dollar per dressed pound)	Average Annual Oregon Price (dollar per dressed pound)
2001	$1.98	$1.61
2002	$1.55	$1.54
2003	$1.91	$1.97
2004	$2.87	$3.45
2005	$2.97	$3.17
2006	$5.13	$5.48
2007	$5.18	$5.66
2008	Season Closed	$7.31
2009	Season Closed	Season Closed
2010	$5.46	$5.49
2011	$5.17	$5.96
2012	$5.34	$5.75

Source: PFMC 2014b (Tables D-4, D-5)

The total value of landings for the commercial ocean fishery in southern Oregon and California are presented in Table 19.48.

Table 19.48 Value of Landings for Salmon for the Commercial Ocean Salmon Fishery

Year	Total Value, California	Total Value, Oregon
2001	$4,773	$4,721
2002	$7,776	$5,391
2003	$12,181	$7,222
2004	$17,895	$9,919
2005	$12,913	$8,503
2006	$5,350	$2,701
2007	$7,902	$2,822
2008	Season Closed	$51,118
2009	Season Closed	$51,118
2010	$1,246	$2,791
2011	$5,133	$2,401
2012	$13,521	$4,271

Sources: PFMC 2014b (Tables D-4, D-5); PacFIN 2014

The economic contribution of the California commercial ocean salmon fishery extends beyond the revenues received by fishermen. Supporting industries include fish processors, boat manufacturers, repair and maintenance. The economic contribution of the commercial ocean salmon fishery can be estimated through the use of Input-Output models. Economic contributions are estimated by PFMC using an Input-Output model, the Fishery Economic Assessment Model (FEAM), as summarized in Table 19.49 for the commercial ocean salmon fishery by management area.

Table 19.49 Estimated Total Economic Impact for the Commercial Fishery by PFMC

Year	Economic Values by Management Areas ($1,000)					
	KMZ – Oregon	KMZ – California	Fort Bragg	San Francisco	Monterey	Total
2001	$635	$328	$1,033	$10,857	$2,297	$15,150
2002	$806	$797	$3,730	$15,516	$4,179	$25,028
2003	$699	$259	$15,160	$15,795	$2,491	$34,404
2004	$1,502	$2,373	$7,434	$23,356	$5,257	$39,922
2005	$1,259	$582	$5,420	$13,496	$7,083	$27,840
2006	$378	$0	$2,471	$6,389	$985	$10,223
2007	$780	$1,156	$3,407	$8,131	$1,658	$15,132
2008	$72	$0	$0	$0	$0	$72
2009	$42	$0	$0	$0	$0	$42
2010	$367	$35	$1,780	$140	$161	$2,483
2011	$504	$505	$4,952	$2,225	$979	$9,165
2012	$698	$725	$4,706	$10,653	$5,759	$22,541
2013	$1,252	$2,146	$12,909	$19,181	$4,010	$39,498

Source: PFMC 2014b (Tables IV-16, IV-17)

Notes:
All values estimated using the Fishery Economic Assessment Model, and presented as 2013 dollars.
Southern Oregon values include data for Brookings, Oregon which may include values from landings outside of the KMZ.
a. KMZ –Oregon represents the area from Humbug Mountain to the Oregon-California Border, and includes landings at the Brookings port and season length and quota values for the entire area including Chetco River Ocean Terminal Area between Twin Rocks and the Oregon-California border.
b. KMZ –California represents the area from Oregon-California Border to Humboldt South Jetty, and includes landings at the Crescent City and Eureka ports.

Fisherman and industries that rely on the commercial ocean salmon fishery have access to financial assistance from the federal government in years of low revenue or closure. The fishery can be declared a failure by the Department of Commerce after requests are sent by state or local officials and certain criteria have been met. After a fishery failure is declared, disaster relief can be provided in the form of monetary compensation, community grants, low-interest loans, habitat restoration, or fishery capacity reduction. Disaster relief related to the California commercial ocean salmon fishery has occurred six times between 1994 and 2009, as summarized in Table 19.50 (CRS 2013). Direct payments may involve a minimum amount to any permit holder and additional amounts based upon past landing values (Hackett and Hansen 2008). Disaster relief funds distribution is conducted by the PFMC and the California Salmon Council.

Table 19.50 Disaster Relief Monies and Programs for the Commercial Ocean Salmon Fishery in California

Year	Programs	Dollar Value
1994	Fishery capacity reduction, habitat restoration jobs, and data collection jobs	$12 Million
1995	Similar programs as in 1994	$13 Million
1998	Fishery capacity reduction	$3.5 Million
2007	Direct payments to fisherman and businesses dependent on the Klamath River salmon	$60.4 Million
2008	Direct payments to fisherman and businesses dependent on the Sacramento River salmon	$170 Million
2009-2010	Continuation of 2008 programs	Remainder of the 2008 $170 Million

Source: CRS 2013

19.3.7.2 Ocean Sport Fisheries for Salmon along the Southern Oregon and Northern California Coasts

The PFMC and CDFW also manages the ocean sport fishery. The economic contribution of the ocean sport salmon fishery can be estimated through the use of Input-Output models. Economic contributions are estimated by PFMC using an Input-Output model, the Fishery Economic Assessment Model (FEAM), as summarized in Table 19.51.

Table 19.51 Estimated Total Economic Impact for the Recreational Fishery by PFMC

Year	Economic Values by Management Areas ($1,000)					
	KMZ – Oregon	KMZ-California	Fort Bragg	San Francisco	Monterey	Total
2001	$1,052	$1,136	$2,101	$7,683	$3,079	$15,051
2002	$775	$1,026	$2,221	$9,646	$4,752	$18,420
2003	$608	$743	$1,677	$6,990	$2,288	$12,306
2004	$751	$1,229	$2,175	$11,310	$4,439	$19,904
2005	$501	$794	$1,759	$8,554	$3,234	$14,842
2006	$426	$743	$1,450	$5,812	$1,947	$10,378
2007	$437	$977	$1,170	$4,119	$1,427	$8,130
2008	$189	$0	$26	$0	$0	$215
2009	$241	$276	$0	$0	$0	$517
2010	$229	$201	$421	$1,712	$1,140	$3,703
2011	$241	$744	$972	$3,367	$1,778	$7,102
2012	$732	$1,614	$970	$6,069	$2,947	$12,332

Source: PFMC 2014b (Tables IV-16, IV-17)

Notes:
All values estimated using the Fishery Economic Assessment Model, and presented as 2013 dollars.
Southern Oregon values include data for Brookings, Oregon which may include values from landings outside of the KMZ.

a. KMZ –Oregon represents the area from Humbug Mountain to the Oregon-California Border, and includes landings at the Brookings port and season length and quota values for the entire area including Chetco River Ocean Terminal Area between Twin Rocks and the Oregon-California border.
b. KMZ –California represents the area from Oregon-California Border to Humboldt South Jetty, and includes landings at the Crescent City and Eureka ports.

19.3.8 Ocean Salmon Fisheries for the Yurok and Hoopa Valley Tribes

The salmon populations are extremely important to the Yurok Tribe and Hoopa Valley Tribe as part of their lives, cultural traditions, ceremonies, and community health (Reclamation 2012). Fifty percent of the total available salmon in the Trinity River is the federally protected harvest for the Yurok and Hoopa Valley tribes (DOI 1993). Each tribe determines the use of the harvest. Historical landing data for the Yurok and Hoopa Valley tribes are presented in Table 19.52 (Reclamation 2012).

Table 19.52 Salmon Landings by the Yurok Tribe and Hoopa Valley Tribe

Year	Spring Run Chinook Salmon	Fall Run Chinook Salmon	Total
2001	19,640	39,044	58,684
2002	15,136	24,700	39,836
2003	9,065	30,078	39,143
2004	8,682	25,971	34,653
2005	7,302	8,087	15,389
2006	4,409	10,698	15,107
2007	5,849	27,594	33,443
2008	3,439	22,901	26,340
2009	3,562	28,565	32,127
2010	5,023	30,315	35,338
2011	5,005	28,084	33,089
2012	6,477	101,662	108,139
2013[a]	4,972	63,030	68,002

Source: PFMC 2014b (Table B-5)
Note:
a. 2013 data are preliminary.
Includes landings at the Klamath River estuary, along the Klamath River from the estuary to Weitchpec (at the confluence of the Klamath and Trinity rivers), and along the Trinity River.

19.4 Impact Analysis

This section describes the potential mechanisms and analytical methods for change in socioeconomic factors; results of the impact analysis; potential mitigation measures; and cumulative effects.

This Chapter includes the analysis of overall regional economic changes and economic changes related to changes in CVP and SWP water supplies for M&I water users. More detailed discussions of changes in agricultural production are presented in Chapter 12, Agricultural Resources.

19.4.1 Potential Mechanisms and Analytical Methods

As described in Chapter 4, Approach to Environmental Analysis, the impact assessment considers changes in socioeconomic factors related to changes in CVP and SWP operations under the alternatives as compared to the No Action Alternative and Second Basis of Comparison.

Changes in CVP and SWP operations under the alternatives as compared to the No Action Alternative and Second Basis of Comparison could change water supply availability for CVP and SWP water users, recreational opportunities at reservoirs that store CVP and SWP water, and salmon from the Delta watershed that are relied upon by commercial, sport, and tribal fisherman.

19.4.1.1 Regional Changes in Irrigated Agricultural Production Value

Changes in CVP and SWP operations could change the extent of total agricultural production value as compared to the No Action Alternative and the Second Basis of Comparison. As described in Chapter 12, Agricultural Resources, there was no changes in agricultural production in the Central Valley under long-term conditions (over the 81-year model simulation period). Therefore, this analysis only addresses regional economic changes during dry and critical dry years.

This analysis uses model output from the Statewide Agricultural Production (SWAP) model and the IMPLAN model. The SWAP model, **a**s described in Chapter 12, is a regional model of irrigated agricultural production and economics that simulates the decisions of producers (farmers) in the Central Valley Region. The model selects the crops, water supplies, and other inputs that maximize profit subject to constraints on water and land, and subject to economic conditions regarding prices, yields, and costs. The SWAP model incorporates CVP and SWP water supplies, other local water supplies represented in the CalSim II model, and groundwater. As conditions change within a SWAP subregion (e.g., the quantity of available project water supply declines), the model optimizes production by adjusting the crop mix, water sources and quantities used, and other inputs. The model also fallows land when that appears to be the most cost-effective response to resource conditions. The analysis only reduces groundwater withdrawals based upon an optimization of agricultural production costs. The analysis does not restrict groundwater withdrawals based upon groundwater overdraft or groundwater quality conditions.

As described in Chapter 7, Groundwater Resources and Groundwater Quality, The Sustainable Groundwater Management Act (SGMA) requires preparation of Groundwater Sustainability Plans (GSPs) by 2020 or 2022 for most of the groundwater basins. The GSPs will identify methods to implement measures that will achieve sustainable groundwater operations by 2040 or 2042. The analysis in this Chapter is focused on conditions that would occur in 2030. If local agencies fully implement GSPs prior to the regulatory deadline, increasing groundwater use would be less of an option for agricultural water users. However, to achieve sustainable conditions, some measures could require several years to design and construct new water supply facilities, and sustainable groundwater conditions are not required until the 2040s. Therefore, it was assumed that Central Valley agriculture water users would not reduce groundwater use by 2030, and that groundwater use would increase in response to reduced CVP and SWP water supplies.

As described in Chapter 12, the impact to irrigated acreage and agricultural production is relatively small. Most of the change in CVP or SWP irrigation supplies would be offset by changes in groundwater pumping, with only small changes in crop acreage in production. However, this is an aggregate result for the Central Valley. Individual growers that rely on CVP or SWP supply and have no access to groundwater would have their irrigated acreage affected by larger amounts. Some of their change in production can and would be offset by changes on other farms that have access to groundwater or other surface supplies. Over time, growers without the buffer of access to groundwater could be driven to sell to or merge with other farming operations. From the larger, regional perspective, total value of production is estimated to change relatively little.

The regional economic analysis was conducted using the results of the impact analysis on agricultural production and M&I water use. The incremental impact results, estimated by the SWAP and CWEST economic models, were input into the regional IMPLAN models as the direct change caused by each of Alternative as compared to the No Action Alternative and the Second Basis of Comparison. Changes in economic effects depend upon loss of production or expenditures for water supplies, interactions within the regional economy, and “leakage” of economic activity between regions. Economic linkages create multiplier effects in a regional economy in the IMPLAN input-output model based upon estimates of county-level final demands and final payments developed from published data, national average matrix of technical coefficients, and mathematical relationships. IMPLAN uses information from the U.S. Department of Commerce’s Bureau of Economic Analysis, U.S. Department of Labor’s Bureau of Labor Statistics, and other federal and state government agencies. Data is collected for 440 different industrial sectors of the national economy per the North American Industry Classification System based on the primary commodity or service produced. Data sets are provided for the IMPLAN model for each county in the United States. In this analysis counties were grouped into the Central Valley Region (does not include Contra Costa County), San Francisco Bay Area Region (does include Contra Costa County), Central Coast Region, and Southern California Region.

IMPLAN is a static model that estimates impacts for a snapshot in time when the impacts are expected to occur, based on the makeup of the economy at the time of the underlying IMPLAN data. IMPLAN measures the initial impact to the economy based on average expenditure patterns, but does not consider long-term adjustments if labor and capital move into alternative uses.

Irrigated acreage occurs in the San Francisco Bay Area, Central Coast, and Southern California regions that use CVP and SWP water. This irrigated acreage is not included in the SWAP model simulation; and therefore, is not evaluated quantitatively in this EIS. However, changes in irrigated acreage in response to reductions in CVP and SWP water deliveries are assumed to occur in a similar manner as projected for the Central Valley Region.

As described in this chapter, the SWAP and IMPLAN models are annual-time step models that use information from the monthly-time step model. The model results represent long-term responses and must be used in a comparative manner to reduce the effects of use of monthly assumptions and other assumptions that are indicative of real-time operations, but do not specific match real-time observations. The CalSim II model output includes minor fluctuations of up to 5 percent due to model assumptions and approaches. Therefore, if the quantitative changes between a specific alternative and the No Action Alternative and/or Second Basis of Comparison are 5 percent or less, the conditions under the specific alternative would be considered to be "similar" to conditions under the No Action Alternative and/or Second Basis of Comparison.

19.4.1.2 Regional Changes in Municipal and Industrial Water Supplies and Water Supply Costs

Changes in CVP and SWP operations could change availability of water supplies for M&I water in the study area, related costs of additional supplies or shortages, and changes in regional economics as compared to the No Action Alternative and the Second Basis of Comparison. The quantitative analyses of regional changes related to changes in M&I water supplies and associated costs, employment, and economic output are analyzed using the California Water Economics Spreadsheet Tool (CWEST) model and the IMPLAN model.

Changes in M&I water supplies were evaluated using a regional economic model that was specifically modified to address water supply and cost changes to CVP and SWP M&I water users. The CWEST is a regional model that considers the economic costs to M&I water users including the cost of CVP and SWP water supplies, regional surface water supplies (including recycled water), conveyance costs, shortage costs, and changes in groundwater pumping costs. The model operations on an annual time step. Annual supplies are calculated for each water user based upon annual CVP and/or SWP water supplies, local surface water and groundwater supplies, surface water and groundwater storage, wastewater effluent and stormwater recycling water treatment, and desalination water treatment.

CVP and SWP water supply inputs are provided for the 81-year hydrologic period from the CalSim II model. The CWEST model analyzes the changes in annual conditions over the 81-long-term condition, and averages the overall costs for each Alternative over the 81-long-term condition. The CWEST model evaluates responses to changes in CVP and SWP water supplies differently for wet, above normal, and below normal water year types as compared to dry and critical dry water year types.

The goal of the CWEST model is to minimize the cost for the water providers and end-users to meet 2030 water demand. In years when the combination of average existing water supplies (either for the wetter or drier conditions) are greater than the 2030 water demand, the CWEST model assumes any overage water amount would be placed into surface water or groundwater storage, if available. If storage is not available, groundwater pumping would be reduced so that the other available supplies can be utilized. The CWEST model assumes that local surface water, other imported water supplies, recycled water use, and desalinated water use would not be reduced. However, during wet years, total CVP and SWP water deliveries may not be delivered if groundwater pumping is reduced to zero and local storage facilities are full.

In years when annual supplies are less than the 2030 water demand, the model assumes that water users with local surface water and groundwater storage would first fully utilize those supplies, and participate in temporary water transfers or a similar annual option if necessary. If shortage and transfer costs occur frequently, the model can select to purchase additional fixed-yield supplies, such as additional recycled water, desalination water treatment, or groundwater capacity. The model optimizes these long-term supply decisions to provide the lowest-cost water supply portfolio to meet 2030 demands throughout the 81-year hydrologic period.

The CWEST model local supply amounts and costs for this EIS are primarily based upon information presented in 2010 Urban Water Management Plans (UWMPs) developed by the CVP and SWP contractors (see Appendix 5D, Municipal and Industrial Water Demands and Supplies). The assumptions related to future water supplies presented in the UWMPs were evaluated to determine if the projects were reasonable and certain to occur by 2030. Projects that had undergone environmental review, were under design, or under construction were considered to exist in 2030 water supply assumptions in the CWEST model. Projects described in the UWMPs were considered as options to increase fixed-yield supplies. Existing and future water supplies considered for municipalities by 2030 are presented in Appendix 5B, Future Municipal Water Supplies for CVP and SWP Water Users. For smaller water users that are not addressed in an UWMP, information was obtained from water master plans and integrated regional water management plans.

CWEST calculates the change in the cost of water supplies plus end-user shortage costs. It does not calculate the total cost of water supplies. To provide a basis for understanding the relative importance of a change in costs, annual operating expenses were obtained from the fiscal year 2011-12 reports for special districts, counties, and cities published by the State Controllers' office (2013, 2014, 2014a). These operating expenses were updated to 2014 dollars using the California urban consumer price index. The cost change from CWEST, divided by the operating expense, provides a reasonable indication of the relative importance of cost changes for urban water providers.

The level of 2014 operating expense for each region includes:

- Central Valley Region
    - Sacramento Valley - $257 million
    - San Joaquin Valley - $297 million
- San Francisco Bay Area Region - $415 million
- Central Coast Region - $38 million

- Southern California Region (also known as "South Coast") - $1,613 million

The CWEST model assumes that groundwater pumping would occur up to the amounts included in the UWMPs for wetter and drier conditions. As described above for agricultural production, it is assumed that full implementation of SGMA would not occur by 2030. Therefore, it was assumed that water users that are not currently operating groundwater resources in accordance with adjudication or other types of agreements, would not reduce groundwater use by 2030.

The IMPLAN model, described above, also is used to analyze changes in regional economics related to M&I water supplies. Increased costs of water supply are estimated from CWEST results. It is assumed that these costs must be passed on to regional water users. Regional water users are assumed to reduce their spending by an amount equal to the water supply cost increase. This reduced spending is distributed over regional industries according to coefficients provided by IMPLAN.

As described in this chapter, the CWEST and IMPLAN models are annual-time step models that use information from the monthly-time step model. The model results represent long-term responses and must be used in a comparative manner to reduce the effects of use of monthly assumptions and other assumptions that are indicative of real-time operations, but do not specific match real-time observations. The CalSim II model output includes minor fluctuations of up to 5 percent due to model assumptions and approaches. Therefore, if the quantitative changes between a specific alternative and the No Action Alternative and/or Second Basis of Comparison are 5 percent or less, the conditions under the specific alternative would be considered to be "similar" to conditions under the No Action Alternative and/or Second Basis of Comparison.

19.4.1.3 Changes in Local Government Finances

Changes in CVP and SWP operations would not result in major changes in land use, as described in Chapter 13, Land Use. Therefore, changes to collection of local taxes and fees are not anticipated under the alternatives as compared to the No Action Alternative and the Second Basis of Comparison. Therefore, changes in local government finances are not evaluated in this EIS.

19.4.1.4 Changes in Recreational Economics

Reservoirs that store CVP and SWP water provide a wide diversity of recreational experiences on the water surface, as described in Chapter 15, Recreational Resources. However, changes to recreational economic opportunities under the alternatives primarily would occur due to changes in surface water elevations at San Luis Reservoir and reduced Striped Bass fishing opportunities under Alternatives 3 and 4.

This EIS does not quantitatively analyze potential changes in recreation user days or recreation spending because specific projects or responses to the changes in reservoir elevations are not considered under the purpose and need of this EIS. The qualitative analysis presented in this Chapter is based upon potential changes in recreational use related to changes under the alternatives as compared to the No

Action Alternative and the Second Basis of Comparison, as described in Chapter 15, Recreational Resources.

19.4.1.5 Changes in Commercial, Sport, and Tribal Salmon Fishing Opportunities

Changes in CVP and SWP operations under the alternatives could change the salmon population as compared to the No Action Alternative and the Second Basis of Comparison. Commercial, sport, and tribal fishing primarily relies upon Fall-run Chinook Salmon because the populations of other runs of salmon are substantially lower. Specific population changes for Fall-run Chinook Salmon are not projected in this EIS. Therefore, this Chapter presents a qualitative analysis of potential changes in socioeconomic factors under the alternatives as compared to the No Action Alternative and the Second Basis of Comparison.

19.4.1.6 Effects of Cross Delta Water Transfers

Historically water transfer programs have been developed on an annual basis. The demand for water transfers is dependent upon the availability of water supplies to meet water demands. Water transfer transactions have increased over time as CVP and SWP water supply availability has decreased, especially during drier water years.

Parties seeking water transfers generally acquire water from sellers who have available surface water who can make the water available through releasing previously stored water, pump groundwater instead of using surface water (groundwater substitution); idle crops; or substitute crops that uses less water in order to reduce normal consumptive use of surface water.

Water transfers using CVP and SWP Delta pumping plants and south of Delta canals generally occur when there is unused capacity in these facilities. These conditions generally occur drier water year types when the flows from upstream reservoirs plus unregulated flows are adequate to meet the Sacramento Valley water demands and the CVP and SWP export allocations. In non-wet years, the CVP and SWP water allocations would be less than full contract amounts; therefore, capacity may be available in the CVP and SWP conveyance facilities to move water from other sources.

Projecting future socioeconomic conditions related to water transfer activities is difficult because specific water transfer actions required to make the water available, convey the water, and/or use the water would change each year due to changing hydrological conditions, CVP and SWP water availability, specific local agency operations, and local cropping patterns. Reclamation recently prepared a long-term regional water transfer environmental document which evaluated potential changes in conditions related to water transfer actions (Reclamation 2014c). Results from this analysis were used to inform the impact assessment of potential effects of water transfers under the alternatives as compared to the No Action Alternative and the Second Basis of Comparison.

19.4.2 Conditions in Year 2030 without Implementation of Alternatives 1 through 5

This EIS includes two bases of comparison, as described in Chapter 3, Description of Alternatives: the No Action Alternative and the Second Basis of Comparison. Both of these bases are evaluated at 2030 conditions. Changes that would occur over the next 15 years without implementation of the alternatives are not analyzed in this EIS. However, the changes to socioeconomics that are assumed to occur by 2030 under the No Action Alternative and the Second Basis of Comparison are summarized in this section. Many of the changed conditions would occur in the same manner under both the No Action Alternative and the Second Basis of Comparison.

19.4.2.1 Common Changes in Conditions under the No Action Alternative and Second Basis of Comparison

Conditions in 2030 would be different than existing conditions due to:

- Climate change and sea level rise
- General plan development throughout California, including increased water demands in portions of Sacramento Valley
- Implementation of reasonable and foreseeable water resources management projects to provide water supplies

It is anticipated that climate change would result in more short-duration high-rainfall events and less snowpack in the winter and early spring months. The reservoirs would be full more frequently by the end of April or May by 2030 than in recent historical conditions. However, as the water is released in the spring, there would be less snowpack to refill the reservoirs. This condition would reduce reservoir storage and available water supplies to downstream uses in the summer. The reduced end of September storage also would reduce the ability to release stored water to downstream regional reservoirs. These conditions would occur for all reservoirs in the California foothills and mountains, including non-CVP and SWP reservoirs.

These changes would result in a decline of the long-term average CVP and SWP water supply deliveries by 2030 as compared to recent historical long-term average deliveries under the No Action Alternative and the Second Basis of Comparison. However, the CVP and SWP water deliveries would be less under the No Action Alternative as compared to the Second Basis of Comparison, as described in Chapter 5, Surface Water Resources and Water Supplies, which could result in more crop idling.

Under the No Action Alternative and the Second Basis of Comparison, land uses in 2030 would occur in accordance with adopted general plans.

The No Action Alternative and the Second Basis of Comparison assumes completion of water resources management and environmental restoration projects that would have occurred without implementation of Alternatives 1 through 5, including regional and local recycling projects, surface water and groundwater storage projects, conveyance improvement projects, and desalination projects, as described in Chapter 3, Description of Alternatives. The No Action Alternative and the Second Basis of Comparison also assumes implementation of actions included in the 2008 U.S. Fish and Wildlife Service (USFWS) Biological Opinion (BO) and 2009 National Marine Fisheries Service (NMFS) BO that would have been implemented without the BOs by 2030, as described in Chapter 3, Description of Alternatives.

19.4.2.2 Population Projections under the No Action Alternative and Second Basis of Comparison

The 2030 population projections for each region addressed in this EIS are presented in Tables 19.53 through 19.59.

Table 19.53 Population Projections in Trinity River Region

Area	Population		Average Annual Growth Rate (percent)
	2012	2030	2012-2030
Trinity County	13,471	15,309	0.7
Humboldt County	134,728	143,811	0.4
Del Norte County	28,527	31,252	0.5
Total Trinity River Region	176,726	190,373	0.4
STATE OF CALIFORNIA	**37,427,946**	**44,574,756**	**0.9**

Sources: DOF 2013a, 2013b, 2014

Table 19.54 Population Projections in Central Valley Region – Sacramento Valley

Area	Population		Average Annual Growth Rate (percent)
	2012	2030	2012-2030
Shasta County	177,516	210,997	0.9
Plumas County	19,901	20,390	0.1
Tehama County	62,985	75,522	1.0
Glenn County	28,105	33,318	0.9
Colusa County	21,552	28,112	1.4
Butte County	220,465	276,009	1.2
Yuba County	72,642	97,037	1.6
Nevada County	97,366	111,836	0.8
Sutter County	94,620	131,390	1.7
Placer County	351,463	454,124	1.4
El Dorado County	180,483	230,503	1.3
Sacramento Valley Subtotal	1,333,615	1,669,238	1.3
Total Central Valley Region	7,408,750	9,677,315	1.5
STATE OF CALIFORNIA	**37,668,804**	**44,574,756**	**0.9**

Sources: DOF 2013a, 2013b, 2014

Table 19.55 Population Projections in Central Valley – San Joaquin Valley

	Population		Average Annual Growth Rate (percent)
Area	**2012**	**2030**	**2012-2030**
Stanislaus County	519,339	666,446	1.4
Madera County	152,325	219,908	2.1
Merced County	260,029	359,798	1.8
Fresno County	943,493	1,232,151	1.5
Tulare County	451,540	636,606	1.9
Kings County	151,774	209,440	1.8
Kern County	849,977	1,276,155	2.3
San Joaquin Valley Subtotal	3,328,477	4,600,505	1.8
Total Central Valley Region	7,238,742	9,468,443	1.5
STATE OF CALIFORNIA	**37,668,804**	**44,574,756**	**0.9**

Sources: DOF 2013a, 2013b, 2014

Table 19.56 Population Projections in Central Valley Region – Delta and Suisun Marsh

	Population		Average Annual Growth Rate (percent)
Area	**2012**	**2030**	**2012-2030**
Sacramento County	1,433,525	1,731,061	1.1
Yolo County	204,349	250,420	1.1
Solano County	415,787	490,381	0.9
San Joaquin County	692,997	935,709	1.7
Contra Costa County	1,066,602	1,263,049	0.9
Delta and Suisun Marsh Subtotal	3,813,260	4,670,621	1.1
Total Central Valley Region	7,238,742	9,468,443	1.5
STATE OF CALIFORNIA	**37,668,804**	**44,574,756**	**0.9**

Sources: DOF 2013a, 2013b, 2014

Table 19.57 Population Projections in San Francisco Bay Area Region

Area	Population		Average Annual Growth Rate (percent)
	2012	2030	2012-2030
Alameda County	1,530,176	1,650,596	0.4
Santa Clara County	1,813,696	2,048,021	0.7
San Benito County	56,137	59,259	0.3
Napa County	137,731	158,538	0.8
Total San Francisco Bay Area Region	3,537,740	3,916,413	0.6
STATE OF CALIFORNIA	**37,668,804**	**44,574,756**	**0.9**

Sources: DOF 2013a, 2013b, 2014

Table 19.58 Population Projections in Central Coast Region

Area	Population		Average Annual Growth Rate (percent)
	2000	2030	2012-2030
San Luis Obispo County	271,502	311,388	0.8
Santa Barbara County	426,351	469,070	0.5
Total Central Coast Region	697,853	780,457	0.6
STATE OF CALIFORNIA	**37,668,804**	**44,574,756**	**0.9**

Sources: DOF 2013a, 2013b, 2014

Table 19.59 Population Projections in Southern California Region

Area	Population		Average Annual Growth Rate (percent)
	2012	2030	2012-2030
Ventura County	829,065	956,324	0.8
Los Angeles County	9,889,520	11,138,280	0.7
Orange County	3,057,879	3,385,762	0.6
San Diego County	3,128,734	3,665,358	0.9
Riverside County	2,234,193	3,145,948	1.9
San Bernardino County	2,059,699	2,588,990	1.3
Total Southern California Region	21,199,090	24,880,663	0.9
STATE OF CALIFORNIA	**37,668,804**	**44,574,756**	**0.9**

Sources: DOF 2013a, 2013b, 2014

19.4.3 Evaluation of Alternatives

Alternatives 1 through 5 have been compared to the No Action Alternative; and the No Action Alternative and Alternatives 1 through 5 have been compared to the Second Basis of Comparison.

During review of the numerical modeling analyses used in this EIS, an error was determined in the CalSim II model assumptions related to the Stanislaus River operations for the Second Basis of Comparison, Alternative 1, and Alternative 4 model runs. Appendix 5C includes a comparison of the CalSim II model run results presented in this Chapter and CalSim II model run results with the error corrected. Appendix 5C also includes a discussion of changes in the comparison of groundwater conditions for the following Alternative analyses.

- No Action Alternative compared to the Second Basis of Comparison
- Alternative 1 compared to the No Action Alternative
- Alternative 3 compared to the Second Basis of Comparison
- Alternative 5 compared to the Second Basis of Comparison.

19.4.3.1 No Action Alternative

The No Action Alternative is compared to the Second Basis of Comparison.

19.4.3.1.1 Trinity River Region

Regional Changes to Irrigated Agriculture

There are no agricultural lands irrigated with CVP and SWP water supplies in the Trinity River Region. Therefore, there would be no changes in irrigated lands under the No Action Alternative as compared to the Second Basis of Comparison.

Regional Changes to Municipal and Industrial Water Supplies

The CVP would continue to release water in Trinity River for downstream beneficial uses, including water supplies under the No Action Alternative and the Second Basis of Comparison. There are no municipal and industrial CVP or SWP water service contractors in the Trinity River Region.

Regional Changes to Recreational Opportunities

Recreational opportunities would be similar in the Trinity River Region under the No Action Alternative as compared to the Second Basis of Comparison as described in Chapter 15, Recreational Resources.

Regional Changes related to Changes in Salmon Fishing

Trinity River flows would be similar under the No Action Alternative as compared to the Second Basis of Comparison. This could result in similar salmon harvest conditions by the Yurok and Hoopa Valley tribes.

19.4.3.1.2 Central Valley Region

Regional Changes to Irrigated Agriculture

As described in Chapter 5, Surface Water Resources and Water Supplies, CVP and SWP water supplies would be less under the No Action Alternative than under the Second Basis of Comparison. It is anticipated that groundwater use would increase in response to reduced CVP and SWP water supplies in 2030 because sustainable groundwater management plans would not be fully implemented until the 2040s, as discussed in Chapter 12, Agricultural Resources.

The agricultural production value under long-term average conditions would be reduced by less than 1 percent ($1.6 million/year in the Sacramento Valley and $0.5 million/year in the San Joaquin Valley) primarily due to an increase in groundwater pumping of approximately 6 percent. The agricultural production value under dry and critical dry conditions also would be reduced by less than 1 percent ($11.3 million/year in the Sacramento Valley and $20.3 million/year in the San Joaquin Valley) primarily due to an increase in groundwater pumping.

The overall reduction in agricultural production values are less than 0.05 percent under long-term conditions; and, changes in employment and regional economic output would be minimal. Therefore, the analysis of employment and regional economic output is focused on dry and critical dry years.

The direct changes in agricultural production would result in changes to employment and regional economic output in the Sacramento and San Joaquin valleys, as summarized in Tables 19.60 and 19.61, respectively.

Table 19.60 Changes in Agricultural-Related Employment and Regional Economic Output for the Sacramento Valley under the No Action Alternative as Compared to the Second Basis of Comparison in Dry and Critical Dry Years

Economic Sectors	Employment				Economic Output ($ millions)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	-87	-21	0	-108	-11.3	-1.3	0.0	-12.7
Mining & Logging	0	0	0	0	0.0	0.0	0.0	0.0
Construction	0	-1	0	-1	0.0	-0.1	0.0	-0.2
Manufacturing	0	0	0	0	0.0	-0.1	0.0	-0.1
Transportation, Warehousing & Utilities	0	-1	0	-2	0.0	-0.4	-0.1	-0.5
Wholesale Trade	0	-1	-1	-2	0.0	-0.2	-0.1	-0.3
Retail Trade	0	0	-4	-4	0.0	0.0	-0.3	-0.3
Information	0	0	0	0	0.0	0.0	-0.1	-0.1
Financial Activities	0	-7	-2	-9	0.0	-1.6	-0.8	-2.5
Services	0	-3	-12	-15	0.0	-0.3	-1.0	-1.3
Government	0	0	0	0	0.0	-0.1	0.0	-0.1
Total	**-87**	**-36**	**-19**	**-142**	**-11.3**	**-4.2**	**-2.5**	**-18.1**

Table 19.61 Changes in Agricultural-Related Employment and Regional Economic Output for the San Joaquin Valley under the No Action Alternative as Compared to the Second Basis of Comparison in Dry and Critical Dry Years

Economic Sectors	Employment				Economic Output ($ millions)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	-139	-53	0	-192	-20.3	-2.3	-0.1	-22.7
Mining & Logging	0	-1	0	-1	0.0	-0.3	0.0	-0.3
Construction	0	-2	0	-2	0.0	-0.2	0.0	-0.2
Manufacturing	0	-1	0	-2	0.0	-1.8	-0.3	-2.1
Transportation, Warehousing & Utilities	0	-3	-1	-4	0.0	-0.8	-0.2	-1.0
Wholesale Trade	0	-2	-1	-3	0.0	-0.4	-0.2	-0.5
Retail Trade	0	0	-7	-8	0.0	0.0	-0.6	-0.6
Information	0	0	0	-1	0.0	-0.1	-0.1	-0.2
Financial Activities	0	-12	-3	-15	0.0	-2.7	-1.5	-4.1
Services	0	-5	-21	-26	0.0	-0.5	-1.7	-2.2
Government	0	-1	0	-1	0.0	-0.2	-0.1	-0.3
Total	**-139**	**-79**	**-35**	**-254**	**-20.3**	**-9.2**	**-4.9**	**-34.4**

As described in Chapter 11, Geology and Soils Resources, increased groundwater pumping under the long-term average conditions may result in an additional increment of subsidence in those areas within the Central Valley. The additional amount of subsidence and the economic costs associated with it have not been quantified in this EIS. However, total subsidence-related costs have been shown to be substantial, as reported by Borchers et al. (2014) who estimated that the cost of subsidence in San Joaquin Valley between 1955 and 1972 was more than $1.3 billion (in 2013 dollars). These estimates are based on the impacts to major infrastructure in the region including the San Joaquin River, Delta Mendota Canal, Friant-Kern Canal and San Luis Canal in addition to privately owned infrastructure. The incremental subsidence-related costs, expressed on an annual basis, could be an unknown fraction of that cumulative cost.

Regional Changes to Municipal and Industrial Water Supplies

As described in Chapter 5, Surface Water Resources and Water Supplies, CVP and SWP water supplies would be less under the No Action Alternative than under the Second Basis of Comparison. The analysis assumed CVP and SWP water deliveries, as described in Chapter 5, and determined the need for new water supplies, changes in water storage and groundwater pumping, water transfers, water shortage costs, and excess water savings. The factors and basis of the analysis are described in detail in Appendix 19A, CWEST Model. The analysis assumes that no new annual transfer supplies would be implemented until shortages were greater than 5 percent. The costs of these shortages are included in the analysis. It is assumed that some communities that do not have alternative water supplies (e.g., cities of Huron and Coalinga) and would utilize water transfers.

The average annual water supply costs over the 81-year hydrologic period for M&I water supplies are presented in Tables 19.62 and 19.63 for the Sacramento and San Joaquin Valley, respectively.

Table 19.62 Changes in Municipal and Industrial Water Supply Costs for the Sacramento Valley under the No Action Alternative as Compared to the Second Basis of Comparison

Differences in Total	No Action Alternative	Second Basis of Comparison	Changes
Average Annual CVP/SWP Deliveries (TAF)	447	463	-16
Delivery Cost ($1,000)	$8,031	$8,317	-$287
Assumed New Supply Deliveries (TAF)	0	0	0
Annualized New Supply Costs ($1,000)	$0	$0	$0
Water Storage Costs ($1,000)	$0	$0	$0
Lost Water Sales Revenues ($1,000)	$213	$207	$6
Transfer Costs ($1,000)	$739	$517	$222
Shortage Costs ($1,000)	$69	$68	$1
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) ($1,000)	-$3,858	-$3,916	$58
Excess Water Savings ($1,000)	-$2,275	-$2,563	$288
Average Annual Changes in Water Supply Costs ($1,000)	**$2,919**	**$2,630**	**$288**

Note: In 2012 dollars

Table 19.63 Changes in Municipal and Industrial Water Supply Costs for the San Joaquin Valley under the No Action Alternative as Compared to the Second Basis of Comparison

Differences in Total	No Action Alternative	Second Basis of Comparison	Changes
Average Annual CVP/SWP Deliveries (TAF)	214	237	-23
Delivery Cost ($1,000)	$3,460	$3,854	-$394
Assumed New Supply Deliveries (TAF)	2	0	2
Annualized New Supply Costs ($1,000)	$429	$15	$414
Water Storage Costs ($1,000)	$942	$820	$122
Lost Water Sales Revenues ($1,000)	$361	$322	$39
Transfer Costs ($1,000)	$2,673	$2,623	$50
Shortage Costs ($1,000)	$115	$102	$13
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) ($1,000)	-$15,377	-$16,011	$634
Excess Water Savings ($1,000)	-$1,029	-$1,318	$289
Average Annual Changes in Water Supply Costs ($1,000)	**-$8,427**	**-$9,593**	**$1,166**

Note: In 2012 dollars

The changes in M&I water supply costs would result in changes to employment and regional economic output in the Sacramento and San Joaquin valleys, as summarized in Tables 19.64 and 19.65, respectively. The M&I average annual water supply operating expenses would increase by 0.11 and 0.39 percent in the Sacramento Valley and the San Joaquin Valley, respectively; and therefore, the results would be similar.

Table 19.64 Changes in Municipal and Industrial Water Supply Related Employment and Regional Economic Output for the Sacramento Valley under the No Action Alternative as Compared to the Second Basis of Comparison

Economic Sectors	Employment				Economic Output ($ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	0.1	-1.7	-1.6
Mining & Logging	0	0	0	0	0.0	0.4	-0.3	0.1
Construction	0	0	0	0	0.0	29.0	-2.5	26.5
Manufacturing	0	0	0	0	0.0	3.1	-22.2	-19.1
Transportation, Warehousing & Utilities	1	0	0	1	286.4	2.8	-18.0	271.2
Wholesale Trade	0	0	0	0	0.0	1.0	-27.1	-26.1
Retail Trade	0	0	-1	-1	0.0	0.9	-46.6	-45.6
Information	0	0	0	0	0.0	3.4	-20.6	-17.2
Financial Activities	0	0	0	0	0.0	13.0	-147.7	-134.6
Services	0	0	-2	-1	0.0	30.8	-154.7	-123.9
Government	0	0	0	0	0.0	0.2	-3.8	-3.7
Total	**1**	**1**	**-3**	**-1**	**286.4**	**84.8**	**-445.2**	**-74.0**

Note: In 2012 dollars

Table 19.65 Changes in Municipal and Industrial Water Supply Related Employment and Regional Economic Output for the San Joaquin Valley under the No Action Alternative as Compared to the Second Basis of Comparison

Economic Sectors	Employment				Economic Output ($thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	0.0	-6.7	-6.7
Mining & Logging	0	0	0	0	0.0	-0.4	-6.4	-6.8
Construction	0	0	0	0	0.0	-13.3	-5.6	-18.9
Manufacturing	0	0	0	0	0.0	-1.4	-46.4	-47.8
Transportation, Warehousing & Utilities	-1	0	0	-1	-140.8	-1.4	-44.7	-186.9
Wholesale Trade	0	0	0	0	0.0	-0.4	-39.0	-39.3
Retail Trade	0	0	-1	-1	0.0	-0.4	-97.4	-97.8
Information	0	0	0	0	0.0	-1.0	-27.0	-28.0
Financial Activities	0	0	-1	-1	0.0	-4.3	-263.7	-268.0
Services	0	0	-3	-3	0.0	-11.7	-292.3	-303.9
Government	0	0	0	0	0.0	-0.1	-12.9	-13.0
Total	**-1**	**0**	**-6**	**-7**	**-140.8**	**-34.3**	**-842.0**	**-1,017.2**

Note:
In 2012 dollars

Regional Changes to Recreational Opportunities

Recreational opportunities would decrease at San Luis Reservoir by 6 percent under the No Action Alternative as compared to the Second Basis of Comparison, as described in Chapter 15, Recreation Resources. Therefore, it is anticipated that recreational economic factors would be reduced under the No Action Alternative as compared to the Second Basis of Comparison.

Effects Related to Cross Delta Water Transfers

Potential effects to socioeconomic factors could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c). Potential effects to socioeconomic factors were identified as adverse in the seller’s service area related to loss of income to farm workers and the associated agriculturally-related businesses and retail enterprises if crop idling methods were used to provide transfer water. The analysis also identified that local sales taxes could decline due to the loss of household income. If groundwater substitution was used to provide transfer water, agricultural production values could decline due to additional cost of pumping. However, income from the water transfer could increase operating income for the sellers. The regional impact would depend upon the extent of lands involved in the water transfer program in any specific year.

Under the No Action Alternative, the timing of cross Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Under the Second Basis of Comparison, water could be transferred throughout the year without an annual volumetric limit. Overall, the potential for cross Delta water transfers would be less under the No Action Alternative than under the Second Basis of Comparison.

19.4.3.1.3 San Francisco Bay Area Region

Regional Changes to Irrigated Agriculture

It is anticipated that as in the Central Valley Region, reductions in CVP and SWP water supplies within the San Francisco Bay Area Region would not result in reductions in long-term irrigated acreage or land use changes due to the use of other water supplies. However, there could be a reduction in irrigated acreage in dry and critical dry years under the No Action Alternative as compared to the Second Basis of Comparison.

Regional Changes to Municipal and Industrial Water Supplies

As described in Chapter 5, Surface Water Resources and Water Supplies, CVP and SWP water supplies would be less under the No Action Alternative than under the Second Basis of Comparison. The analysis assumed CVP and SWP water deliveries, as described in Chapter 5, and determined the need for new water supplies, changes in water storage and groundwater pumping, water transfers, water shortage costs, and excess water savings. The factors and basis of the analysis is described in detail in Appendix 19A, CWEST Model. The analysis assumes that no new annual transfer supplies would be implemented until shortages were greater than 5 percent. The costs of these shortages are included in the analysis.

The average annual water supply operating expenses over the 81-year hydrologic period for M&I water supplies would increase by $7.276 million, or 1.75 percent, as presented in Table 19.66; and therefore, the results would be similar under the No Action Alternative and Second Basis of Comparison.

Table 19.66 Changes in Municipal and Industrial Water Supply Costs for the San Francisco Bay Area Region under the No Action Alternative as Compared to the Second Basis of Comparison

Differences in Total	No Action Alternative	Second Basis of Comparison	Changes
Average Annual CVP/SWP Deliveries (TAF)	396	445	-48
Delivery Cost ($1,000)	$11,044	$12,515	-$1,471
Assumed New Supply Deliveries (TAF)	18	16	2
Annualized New Supply Costs ($1,000)	$599	$234	$365
Water Storage Costs ($1,000)	$1,577	$1,963	-$386
Lost Water Sales Revenues ($1,000)	$4,286	$1,595	$2,691
Transfer Costs ($1,000)	$5,722	$1,154	$4,568
Shortage Costs ($1,000)	$1,410	$523	$887
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) ($1,000)	-$493	-$792	$298
Excess Water Savings ($1,000)	-$225	-$549	$324
Average Annual Changes in Water Supply Costs ($1,000)	**$23,919**	**$16,643**	**$7,276**

Note: In 2012 dollars

The changes in M&I water supply costs would result in changes to employment and regional economic output, as summarized in Table 19.67.

Table 19.67 Changes in Municipal and Industrial Water Supply Related Employment and Regional Economic Output for the San Francisco Bay Area Region under the No Action Alternative as Compared to the Second Basis of Comparison

Economic Sectors	Employment				Economic Output ($ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	0.1	-7.9	-7.8
Mining & Logging	0	0	0	0	0.0	1.6	-5.0	-3.4
Construction	0	1	0	1	0.0	158.8	-37.1	121.7
Manufacturing	0	0	0	0	0.0	28.8	-478.0	-449.1
Transportation, Warehousing & Utilities	5	0	-1	4	1,492.4	11.2	-183.5	1,320.1
Wholesale Trade	0	0	-1	-1	0.0	5.0	-350.6	-345.7
Retail Trade	0	0	-6	-6	0.0	4.2	-567.2	-563.0
Information	0	0	-1	-1	0.0	16.8	-306.6	-289.8
Financial Activities	0	0	-5	-4	0.0	55.8	-1,740.5	-1,684.7
Services	0	1	-20	-19	0.0	133.7	-2,162.8	-2,029.1
Government	0	0	0	0	0.0	0.7	-55.1	-54.4
Total	**5**	**3**	**-35**	**-27**	**1,492.4**	**416.7**	**-5,894.3**	**-3,985.2**

Note: In 2012 dollars

Regional Changes to Recreational Opportunities

Changes in CVP and SWP water supplies and operations under the No Action Alternative as compared to the Second Basis of Comparison generally would result in lower reservoir elevations in reservoirs (up to 10 to 18 percent) that store CVP and SWP water; and would result in reduced recreational economic factors under the No Action Alternative as compared to the Second Basis of Comparison.

Regional Changes to Salmon Fishing

Changes in commercial and sport ocean salmon fishing primarily would be related to the presence of fall-run Chinook Salmon from Central Valley hatcheries. It is assumed that the production of hatchery fish would be similar under the No Action Alternative and the Second Basis of Comparison. However, survival of the fall-run Chinook Salmon hatchery fish to the Pacific Ocean could be related to changes in CVP and SWP operations. As described in Chapter 9, Fish and Aquatic Resources, there would be little change in through-Delta survival by emigrating natural juvenile fall-run Chinook Salmon under the No Action Alternative as compared to the Second Basis of Comparison. It is assumed that the survival of the hatchery juvenile fall-run Chinook Salmon would be similar to the survival of the natural juvenile fall-run Chinook Salmon. Therefore, the availability of fish for commercial and sport ocean salmon fishing and the associated economic conditions for the fishing industry would be similar under the No Action Alternative and the Second Basis of Comparison.

19.4.3.1.4 Central Coast Region

Regional Changes to Irrigated Agriculture

It is anticipated that as in the Central Valley Region, reductions in CVP and SWP water supplies within the Central Coast Region would not result in reductions in long-term irrigated acreage or land use changes due to the use of other water supplies. However, there could be a reduction in irrigated acreage in dry and critical dry years under the No Action Alternative as compared to the Second Basis of Comparison.

Regional Changes to Municipal and Industrial Water Supplies

As described in Chapter 5, Surface Water Resources and Water Supplies, CVP and SWP water supplies would be less under the No Action Alternative than under the Second Basis of Comparison. The analysis assumed CVP and SWP water deliveries, as described in Chapter 5, and determined the need for new water supplies, changes in water storage and groundwater pumping, water transfers, water shortage costs, and excess water savings. The factors and basis of the analysis is described in detail in Appendix 19A, CWEST Model. The analysis assumes that no new annual transfer supplies would be implemented until shortages were greater than 5 percent. The costs of these shortages are included in the analysis. It is assumed that some communities that do not have alternative water supplies would utilize water transfers.

The average annual water supply operating expenses over the 81-year hydrologic period for M&I water supplies would increase by 0.7 percent, as presented in Table 19.68; and therefore, the results would be similar under the No Action Alternative and Second Basis of Comparison.

Table 19.68 Changes in Municipal and Industrial Water Supply Costs for the Central Coast Region under the No Action Alternative as Compared to the Second Basis of Comparison

Differences in Total	No Action Alternative	Second Basis of Comparison	Changes
Average Annual CVP/SWP Deliveries (TAF)	44	54	-10
Delivery Cost ($1,000)	$6,663	$8,174	-$1,510
Assumed New Supply Deliveries (TAF)	0	0	0
Annualized New Supply Costs ($1,000)	$0	$0	$0
Water Storage Costs ($1,000)	$0	$0	$0
Lost Water Sales Revenues ($1,000)	$0	$0	$0
Transfer Costs ($1,000)	$0	$0	$0
Shortage Costs ($1,000)	$0	$0	$0
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) ($1,000)	-$8,068	-$8,643	$575
Excess Water Savings ($1,000)	-$2,970	-$4,176	$1,206
Average Annual Changes in Water Supply Costs ($1,000)	**-$4,374**	**-$4,645**	**$271**

Note: In 2012 dollars

The changes in M&I water supply costs would result in changes to employment and regional economic output, as summarized in Table 19.69.

Table 19.69 Changes in Municipal and Industrial Water Supply Related Employment and Regional Economic Output for the Central Coast Region under the No Action Alternative as Compared to the Second Basis of Comparison

Economic Sectors	Employment				Economic Output ($ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	0.6	-4.0	-3.4
Mining & Logging	0	0	0	0	0.0	6.4	-9.3	-2.9
Construction	0	2	0	2	0.0	201.9	-9.7	192.2
Manufacturing	0	0	0	0	0.0	26.8	-51.8	-25.0
Transportation, Warehousing & Utilities	6	0	0	6	1,510.8	17.0	-56.2	1,471.6
Wholesale Trade	0	0	0	0	0.0	4.8	-58.6	-53.8
Retail Trade	0	0	-1	-1	0.0	6.1	-118.5	-112.4
Information	0	0	0	0	0.0	12.0	-39.0	-27.0
Financial Activities	0	0	-1	-1	0.0	68.9	-352.0	-283.2
Services	0	2	-5	-3	0.0	167.1	-447.4	-280.3
Government	0	0	0	0	0.0	0.9	-13.2	-12.3
Total	**6**	**4**	**-8**	**2**	**1,510.8**	**512.7**	**-1,159.9**	**863.6**

Note: In 2012 dollars

Regional Changes to Recreational Opportunities

Changes in CVP and SWP water supplies and operations under the No Action Alternative as compared to the Second Basis of Comparison generally would result in lower reservoir elevations in reservoirs that store CVP and SWP water (up to 10 to 18 percent) that store CVP and SWP water; and would result in reduced recreational economic factors under the No Action Alternative as compared to the Second Basis of Comparison..

19.4.3.1.5 Southern California Region

Regional Changes to Irrigated Agriculture

It is anticipated that as in the Central Valley Region, reductions in CVP and SWP water supplies within the Southern California Region would not result in reductions in long-term irrigated acreage or land use changes due to the use of other water supplies. However, there could be a reduction in irrigated acreage in dry and critical dry years under the No Action Alternative as compared to the Second Basis of Comparison.

Regional Changes to Municipal and Industrial Water Supplies

As described in Chapter 5, Surface Water Resources and Water Supplies, CVP and SWP water supplies would be less under the No Action Alternative than under the Second Basis of Comparison. The analysis assumed CVP and SWP water deliveries, as described in Chapter 5, and determined the need for new water supplies, changes in water storage and groundwater pumping, water transfers, water shortage costs, and excess water savings. The factors and basis of the analysis is described in detail in Appendix 19A, CWEST Model. The analysis assumes that no new annual transfer supplies would be implemented until shortages were greater than 5 percent. The costs of these shortages are included in the analysis. It is assumed that some communities that do not have alternative water supplies would utilize water transfers.

The average annual water supply costs over the 81-year hydrologic period for M&I water supplies would increase by 2.14 percent, as presented in Table 19.70; and therefore, the results would be similar under the No Action Alternative and Second Basis of Comparison.

Table 19.70 Changes in Municipal and Industrial Water Supply Costs for the Southern California Region under the No Action Alternative as Compared to the Second Basis of Comparison

Differences in Total	No Action Alternative	Second Basis of Comparison	Changes
Average Annual CVP/SWP Deliveries (TAF)	1,932	2,394	-461
Delivery Cost ($1,000)	$239,692	$296,795	-$57,103
Assumed New Supply Deliveries (TAF)	47	11	35
Annualized New Supply Costs ($1,000)	$12,688	$4,032	$8,656
Water Storage Costs ($1,000)	$7,598	$2,824	$4,774
Lost Water Sales Revenues ($1,000)	$14,614	$1,119	$13,495
Transfer Costs ($1,000)	$11,484	$3,705	$7,779
Shortage Costs ($1,000)	$17,319	$353	$16,966
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) ($1,000)	-$57,474	-$91,507	$34,033
Excess Water Savings ($1,000)	-$4,629	-$10,573	$5,944
Average Annual Changes in Water Supply Costs ($1,000)	**$241,291**	**$206,749**	**$34,542**

Note: In 2012 dollars

The changes in M&I water supply costs would result in changes to employment and regional economic output, as summarized in Table 19.71.

Table 19.71 Changes in Municipal and Industrial Water Supply Related Employment and Regional Economic Output for the Southern California Region under the No Action Alternative as Compared to the Second Basis of Comparison

Economic Sectors	Employment				Economic Output ($ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	2	0	0.0	-12.5	272.7	260.2
Mining & Logging	0	-1	1	0	0.0	-164.2	369.0	204.8
Construction	0	-43	3	0	0.0	-5,205.5	395.5	-4,810.0
Manufacturing	0	-2	10	0	0.0	-1,452.6	6,814.5	5,361.9
Transportation, Warehousing & Utilities	-175	-2	12	-175	-43,673.4	-592.0	2,602.9	-41,662.5
Wholesale Trade	0	-1	20	0	0.0	-275.3	4,339.0	4,063.8
Retail Trade	0	-2	58	0	0.0	-170.6	5,106.3	4,935.7
Information	0	-1	6	0	0.0	-637.5	2,962.1	2,324.6
Financial Activities	0	-9	52	0	0.0	-2,528.7	17,797.9	15,269.1
Services	0	-46	212	0	0.0	-5,542.2	20,430.6	14,888.4
Government	0	0	3	0	0.0	-29.8	587.3	557.5
Total	**-175**	**-108**	**378**	**-175**	**-43,673.4**	**-16,611.0**	**61,677.8**	**1,393.5**

Note: In 2012 dollars

Regional Changes to Recreational Opportunities

Changes in CVP and SWP water supplies and operations under the No Action Alternative as compared to the Second Basis of Comparison generally would result in lower reservoir elevations in reservoirs that store CVP and SWP water, (up to 10 to 18 percent) that store CVP and SWP water; and would result in reduced recreational economic factors under the No Action Alternative as compared to the Second Basis of Comparison..

19.4.3.2 Alternative 1

As described in Chapter 3, Description of Alternatives, Alternative 1 is identical to the Second Basis of Comparison. As described in Chapter 4, Approach to Environmental Analysis, Alternative 1 as compared to the No Action Alternative and the Second Basis of Comparison. However, because socioeconomic factors under Alternative 1 are identical to socioeconomic factors under the Second Basis of Comparison; Alternative 1 is only compared to the No Action Alternative.

19.4.3.2.1 Alternative 1 Compared to the No Action Alternative

Trinity River Region

Regional Changes to Irrigated Agriculture

There are no agricultural lands irrigated with CVP and SWP water supplies in the Trinity River Region. Therefore, there would be no changes in irrigated lands under Alternative 1 as compared to the No Action Alternative.

Regional Changes to Municipal and Industrial Water Supplies

The CVP would continue to release water in Trinity River for downstream beneficial uses, including water supplies under Alternative 1 as compared to the No Action Alternative. There are no CVP or SWP water contractors in the Trinity River Region.

Regional Changes to Recreational Opportunities

Recreational opportunities would be similar in the Trinity River Region under Alternative 1 as compared to the No Action Alternative as described in Chapter 15, Recreational Resources.

Regional Changes to Salmon Fishing

Trinity River flows would be similar under Alternative 1 as compared to the No Action Alternative. This could result in similar salmon harvest conditions by the Yurok and Hoopa Valley tribes.

Central Valley Region

Regional Changes to Irrigated Agriculture

As described in Chapter 5, Surface Water Resources and Water Supplies, CVP and SWP water supplies would be greater under Alternative 1 as compared to the No Action Alternative. It is anticipated that groundwater use would decrease in response to increased CVP and SWP water supplies in 2030; and sustainable groundwater management plans would not be fully implemented until the 2040s, as discussed in Chapter 12, Agricultural Resources.

The agricultural production value under long-term average conditions would be increased by less than 1 percent ($1.6 million/year in the Sacramento Valley and $0.5 million/year in the San Joaquin Valley) primarily due to a decrease in groundwater pumping of approximately 7 percent. The agricultural production value under dry and critical dry conditions also would be increased by less than 1 percent ($11.3 million/year in the Sacramento Valley and $20.3 million/year in the San Joaquin Valley) primarily due to a decrease in groundwater pumping.

The overall increase in agricultural production values are less than 0.05 percent under long-term conditions; and, changes in employment and regional economic output would be minimal. Therefore, the analysis of employment and regional economic output is focused on dry and critical dry years.

The direct changes in agricultural production would result in changes to employment and regional economic output in the Sacramento and San Joaquin valleys, as summarized in Tables 19.72 and 19.73, respectively.

Table 19.72 Changes in Agricultural-Related Employment and Regional Economic Output for the Sacramento Valley under Alternative 1 as compared to the No Action Alternative in Dry and Critical Dry Years

Economic Sectors	Employment				Economic Output ($ millions)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	87	21	0	108	11.3	1.3	0	12.7
Mining & Logging	0	0	0	0	0	0	0	0
Construction	0	1	0	1	0	0.1	0	0.2
Manufacturing	0	0	0	0	0	0.1	0	0.1
Transportation, Warehousing & Utilities	0	1	0	2	0	0.4	0.1	0.5
Wholesale Trade	0	1	1	2	0	0.2	0.1	0.3
Retail Trade	0	0	4	4	0	0	0.3	0.3
Information	0	0	0	0	0	0	0.1	0.1
Financial Activities	0	7	2	9	0	1.6	0.8	2.5
Services	0	3	12	15	0	0.3	1	1.3
Government	0	0	0	0	0	0.1	0	0.1
Total	**87**	**36**	**19**	**142**	**11.3**	**4.2**	**2.5**	**18.1**

Note: In 2012 dollars.

Table 19.73 Changes in Agricultural-Related Employment and Regional Economic Output for the San Joaquin Valley under Alternative 1 as compared to the No Action Alternative in Dry and Critical Dry Years

Economic Sectors	Employment				Economic Output ($ millions)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	139	53	0	192	20.3	2.3	0.1	22.7
Mining & Logging	0	1	0	1	0	0.3	0	0.3
Construction	0	2	0	2	0	0.2	0	0.2
Manufacturing	0	1	0	2	0	1.8	0.3	2.1
Transportation, Warehousing & Utilities	0	3	1	4	0	0.8	0.2	1
Wholesale Trade	0	2	1	3	0	0.4	0.2	0.5
Retail Trade	0	0	7	8	0	0	0.6	0.6
Information	0	0	0	1	0	0.1	0.1	0.2
Financial Activities	0	12	3	15	0	2.7	1.5	4.1
Services	0	5	21	26	0	0.5	1.7	2.2
Government	0	1	0	1	0	0.2	0.1	0.3
Total	**139**	**79**	**35**	**254**	**20.3**	**9.2**	**4.9**	**34.4**

Note: In 2012 dollars.

As described in Chapter 11, Geology and Soils Resources, increased groundwater pumping under the long-term average conditions may result in an additional increment of subsidence in those areas within the Central Valley. The additional amount of subsidence and the economic costs associated with it have not been quantified in this EIS. However, total subsidence-related costs have been shown to be substantial, as reported by Borchers et al. (2014) who estimated that the cost of subsidence in San Joaquin Valley between 1955 and 1972 was more than $1.3 billion (in 2013 dollars). These estimates are based on the impacts to major infrastructure in the region including the San Joaquin River, Delta Mendota Canal, Friant-Kern Canal and San Luis Canal in addition to privately owned infrastructure. The incremental subsidence-related costs, expressed on an annual basis, could be an unknown fraction of that cumulative cost.

Regional Changes to Municipal and Industrial Water Supplies

As described in Chapter 5, Surface Water Resources and Water Supplies, CVP and SWP water supplies would increase under Alternative 1 as compared to the No Action Alternative. The analysis assumed CVP and SWP water deliveries, as described in Chapter 5, and determined the need for new water supplies, changes in water storage and groundwater pumping, water transfers, water shortage costs, and excess water savings. The factors and basis of the analysis are described in detail in Appendix 19A, CWEST Model. The analysis assumes that no new annual transfer supplies would be implemented until shortages were greater than 5 percent. The costs of these shortages are included in the analysis. It is assumed that some communities that do not have alternative water supplies would utilize water transfers.

The average annual water supply costs over the 81-year hydrologic period for M&I water supplies are presented in Tables 19.74 and 19.75 for the Sacramento and San Joaquin Valley, respectively. The average annual water supply operating expenses would decrease by 0.11 and 0.39 percent in the Sacramento Valley and the San Joaquin Valley, respectively; and therefore, the results would be similar under Alternative 1 and the No Action Alternative.

Table 19.74 Changes in Municipal and Industrial Water Supply Costs for the Sacramento Valley under Alternative 1 as compared to the No Action Alternative

Differences in Total	Alternative 1	No Action Alternative	Changes
Average Annual CVP/SWP Deliveries (TAF)	463	447	16
Delivery Cost ($1,000)	$8,317	$8,031	$287
Assumed New Supply Deliveries (TAF)	0	0	0
Annualized New Supply Costs ($1,000)	$0	$0	$0
Water Storage Costs ($1,000)	$0	$0	$0
Lost Water Sales Revenues ($1,000)	$207	$213	-$6
Transfer Costs ($1,000)	$517	$739	-$222
Shortage Costs ($1,000)	$68	$69	-$1
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) ($1,000)	-$3,916	-$3,858	-$58
Excess Water Savings ($1,000)	-$2,563	-$2,275	-$288
Average Annual Changes in Water Supply Costs ($1,000)	**$2,630**	**$2,919**	**-$288**

Note: In 2012 dollars

Table 19.75 Changes in Municipal and Industrial Water Supply Costs for the San Joaquin Valley under Alternative 1 as compared to the No Action Alternative

Differences in Total	Alternative 1	No Action Alternative	Changes
Average Annual CVP/SWP Deliveries (TAF)	237	214	23
Delivery Cost ($1,000)	$3,854	$3,460	$394
Assumed New Supply Deliveries (TAF)	0	2	-2
Annualized New Supply Costs ($1,000)	$15	$429	-$414
Water Storage Costs ($1,000)	$820	$942	-$122
Lost Water Sales Revenues ($1,000)	$322	$361	-$39
Transfer Costs ($1,000)	$2,623	$2,673	-$50
Shortage Costs ($1,000)	$102	$115	-$13
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) ($1,000)	-$16,011	-$15,377	-$634
Excess Water Savings ($1,000)	-$1,318	-$1,029	-$289
Average Annual Changes in Water Supply Costs ($1,000)	**-$9,593**	**-$8,427**	**-$1,166**

The changes in M&I water supply costs would result in changes to employment and regional economic output in the Sacramento and San Joaquin valleys, as summarized in Tables 19.76 and 19.77, respectively.

Table 19.76 Changes in Municipal and Industrial Water Supply Related Employment and Regional Economic Output for the Sacramento Valley under Alternative 1 as compared to the No Action Alternative

Economic Sectors	Employment				Economic Output ($ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	-0.1	1.7	1.6
Mining & Logging	0	0	0	0	0.0	-0.4	0.3	-0.1
Construction	0	0	0	0	0.0	-29.0	2.5	-26.5
Manufacturing	0	0	0	0	0.0	-3.1	22.2	19.1
Transportation, Warehousing & Utilities	-1	0	0	-1	-286.4	-2.8	18.0	-271.2
Wholesale Trade	0	0	0	0	0.0	-1.0	27.1	26.1
Retail Trade	0	0	1	1	0.0	-0.9	46.6	45.6
Information	0	0	0	0	0.0	-3.4	20.6	17.2
Financial Activities	0	0	0	0	0.0	-13.0	147.7	134.6
Services	0	0	2	-1	0.0	-30.8	154.7	123.9
Government	0	0	0	0	0.0	-0.2	3.8	3.7
Total	**-1**	**-1**	**3**	**-1**	**-286.4**	**-84.8**	**445.2**	**74.0**

Note: In 2012 dollars

Table 19.77 Changes in Municipal and Industrial Water Supply Related Employment and Regional Economic Output for the San Joaquin Valley under Alternative 1 as compared to the No Action Alternative

Economic Sectors	Employment				Economic Output ($ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	0.0	6.7	6.7
Mining & Logging	0	0	0	0	0.0	0.4	6.4	6.8
Construction	0	0	0	0	0.0	13.3	5.6	18.9
Manufacturing	0	0	0	0	0.0	1.4	46.4	47.8
Transportation, Warehousing & Utilities	1	0	0	1	140.8	1.4	44.7	186.9
Wholesale Trade	0	0	0	0	0.0	0.4	39.0	39.3
Retail Trade	0	0	1	1	0.0	0.4	97.4	97.8
Information	0	0	0	0	0.0	1.0	27.0	28.0
Financial Activities	0	0	1	1	0.0	4.3	263.7	268.0
Services	0	0	3	3	0.0	11.7	292.3	303.9
Government	0	0	0	0	0.0	0.1	12.9	13.0
Total	**1**	**0**	**6**	**7**	**140.8**	**34.3**	**842.0**	**1,017.2**

Note: In 2012 dollars

Regional Changes to Recreational Opportunities

Recreational opportunities would increase at San Luis Reservoir by 6 percent under Alternative 1 as compared to the No Action Alternative, as described in Chapter 15, Recreation Resources. Therefore, it is anticipated that recreational economic factors would be increased under Alternative 1 as compared to the No Action Alternative.

Effects Related to Cross Delta Water Transfers

Potential effects to socioeconomic factors could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions would occur during implementation of cross Delta water transfers under Alternative 1 and the No Action Alternative, and that impacts on socioeconomic factors could be adverse in the seller's service area.

Under Alternative 1, water could be transferred throughout the year without an annual volumetric limit. Under the No Action Alternative, the timing of cross Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Overall, the potential for cross Delta water transfers would be increased under Alternative 1 as compared to the No Action Alternative.

San Francisco Bay Area Region

Regional Changes to Irrigated Agriculture

It is anticipated that as in the Central Valley Region, increases in CVP and SWP water supplies within the San Francisco Bay Area Region would not result in changes in long-term irrigated acreage or land use changes due to the use of other water supplies. However, there could be an increase in irrigated acreage in dry and critical dry years under Alternative 1 as compared to the No Action Alternative.

Regional Changes to Municipal and Industrial Water Supplies

As described in Chapter 5, Surface Water Resources and Water Supplies, CVP and SWP water supplies would increase under Alternative 1 as compared to the No Action Alternative. The analysis assumed CVP and SWP water deliveries, as described in Chapter 5, and determined the need for new water supplies, changes in water storage and groundwater pumping, water transfers, water shortage costs, and excess water savings. The factors and basis of the analysis is described in detail in Appendix 19A, CWEST Model. The analysis assumes that no new annual transfer supplies would be implemented until shortages were greater than 5 percent. The costs of these shortages are included in the analysis.

The average annual water supply operating expenses over the 81-year hydrologic period for M&I water supplies would decrease by 1.75 percent, as presented in Table 19.78; and therefore, the results would be similar under Alternative 1 and the No Action Alternative.

Table 19.78 Changes in Municipal and Industrial Water Supply Costs for the San Francisco Bay Area Region under Alternative 1 as compared to the No Action Alternative

Differences in Total	Alternative 1	No Action Alternative	Changes
Average Annual CVP/SWP Deliveries (TAF)	445	396	48
Delivery Cost ($1,000)	$12,515	$11,044	$1,471
Assumed New Supply Deliveries (TAF)	16	18	-2
Annualized New Supply Costs ($1,000)	$234	$599	-$365
Water Storage Costs ($1,000)	$1,963	$1,577	$386
Lost Water Sales Revenues ($1,000)	$1,595	$4,286	-$2,691
Transfer Costs ($1,000)	$1,154	$5,722	-$4,568
Shortage Costs ($1,000)	$523	$1,410	-$887
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) ($1,000)	-$792	-$493	-$298
Excess Water Savings ($1,000)	-$549	-$225	-$324
Average Annual Changes in Water Supply Costs ($1,000)	**$16,643**	**$23,919**	**-$7,276**

Note: In 2012 dollars

The changes in M&I water supply costs would result in changes to employment and regional economic output, as summarized in Table 19.79.

Table 19.79 Changes in Municipal and Industrial Water Supply Related Employment and Regional Economic Output for the San Francisco Bay Area Region under Alternative 1 as compared to the No Action Alternative

Economic Sectors	Employment				Economic Output ($ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	-0.1	7.9	7.8
Mining & Logging	0	0	0	0	0.0	-1.6	5.0	3.4
Construction	0	-1	0	-1	0.0	-158.8	37.1	-121.7
Manufacturing	0	0	0	0	0.0	-28.8	478.0	449.1
Transportation, Warehousing & Utilities	-5	0	1	-4	-1,492.4	-11.2	183.5	-1,320.1
Wholesale Trade	0	0	1	1	0.0	-5.0	350.6	345.7
Retail Trade	0	0	6	6	0.0	-4.2	567.2	563.0
Information	0	0	1	1	0.0	-16.8	306.6	289.8
Financial Activities	0	0	5	4	0.0	-55.8	1,740.5	1,684.7
Services	0	-1	20	19	0.0	-133.7	2,162.8	2,029.1
Government	0	0	0	0	0.0	-0.7	55.1	54.4
Total	**-5**	**-3**	**35**	**27**	**-1,492.4**	**-416.7**	**5,894.3**	**3,985.2**

Note: In 2012 dollars

Regional Changes to Recreational Opportunities

Changes in CVP and SWP water supplies and operations under Alternative 1 as compared to the No Action Alternative generally would result in higher reservoir elevations in reservoirs that store CVP and SWP water (up to 11 to 21 percent); and would result in increased recreational economic factors under Alternative 1 as compared to the No Action Alternative.

Regional Changes to Salmon Fishing

Changes in commercial and sport ocean salmon fishing primarily would be related to the presence of fall-run Chinook Salmon from Central Valley hatcheries. It is assumed that the production of hatchery fish would be similar under Alternative 1 and the No Action Alternative. However, survival of the fall-run Chinook Salmon hatchery fish to the Pacific Ocean could be related to changes in CVP and SWP operations. As described in Chapter 9, Fish and Aquatic Resources, there would be little change in through-Delta survival by emigrating natural juvenile fall-run Chinook Salmon under Alternative 1 and the No Action Alternative. It is assumed that the survival of the hatchery juvenile fall-run Chinook Salmon would be similar to the survival of the natural juvenile fall-run Chinook Salmon. Therefore, the availability of fish for commercial and sport ocean salmon fishing and the associated economic conditions for the fishing industry would be similar under Alternative 1 and the No Action Alternative.

Central Coast Region

Regional Changes to Irrigated Agriculture

It is anticipated that as in the Central Valley Region, increases in CVP and SWP water supplies within the Central Coast Region would not result in increases in long-term irrigated acreage or land use changes due to the use of other water supplies. However, there could be increased irrigated acreage in dry and critical dry years under Alternative 1 as compared to the No Action Alternative.

Regional Changes to Municipal and Industrial Water Supplies

As described in Chapter 5, Surface Water Resources and Water Supplies, CVP and SWP water supplies would be higher under Alternative 1 as compared to the No Action Alternative. The analysis assumed CVP and SWP water deliveries, as described in Chapter 5, and determined the need for new water supplies, changes in water storage and groundwater pumping, water transfers, water shortage costs, and excess water savings. The factors and basis of the analysis is described in detail in Appendix 19A, CWEST Model. The analysis assumes that no new annual transfer supplies would be implemented until shortages were greater than 5 percent. The costs of these shortages are included in the analysis. It is assumed that some communities that do not have alternative water supplies would utilize water transfers.

The average annual water supply operating expenses over the 81-year hydrologic period for M&I water supplies would increase 0.7 percent, as presented in Table 19.80; and therefore, the results would be similar under Alternative 1 and the No Action Alternative.

Table 19.80 Changes in Municipal and Industrial Water Supply Costs for the Central Coast Region under Alternative 1 as compared to the No Action Alternative

Differences in Total	Alternative 1	No Action Alternative	Changes
Average Annual CVP/SWP Deliveries (TAF)	54	44	10
Delivery Cost ($1,000)	$8,174	$6,663	$1,510
Assumed New Supply Deliveries (TAF)	0	0	0
Annualized New Supply Costs ($1,000)	$0	$0	$0
Water Storage Costs ($1,000)	$0	$0	$0
Lost Water Sales Revenues ($1,000)	$0	$0	$0
Transfer Costs ($1,000)	$0	$0	$0
Shortage Costs ($1,000)	$0	$0	$0
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) ($1,000)	-$8,643	-$8,068	-$575
Excess Water Savings ($1,000)	-$4,176	-$2,970	-$1,206
Average Annual Changes in Water Supply Costs ($1,000)	**-$4,645**	**-$4,374**	**-$271**

Note: In 2012 dollars

The changes in M&I water supply costs would result in changes to employment and regional economic output, as summarized in Table 19.81.

Table 19.81 Changes in Municipal and Industrial Water Supply Related Employment and Regional Economic Output for the Central Coast Region under Alternative 1 as compared to the No Action Alternative

Economic Sectors	Employment				Economic Output ($ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	-0.6	4.0	3.4
Mining & Logging	0	0	0	0	0.0	-6.4	9.3	2.9
Construction	0	-2	0	-2	0.0	-201.9	9.7	-192.2
Manufacturing	0	0	0	0	0.0	-26.8	51.8	25.0
Transportation, Warehousing & Utilities	-6	0	0	-6	-1,510.8	-17.0	56.2	-1,471.6
Wholesale Trade	0	0	0	0	0.0	-4.8	58.6	53.8
Retail Trade	0	0	1	1	0.0	-6.1	118.5	112.4
Information	0	0	0	0	0.0	-12.0	39.0	27.0
Financial Activities	0	0	1	1	0.0	-68.9	352.0	283.2
Services	0	-2	5	3	0.0	-167.1	447.4	280.3
Government	0	0	0	0	0.0	-0.9	13.2	12.3
Total	**-6**	**-4**	**8**	**-2**	**-1,510.8**	**-512.7**	**1,159.9**	**-863.6**

Note: In 2012 dollars

Regional Changes to Recreational Opportunities

Changes in CVP and SWP water supplies and operations under Alternative 1 as compared to the No Action Alternative generally would result in higher reservoir elevations in reservoirs that store CVP and SWP water (up to 11 to 21 percent); and would result in increased recreational economic factors under Alternative 1 as compared to the No Action Alternative.

Southern California Region

Regional Changes to Irrigated Agriculture

It is anticipated that as in the Central Valley Region, increases in CVP and SWP water supplies within the Southern California Region would not result in increases in long-term irrigated acreage or land use changes due to the use of other water supplies. However, there could be increased irrigated acreage in dry and critical dry years under Alternative 1 as compared to the No Action Alternative.

Regional Changes to Municipal and Industrial Water Supplies

As described in Chapter 5, Surface Water Resources and Water Supplies, CVP and SWP water supplies would be higher under Alternative 1 as compared to the No Action Alternative. The analysis assumed CVP and SWP water deliveries, as described in Chapter 5, and determined the need for new water supplies, changes in water storage and groundwater pumping, water transfers, water shortage costs, and excess water savings. The factors and basis of the analysis is described in detail in Appendix 19A, CWEST Model. The analysis assumes that no new annual transfer supplies would be implemented until shortages were greater than 5 percent. The costs of these shortages are included in the analysis. It is assumed that some communities that do not have alternative water supplies would utilize water transfers.

The average annual water supply operating expenses over the 81-year hydrologic period for M&I water supplies would decrease 2.14 percent, as presented in Table 19.82; and therefore, the results would be similar under Alternative 1 and the No Action Alternative.

Table 19.82 Changes in Municipal and Industrial Water Supply Costs for the Southern California Region under Alternative 1 as compared to the No Action Alternative

Differences in Total	Alternative 1	No Action Alternative	Changes
Average Annual CVP/SWP Deliveries (TAF)	2,394	1,932	461
Delivery Cost ($1,000)	$296,795	$239,692	$57,103
Assumed New Supply Deliveries (TAF)	11	47	-35
Annualized New Supply Costs ($1,000)	$4,032	$12,688	-$8,656
Water Storage Costs ($1,000)	$2,824	$7,598	-$4,774
Lost Water Sales Revenues ($1,000)	$1,119	$14,614	-$13,495
Transfer Costs ($1,000)	$3,705	$11,484	-$7,779
Shortage Costs ($1,000)	$353	$17,319	-$16,966
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) ($1,000)	-$91,507	-$57,474	-$34,033
Excess Water Savings ($1,000)	-$10,573	-$4,629	-$5,944
Average Annual Changes in Water Supply Costs ($1,000)	**$206,749**	**$241,291**	**-$34,542**

Note: In 2012 dollars

The changes in M&I water supply costs would result in changes to employment and regional economic output, as summarized in Table 19.83.

Table 19.83 Changes in Municipal and Industrial Water Supply Related Employment and Regional Economic Output for the Southern California Region under Alternative 1 as compared to the No Action Alternative

Economic Sectors	Employment				Economic Output ($ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	-2	-1	0.0	12.5	-272.7	-260.2
Mining & Logging	0	1	-1	-1	0.0	164.2	-369.0	-204.8
Construction	0	43	-3	40	0.0	5,205.5	-395.5	4,810.0
Manufacturing	0	2	-10	-8	0.0	1,452.6	-6,814.5	-5,361.9
Transportation, Warehousing & Utilities	175	2	-12	166	43,673.4	592.0	-2,602.9	41,662.5
Wholesale Trade	0	1	-20	-19	0.0	275.3	-4,339.0	-4,063.8
Retail Trade	0	2	-58	-56	0.0	170.6	-5,106.3	-4,935.7
Information	0	1	-6	-5	0.0	637.5	-2,962.1	-2,324.6
Financial Activities	0	9	-52	-43	0.0	2,528.7	-17,797.9	-15,269.1
Services	0	46	-212	-166	0.0	5,542.2	-20,430.6	-14,888.4
Government	0	0	-3	-3	0.0	29.8	-587.3	-557.5
Total	**175**	**108**	**-378**	**-95**	**43,673.4**	**16,611.0**	**-61,677.8**	**-1,393.5**

Note: In 2012 dollars

Regional Changes to Recreational Opportunities

Changes in CVP and SWP water supplies and operations under Alternative 1 as compared to the No Action Alternative generally would result in higher reservoir elevations in reservoirs that store CVP and SWP water (up to 11 to 21 percent); and would result in increased recreational economic factors under Alternative 1 as compared to the No Action Alternative.

19.4.3.2.2 Alternative 1 Compared to the Second Basis of Comparison

As described in Chapter 3, Description of Alternatives, Alternative 1 is identical to the Second Basis of Comparison.

19.4.3.3 Alternative 2

The CVP and SWP operations under Alternative 2 are identical to the CVP and SWP operations under the No Action Alternative, therefore, Alternative 2 is only compared to the Second Basis of Comparison.

19.4.3.3.1 Alternative 2 Compared to the Second Basis of Comparison

The CVP and SWP operations under Alternative 2 are identical to the CVP and SWP operations under the No Action Alternative. Therefore, changes to socioeconomic factors under Alternatives 2 as compared to the Second Basis of Comparison would be the same as the impacts described in Section 12.4.3.1, No Action Alternative.

19.4.3.4 Alternative 3

As described in Chapter 3, Description of Alternatives, CVP and SWP operations under Alternative 3 are similar to the Second Basis of Comparison with modified Old and Middle River flow criteria and New Melones Reservoir operations and reductions in Striped Bass fishing opportunities. As described in Chapter 4, Approach to Environmental Analysis, Alternative 3 is compared to the No Action Alternative and the Second Basis of Comparison.

19.4.3.4.1 Alternative 3 Compared to the No Action Alternative

Trinity River Region

Regional Changes to Irrigated Agriculture

There are no agricultural lands irrigated with CVP and SWP water supplies in the Trinity River Region. Therefore, there would be no changes in irrigated lands under Alternative 3 as compared to the No Action Alternative.

Regional Changes to Municipal and Industrial Water Supplies

The CVP would continue to release water in Trinity River for downstream beneficial uses, including water supplies under Alternative 3 as compared to the No Action Alternative. There are no CVP or SWP water contractors in the Trinity River Region.

Regional Changes to Recreational Opportunities

Recreational opportunities would be similar in the Trinity River Region under Alternative 3 as compared to the No Action Alternative as described in Chapter 15, Recreational Resources.

Regional Changes to Salmon Fishing

Trinity River flows would be similar under Alternative 3 as compared to the No Action Alternative. This could result in similar salmon harvest conditions by the Yurok and Hoopa Valley tribes.

Central Valley Region

Regional Changes to Irrigated Agriculture

As described in Chapter 5, Surface Water Resources and Water Supplies, CVP and SWP water supplies would be greater under Alternative 3 as compared to the No Action Alternative. It is anticipated that groundwater use would decrease in response to increased CVP and SWP water supplies in 2030; and sustainable groundwater management plans would not be fully implemented until the 2040s, as discussed in Chapter 12, Agricultural Resources.

The agricultural production value under long-term average conditions would be increased by less than 1 percent ($1.2 million/year in the Sacramento Valley and $0.3 million/year in the San Joaquin Valley) primarily due to a decrease in groundwater pumping of approximately 4 percent. The agricultural production value under dry and critical dry conditions also would be increased by less than 1 percent ($9.2 million/year in the Sacramento Valley and $11.4 million/year in the San Joaquin Valley), primarily due to a decrease in groundwater pumping.

The overall increase in agricultural production values are less than 0.05 percent under long-term conditions; and, changes in employment and regional economic output would be minimal. Therefore, the analysis of employment and regional economic output is focused on dry and critical dry years.

The direct changes in agricultural production would result in changes to employment and regional economic output in the Sacramento and San Joaquin valleys, as summarized in Tables 19.84 and 19.85, respectively.

Table 19.84 Changes in Agricultural-Related Employment and Regional Economic Output for the Sacramento Valley under Alternative 3 as compared to the No Action Alternative in Dry and Critical Dry Years

Economic Sectors	Employment				Economic Output ($ millions)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	69	18	0	86	9.2	1.1	0.0	10.3
Mining & Logging	0	0	0	0	0.0	0.0	0.0	0.0
Construction	0	1	0	1	0.0	0.1	0.0	0.1
Manufacturing	0	0	0	0	0.0	0.1	0.0	0.1
Transportation, Warehousing & Utilities	0	1	0	1	0.0	0.3	0.1	0.4
Wholesale Trade	0	1	0	1	0.0	0.2	0.1	0.3
Retail Trade	0	0	3	3	0.0	0.0	0.3	0.3
Information	0	0	0	0	0.0	0.0	0.1	0.1
Financial Activities	0	5	2	7	0.0	1.3	0.7	2.0
Services	0	3	10	13	0.0	0.2	0.9	1.1
Government	0	0	0	0	0.0	0.1	0.0	0.1
Total	**69**	**29**	**17**	**115**	**9.2**	**3.4**	**2.2**	**14.8**

Note: In 2012 dollars

Table 19.85 Changes in Agricultural-Related Employment and Regional Economic Output for the San Joaquin Valley under Alternative 3 as compared to the No Action Alternative in Dry and Critical Dry Years

Economic Sectors	Employment				Economic Output ($ millions)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	103	26	0	130	11.4	1.2	0.0	12.7
Mining & Logging	0	1	0	1	0.0	0.2	0.0	0.2
Construction	0	1	0	1	0.0	0.1	0.0	0.1
Manufacturing	0	1	0	1	0.0	1.2	0.1	1.3
Transportation, Warehousing & Utilities	0	2	0	2	0.0	0.5	0.1	0.6
Wholesale Trade	0	1	0	1	0.0	0.2	0.1	0.3
Retail Trade	0	0	3	3	0.0	0.0	0.3	0.3
Information	0	0	0	0	0.0	0.0	0.1	0.1
Financial Activities	0	8	1	10	0.0	1.8	0.6	2.5
Services	0	3	9	12	0.0	0.3	0.7	1.0
Government	0	0	0	1	0.0	0.1	0.0	0.1
Total	103	44	15	161	11.4	5.7	2.1	19.1

Note: In 2012 dollars

As described in Chapter 11, Geology and Soils Resources, increased groundwater pumping under the long-term average conditions may result in an additional increment of subsidence in those areas within the Central Valley. The additional amount of subsidence and the economic costs associated with it have not been quantified in this EIS. However, total subsidence-related costs have been shown to be substantial, as reported by Borchers et al. (2014) who estimated that the cost of subsidence in San Joaquin Valley between 1955 and 1972 was more than $1.3 billion (in 2013 dollars). These estimates are based on the impacts to major infrastructure in the region including the San Joaquin River, Delta Mendota Canal, Friant-Kern Canal and San Luis Canal in addition to privately owned infrastructure. The incremental subsidence-related costs, expressed on an annual basis, could be an unknown fraction of that cumulative cost.

Regional Changes to Municipal and Industrial Water Supplies

As described in Chapter 5, Surface Water Resources and Water Supplies, CVP and SWP water supplies would increase under Alternative 3 as compared to the No Action Alternative. The analysis assumed CVP and SWP water deliveries, as described in Chapter 5, and determined the need for new water supplies, changes in water storage and groundwater pumping, water transfers, water shortage costs, and excess water savings. The factors and basis of the analysis is described in detail in Appendix 19A, CWEST Model. The analysis assumes that no new annual transfer supplies would be implemented until shortages were greater than 5 percent. The costs of these shortages are included in the analysis. It is assumed that some communities that do not have alternative water supplies would utilize water transfers.

The average annual water supply costs over the 81-year hydrologic period for M&I water supplies are presented in Tables 19.86 and 19.87 for the Sacramento and San Joaquin Valley, respectively. Average annual water supply operating expenses would decrease by 0.07 and 0.5 percent in the Sacramento Valley and the San Joaquin Valley, respectively; and therefore, the results would be similar under Alternative 3 and the No Action Alternative.

Table 19.86 Changes in Municipal and Industrial Water Supply Costs for the Sacramento Valley under Alternative 3 as compared to the No Action Alternative

Differences in Total	Alternative 3	No Action Alternative	Changes
Average Annual CVP/SWP Deliveries (TAF)	461	447	13
Delivery Cost ($1,000)	$8,285	$8,031	$255
Assumed New Supply Deliveries (TAF)	0	0	0
Annualized New Supply Costs ($1,000)	$0	$0	$0
Water Storage Costs ($1,000)	$0	$0	$0
Lost Water Sales Revenues ($1,000)	$243	$213	$30
Transfer Costs ($1,000)	$601	$739	-$138
Shortage Costs ($1,000)	$77	$69	$8
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) ($1,000)	-$3,938	-$3,858	-$81
Excess Water Savings ($1,000)	-$2,517	-$2,275	-$241
Average Annual Changes in Water Supply Costs ($1,000)	**$2,750**	**$2,919**	**-$169**

Note: In 2012 dollars

Table 19.87 Changes in Municipal and Industrial Water Supply Costs for the San Joaquin Valley under Alternative 3 as compared to the No Action Alternative

Differences in Total	Alternative 3	No Action Alternative	Changes
Average Annual CVP/SWP Deliveries (TAF)	241	214	27
Delivery Cost ($1,000)	$3,896	$3,460	$436
Assumed New Supply Deliveries (TAF)	0	2	-2
Annualized New Supply Costs ($1,000)	$13	$429	-$417
Water Storage Costs ($1,000)	$465	$942	-$477
Lost Water Sales Revenues ($1,000)	$284	$361	-$78
Transfer Costs ($1,000)	$2,104	$2,673	-$568
Shortage Costs ($1,000)	$89	$115	-$26
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) ($1,000)	-$15,660	-$15,377	-$283
Excess Water Savings ($1,000)	-$1,378	-$1,029	-$349
Average Annual Changes in Water Supply Costs ($1,000)	**-$10,187**	**-$8,427**	**-$1,761**

Note: In 2012 dollars

The changes in M&I water supply costs would result in changes to employment and regional economic output in the Sacramento and San Joaquin valleys, as summarized in Tables 19.88 and 19.89, respectively.

Table 19.88 Changes in Municipal and Industrial Water Supply Related Employment and Regional Economic Output for the Sacramento Valley under Alternative 3 as compared to the No Action Alternative

Economic Sectors	Employment				Economic Output ($ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	0.1	-1.2	-1.1
Mining & Logging	0	0	0	0	0.0	0.4	-0.2	0.2
Construction	0	0	0	0	0.0	25.8	-1.8	23.9
Manufacturing	0	0	0	0	0.0	2.8	-16.2	-13.5
Transportation, Warehousing & Utilities	1	0	0	1	254.4	2.5	-13.1	243.7
Wholesale Trade	0	0	0	0	0.0	0.9	-20.0	-19.1
Retail Trade	0	0	0	0	0.0	0.8	-33.8	-33.0
Information	0	0	0	0	0.0	3.0	-15.1	-12.1
Financial Activities	0	0	0	0	0.0	11.6	-107.7	-96.1
Services	0	0	-1	-1	0.0	27.4	-112.8	-85.4
Government	0	0	0	0	0.0	0.1	-2.8	-2.7
Total	**1**	**1**	**-2**	**0**	**254.4**	**75.3**	**-324.8**	**4.9**

Note: In 2012 dollars

Table 19.89 Changes in Municipal and Industrial Water Supply Related Employment and Regional Economic Output for the San Joaquin Valley under Alternative 3 as compared to the No Action Alternative

Economic Sectors	Employment				Economic Output ($ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	-0.2	-8.9	-9.1
Mining & Logging	0	0	0	0	0.0	-1.2	-8.5	-9.7
Construction	0	0	0	0	0.0	-43.3	-7.4	-50.7
Manufacturing	0	0	0	0	0.0	-4.4	-62.0	-66.3
Transportation, Warehousing & Utilities	-2	0	0	-2	-457.3	-4.4	-59.6	-521.3
Wholesale Trade	0	0	0	0	0.0	-1.2	-51.6	-52.8
Retail Trade	0	0	-2	-2	0.0	-1.3	-130.7	-132.0
Information	0	0	0	0	0.0	-3.2	-36.0	-39.2
Financial Activities	0	0	-1	-1	0.0	-14.1	-352.2	-366.3
Services	0	0	-5	-5	0.0	-38.0	-391.1	-429.1
Government	0	0	0	0	0.0	-0.3	-17.2	-17.5
Total	**-2**	**-1**	**-8**	**-11**	**-457.3**	**-111.6**	**-1,125.2**	**-1,694.1**

Note: In 2012 dollars

Regional Changes to Recreational Opportunities

Recreational opportunities would be similar at San Luis Reservoir under Alternative 3 as compared to the No Action Alternative, as described in Chapter 15, Recreation Resources. Recreational opportunities related to Striped Bass fishing would initially be increased when Alternative 3 is implemented.

However, by 2030, Striped Bass fishing opportunities would be reduced under Alternative 3 as compared to the Second Basis of Comparison due to actions to reduce predation. Therefore, it is anticipated that recreational economic factors would be reduced under Alternative 3 as compared to the No Action Alternative.

Effects Related to Cross Delta Water Transfers

Potential effects to socioeconomic factors could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions would occur during implementation of cross Delta water transfers under Alternative 3 and the No Action Alternative, and that impacts on socioeconomic factors could be adverse in the seller’s service area.

Under Alternative 3, water could be transferred throughout the year without an annual volumetric limit. Under the No Action Alternative, the timing of cross Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Overall, the potential for cross Delta water transfers would be increased under Alternative 3 as compared to the No Action Alternative.

San Francisco Bay Area Region

Regional Changes to Irrigated Agriculture

It is anticipated that as in the Central Valley Region, increases in CVP and SWP water supplies within the San Francisco Bay Area Region would not result in changes in long-term irrigated acreage or land use changes due to the use of other water supplies. However, there could be an increase in irrigated acreage in dry and critical dry years under Alternative 3 as compared to the No Action Alternative.

Regional Changes to Municipal and Industrial Water Supplies

As described in Chapter 5, Surface Water Resources and Water Supplies, CVP and SWP water supplies would increase under Alternative 3 as compared to the No Action Alternative. The analysis assumed CVP and SWP water deliveries, as described in Chapter 5, and determined the need for new water supplies, changes in water storage and groundwater pumping, water transfers, water shortage costs, and excess water savings. The factors and basis of the analysis is described in detail in Appendix 19A, CWEST Model. The analysis assumes that no new annual transfer supplies would be implemented until shortages were greater than 5 percent. The costs of these shortages are included in the analysis.

The average annual water supply operating expenses over the 81-year hydrologic period for M&I water supplies would decrease by 1.23 percent, as presented in Table 19.90; and therefore, the results would be similar under Alternative 3 and the No Action Alternative.

Table 19.90 Changes in Municipal and Industrial Water Supply Costs for the San Francisco Bay Area Region under Alternative 3 as compared to the No Action Alternative

Differences in Total	Alternative 3	No Action Alternative	Changes
Average Annual CVP/SWP Deliveries (TAF)	431	396	34
Delivery Cost ($1,000)	$12,096	$11,044	$1,052
Assumed New Supply Deliveries (TAF)	18	18	0
Annualized New Supply Costs ($1,000)	$575	$599	-$24
Water Storage Costs ($1,000)	$2,303	$1,577	$726
Lost Water Sales Revenues ($1,000)	$2,381	$4,286	-$1,905
Transfer Costs ($1,000)	$1,826	$5,722	-$3,896
Shortage Costs ($1,000)	$743	$1,410	-$667
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) ($1,000)	-$726	-$493	-$232
Excess Water Savings ($1,000)	-$393	-$225	-$167
Average Annual Changes in Water Supply Costs ($1,000)	**$18,806**	**$23,919**	**-$5,113**

Note: In 2012 dollars

The changes in M&I water supply costs would result in changes to employment and regional economic output, as summarized in Table 19.91.

Table 19.91 Changes in Municipal and Industrial Water Supply Related Employment and Regional Economic Output for the San Francisco Bay Area Region under Alternative 3 as compared to the No Action Alternative

Economic Sectors	Employment				Economic Output ($ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	0.1	-6.0	-5.9
Mining & Logging	0	0	0	0	0.0	1.9	-3.8	-1.9
Construction	0	1	0	1	0.0	186.7	-28.2	158.6
Manufacturing	0	0	0	0	0.0	33.9	-363.5	-329.6
Transportation, Warehousing & Utilities	6	0	-1	5	1,754.5	13.2	-139.1	1,628.6
Wholesale Trade	0	0	-1	-1	0.0	5.8	-268.7	-262.9
Retail Trade	0	0	-5	-5	0.0	4.9	-428.6	-423.7
Information	0	0	0	0	0.0	19.8	-233.1	-213.4
Financial Activities	0	0	-3	-3	0.0	65.6	-1,320.3	-1,254.7
Services	0	1	-15	-14	0.0	157.2	-1,639.6	-1,482.4
Government	0	0	0	0	0.0	0.8	-41.8	-41.0
Total	**6**	**3**	**-26**	**-17**	**1,754.5**	**489.9**	**-4,472.7**	**-2,228.3**

Note: In 2012 dollars

Regional Changes to Recreational Opportunities

Changes in CVP and SWP water supplies and operations under Alternative 3 as compared to the No Action Alternative generally would result in higher reservoir elevations in reservoirs that store CVP and SWP water (up to 9 to 17 percent);

and would result in increased recreational economic factors under Alternative 3 as compared to the No Action Alternative.

Regional Changes to Salmon Fishing

Commercial and sport ocean salmon fishing would be reduced under Alternative 3 and the No Action Alternative due to increased commercial and sport ocean salmon harvests limits.

Central Coast Region

Regional Changes to Irrigated Agriculture

It is anticipated that as in the Central Valley Region, increases in CVP and SWP water supplies within the Central Coast Region would not result in increases in long-term irrigated acreage or land use changes due to the use of other water supplies. However, there could be increased irrigated acreage in dry and critical dry years under Alternative 3 as compared to the No Action Alternative.

Regional Changes to Municipal and Industrial Water Supplies

As described in Chapter 5, Surface Water Resources and Water Supplies, CVP and SWP water supplies would be higher under Alternative 3 as compared to the No Action Alternative. The analysis assumed CVP and SWP water deliveries, as described in Chapter 5, and determined the need for new water supplies, changes in water storage and groundwater pumping, water transfers, water shortage costs, and excess water savings. The factors and basis of the analysis is described in detail in Appendix 19A, CWEST Model. The analysis assumes that no new annual transfer supplies would be implemented until shortages were greater than 5 percent. The costs of these shortages are included in the analysis. It is assumed that some communities that do not have alternative water supplies would utilize water transfers.

The average annual water supply operating expenses over the 81-year hydrologic period for M&I water supplies would decrease by $125,000, or 0.33 percent, as presented in Table 19.92; and therefore, the results would be similar under Alternative 3 and the No Action Alternative.

Table 19.92 Changes in Municipal and Industrial Water Supply Costs for the Central Coast Region under Alternative 3 as compared to the No Action Alternative

Differences in Total	Alternative 3	No Action Alternative	Changes
Average Annual CVP/SWP Deliveries (TAF)	51	44	8
Delivery Cost ($1,000)	$7,814	$6,663	$1,151
Assumed New Supply Deliveries (TAF)	0	0	0
Annualized New Supply Costs ($1,000)	$0	$0	$0
Water Storage Costs ($1,000)	$0	$0	$0
Lost Water Sales Revenues ($1,000)	$0	$0	$0
Transfer Costs ($1,000)	$0	$0	$0
Shortage Costs ($1,000)	$0	$0	$0
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) ($1,000)	-$8,333	-$8,068	-$265
Excess Water Savings ($1,000)	-$3,980	-$2,970	-$1,010
Average Annual Changes in Water Supply Costs ($1,000)	**-$4,499**	**-$4,374**	**-$125**

Note: In 2012 dollars

The changes in M&I water supply costs would result in changes to employment and regional economic output, as summarized in Table 19.93.

Table 19.93 Changes in Municipal and Industrial Water Supply Related Employment and Regional Economic Output for the Central Coast Region under Alternative 3 as compared to the No Action Alternative

Economic Sectors	Employment				Economic Output ($ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	0.4	-2.8	-2.4
Mining & Logging	0	0	0	0	0.0	4.9	-6.5	-1.7
Construction	0	1	0	1	0.0	153.8	-6.8	147.0
Manufacturing	0	0	0	0	0.0	20.4	-36.5	-16.0
Transportation, Warehousing & Utilities	5	0	0	5	1,150.6	13.0	-39.5	1,124.0
Wholesale Trade	0	0	0	0	0.0	3.7	-41.4	-37.8
Retail Trade	0	0	-1	-1	0.0	4.7	-83.0	-78.4
Information	0	0	0	0	0.0	9.1	-27.4	-18.3
Financial Activities	0	0	-1	0	0.0	52.5	-247.3	-194.8
Services	0	1	-3	-2	0.0	127.3	-314.2	-186.9
Government	0	0	0	0	0.0	0.7	-9.3	-8.6
Total	**5**	**3**	**-6**	**2**	**1,150.6**	**390.4**	**-814.8**	**726.2**

Note: In 2012 dollars

Regional Changes to Recreational Opportunities

Changes in CVP and SWP water supplies and operations under Alternative 3 as compared to the No Action Alternative generally would result in higher reservoir elevations in reservoirs that store CVP and SWP water (up to 9 to 17 percent); and would result in increased recreational economic factors under Alternative 3 as compared to the No Action Alternative.

Southern California Region

Regional Changes to Irrigated Agriculture

It is anticipated that as in the Central Valley Region, increases in CVP and SWP water supplies within the Southern California Region would not result in increases in long-term irrigated acreage or land use changes due to the use of other water supplies. However, there could be increased irrigated acreage in dry and critical dry years under Alternative 3 as compared to the No Action Alternative.

Regional Changes to Municipal and Industrial Water Supplies

As described in Chapter 5, Surface Water Resources and Water Supplies, CVP and SWP water supplies would be higher under Alternative 3 as compared to the No Action Alternative. The analysis assumed CVP and SWP water deliveries, as described in Chapter 5, and determined the need for new water supplies, changes in water storage and groundwater pumping, water transfers, water shortage costs, and excess water savings. The factors and basis of the analysis is described in detail in Appendix 19A, CWEST Model. The analysis assumes that no new annual transfer supplies would be implemented until shortages were greater than 5 percent. The costs of these shortages are included in the analysis. It is assumed that some communities that do not have alternative water supplies would utilize water transfers.

The average annual water supply costs over the 81-year hydrologic period for M&I water supplies would be $4.94 million, or 0.31 percent, as presented in Table 19.94; and therefore, the results would be similar under Alternative 3 and the No Action Alternative.

Table 19.94 Changes in Municipal and Industrial Water Supply Costs for the Southern California Region under Alternative 3 as compared to the No Action Alternative

Differences in Total	Alternative 3	No Action Alternative	Changes
Average Annual CVP/SWP Deliveries (TAF)	2,241	1,932	308
Delivery Cost ($1,000)	$278,085	$239,692	$38,393
Assumed New Supply Deliveries (TAF)	40	47	-7
Annualized New Supply Costs ($1,000)	$10,584	$12,688	-$2,104
Water Storage Costs ($1,000)	$8,154	$7,598	$556
Lost Water Sales Revenues ($1,000)	$11,409	$14,614	-$3,205
Transfer Costs ($1,000)	$6,181	$11,484	-$5,303
Shortage Costs ($1,000)	$12,632	$17,319	-$4,687
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) ($1,000)	-$81,693	-$57,474	-$24,218
Excess Water Savings ($1,000)	-$9,005	-$4,629	-$4,376
Average Annual Changes in Water Supply Costs ($1,000)	**$236,347**	**$241,291**	**-$4,944**

Note: In 2012 dollars

The changes in M&I water supply costs would result in changes to employment and regional economic output, as summarized in Table 19.95.

Table 19.95 Changes in Municipal and Industrial Water Supply Related Employment and Regional Economic Output for the Southern California under Alternative 3 as compared to the No Action Alternative

Economic Sectors	Employment				Economic Output ($ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	-1	-1	0.0	10.5	-146.4	-135.8
Mining & Logging	0	1	-1	0	0.0	138.6	-199.8	-61.2
Construction	0	37	-2	35	0.0	4,391.6	-211.9	4,179.8
Manufacturing	0	2	-6	-3	0.0	1,225.5	-3,662.5	-2,437.0
Transportation, Warehousing & Utilities	148	2	-6	143	36,845.0	499.5	-1,389.7	35,954.8
Wholesale Trade	0	1	-11	-10	0.0	232.2	-2,405.6	-2,173.3
Retail Trade	0	2	-31	-29	0.0	143.9	-2,688.1	-2,544.2
Information	0	1	-3	-2	0.0	537.8	-1,595.7	-1,057.9
Financial Activities	0	7	-28	-20	0.0	2,133.4	-9,496.1	-7,362.8
Services	0	39	-113	-74	0.0	4,675.7	-10,892.2	-6,216.5
Government	0	0	-2	-1	0.0	25.1	-314.7	-289.6
Total	148	91	-202	37	36,845.0	**14,013.9**	**-33,002.7**	**17,856.2**

Note: In 2012 dollars

Regional Changes to Recreational Opportunities

Changes in CVP and SWP water supplies and operations under Alternative 3 as compared to the No Action Alternative generally would result in higher reservoir elevations in reservoirs that store CVP and SWP water (up to 9 to 17 percent); and would result in increased recreational economic factors under Alternative 3 as compared to the No Action Alternative.

19.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison

Trinity River Region

Regional Changes to Irrigated Agriculture

There are no agricultural lands irrigated with CVP and SWP water supplies in the Trinity River Region. Therefore, there would be no changes in irrigated lands under Alternative 3 as compared to the Second Basis of Comparison.

Regional Changes to Municipal and Industrial Water Supplies

The CVP would continue to release water in Trinity River for downstream beneficial uses, including water supplies under Alternative 3 and the Second Basis of Comparison. There are no CVP or SWP water contractors in the Trinity River Region.

Regional Changes to Recreational Opportunities

Recreational opportunities would be similar in the Trinity River Region under Alternative 3 as compared to the Second Basis of Comparison as described in Chapter 15, Recreational Resources.

Regional Changes to Salmon Fishing

Trinity River flows would be similar under Alternative 3 as compared to the Second Basis of Comparison. This could result in similar salmon harvest conditions by the Yurok and Hoopa Valley tribes.

Central Valley Region

Regional Changes to Irrigated Agriculture

As described in Chapter 5, Surface Water Resources and Water Supplies, CVP and SWP water supplies would be less under Alternative 3 than under the Second Basis of Comparison. It is anticipated that groundwater use would increase in response to reduced CVP and SWP water supplies in 2030 because sustainable groundwater management plans would not be fully implemented until the 2040s, as discussed in Chapter 12, Agricultural Resources.

The agricultural production value under long-term average conditions would be reduced by less than 1 percent ($0.3 million/year in the Sacramento Valley and $0.3 million/year in the San Joaquin Valley) primarily due to an increase in groundwater pumping of approximately 2 percent. The agricultural production value under dry and critical dry conditions also would be reduced by less than 1 percent ($2.1 million/year in the Sacramento Valley and $8.9 million/year in the San Joaquin Valley) primarily due to an increase in groundwater pumping.

The overall reduction in agricultural production values are less than 0.05 percent under long-term conditions; and, changes in employment and regional economic output would be minimal. Therefore, the analysis of employment and regional economic output is focused on dry and critical dry years.

The direct changes in agricultural production would result in changes to employment and regional economic output in the Sacramento and San Joaquin valleys, as summarized in Tables 19.96 and 19.97, respectively.

Table 19.96 Changes in Agricultural-Related Employment and Regional Economic Output for the Sacramento Valley under Alternative 3 as Compared to the Second Basis of Comparison in Dry and Critical Dry Years

Economic Sectors	Employment				Economic Output ($ millions)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	-18	-4	0	-22	-2.1	-0.2	0.0	-2.3
Mining & Logging	0	0	0	0	0.0	0.0	0.0	0.0
Construction	0	0	0	0	0.0	0.0	0.0	0.0
Manufacturing	0	0	0	0	0.0	0.0	0.0	0.0
Transportation, Warehousing & Utilities	0	0	0	0	0.0	-0.1	0.0	-0.1
Wholesale Trade	0	0	0	0	0.0	0.0	0.0	-0.1
Retail Trade	0	0	0	-1	0.0	0.0	0.0	0.0
Information	0	0	0	0	0.0	0.0	0.0	0.0
Financial Activities	0	-2	0	-2	0.0	-0.4	-0.1	-0.5
Services	0	-1	-1	-2	0.0	-0.1	-0.1	-0.2
Government	0	0	0	0	0.0	0.0	0.0	0.0
Total	**-18**	**-7**	**-2**	**-27**	**-2.1**	**-0.9**	**-0.3**	**-3.3**

Note: In 2012 dollars

Table 19.97 Changes in Agricultural-Related Employment and Regional Economic Output for the San Joaquin Valley under Alternative 3 as Compared to the Second Basis of Comparison in Dry and Critical Dry Years

Economic Sectors	Employment				Economic Output ($ millions)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	-36	-26	0	-63	-8.9	-1.1	0.0	-10.0
Mining & Logging	0	0	0	0	0.0	-0.1	0.0	-0.1
Construction	0	-1	0	-1	0.0	-0.1	0.0	-0.1
Manufacturing	0	0	0	-1	0.0	-0.7	-0.2	-0.8
Transportation, Warehousing & Utilities	0	-1	-1	-2	0.0	-0.3	-0.1	-0.5
Wholesale Trade	0	-1	-1	-1	0.0	-0.1	-0.1	-0.2
Retail Trade	0	0	-4	-4	0.0	0.0	-0.4	-0.4
Information	0	0	0	0	0.0	0.0	-0.1	-0.1
Financial Activities	0	-4	-2	-5	0.0	-0.8	-0.9	-1.7
Services	0	-2	-12	-14	0.0	-0.2	-1.0	-1.2
Government	0	0	0	0	0.0	-0.1	0.0	-0.1
Total	**-36**	**-36**	**-20**	**-92**	**-8.9**	**-3.5**	**-2.8**	**-15.3**

Note: In 2012 dollars

As described in Chapter 11, Geology and Soils Resources, increased groundwater pumping under the long-term average conditions may result in an additional increment of subsidence in those areas within the Central Valley. The additional amount of subsidence and the economic costs associated with it have not been quantified in this EIS. However, total subsidence-related costs have been shown to be substantial, as reported by Borchers et al. (2014) who estimated that the cost of subsidence in San Joaquin Valley between 1955 and 1972 was more than $1.3 billion (in 2013 dollars). These estimates are based on the impacts to major infrastructure in the region including the San Joaquin River, Delta Mendota Canal, Friant-Kern Canal and San Luis Canal in addition to privately owned infrastructure. The incremental subsidence-related costs, expressed on an annual basis, could be an unknown fraction of that cumulative cost.

Regional Changes to Municipal and Industrial Water Supplies

As described in Chapter 5, Surface Water Resources and Water Supplies, CVP and SWP water supplies would be similar in the Sacramento Valley and greater in the San Joaquin Valley under Alternative 3 than under the Second Basis of Comparison. The analysis assumed CVP and SWP water deliveries, as described in Chapter 5, and determined the need for new water supplies, changes in water storage and groundwater pumping, water transfers, water shortage costs, and excess water savings. The factors and basis of the analysis is described in detail in Appendix 19A, CWEST Model. The analysis assumes that no new annual transfer supplies would be implemented until shortages were greater than 5 percent. The costs of these shortages are included in the analysis. It is assumed that some communities that do not have alternative water supplies would utilize water transfers.

The average annual water supply operating expenses over the 81-year hydrologic period for M&I water supplies are presented in Tables 19.98 and 19.99 for the Sacramento and San Joaquin Valley, respectively. Average annual water supply operating costs would increase in the Sacramento Valley by 0.05 percent, decrease in the San Joaquin Valley by 0.2 percent; and therefore, the results would be similar under Alternative 3 and the Second Basis of Comparison.

Table 19.98 Changes in Municipal and Industrial Water Supply Costs for the Sacramento Valley under Alternative 3 as Compared to the Second Basis of Comparison

Differences in Total	Alternative 3	Second Basis of Comparison	Changes
Average Annual CVP/SWP Deliveries (TAF)	461	463	-2
Delivery Cost ($1,000)	$8,285	$8,317	-$32
Assumed New Supply Deliveries (TAF)	0	0	0
Annualized New Supply Costs ($1,000)	$0	$0	$0
Water Storage Costs ($1,000)	$0	$0	$0
Lost Water Sales Revenues ($1,000)	$243	$207	$35
Transfer Costs ($1,000)	$601	$517	$84
Shortage Costs ($1,000)	$77	$68	$9
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) ($1,000)	-$3,938	-$3,916	-$23
Excess Water Savings ($1,000)	-$2,517	-$2,563	$46
Average Annual Changes in Water Supply Costs ($1,000)	**$2,750**	**$2,630**	**$119**

Note: In 2012 dollars

Table 19.99 Changes in Municipal and Industrial Water Supply Costs for the San Joaquin Valley under Alternative 3 as Compared to the Second Basis of Comparison

Differences in Total	Alternative 3	Second Basis of Comparison	Changes
Average Annual CVP/SWP Deliveries (TAF)	241	237	4
Delivery Cost ($1,000)	$3,896	$3,854	$42
Assumed New Supply Deliveries (TAF)	0	0	0
Annualized New Supply Costs ($1,000)	$13	$15	-$3
Water Storage Costs ($1,000)	$465	$820	-$355
Lost Water Sales Revenues ($1,000)	$284	$322	-$39
Transfer Costs ($1,000)	$2,104	$2,623	-$518
Shortage Costs ($1,000)	$89	$102	-$13
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) ($1,000)	-$15,660	-$16,011	$351
Excess Water Savings ($1,000)	-$1,378	-$1,318	-$59
Average Annual Changes in Water Supply Costs ($1,000)	**-$10,187**	**-$9,593**	**-$595**

Note: In 2012 dollars

The changes in M&I water supply costs would result in changes to employment and regional economic output in the Sacramento and San Joaquin valleys, as summarized in Tables 19.100 and 19.101, respectively.

Table 19.100 Changes in Municipal and Industrial Water Supply Related Employment and Regional Economic Output for the Sacramento Valley under Alternative 3 as Compared to the Second Basis of Comparison

Economic Sectors	Employment				Economic Output ($ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	0.0	0.5	0.5
Mining & Logging	0	0	0	0	0.0	0.0	0.1	0.0
Construction	0	0	0	0	0.0	-3.5	0.7	-2.8
Manufacturing	0	0	0	0	0.0	-0.4	6.4	6.0
Transportation, Warehousing & Utilities	0	0	0	0	-34.6	-0.3	5.2	-29.7
Wholesale Trade	0	0	0	0	0.0	-0.1	7.7	7.6
Retail Trade	0	0	0	0	0.0	-0.1	13.6	13.5
Information	0	0	0	0	0.0	-0.4	6.0	5.5
Financial Activities	0	0	0	0	0.0	-1.6	42.9	41.3
Services	0	0	0	0	0.0	-3.7	45.0	41.2
Government	0	0	0	0	0.0	0.0	1.1	1.1
Total	**0**	**0**	**1**	**1**	**-34.6**	**-10.2**	**129.2**	**84.4**

Note: In 2012 dollars

Table 19.101 Changes in Municipal and Industrial Water Supply Related Employment and Regional Economic Output for the San Joaquin Valley under Alternative 3 as Compared to the Second Basis of Comparison

Economic Sectors	Employment				Economic Output ($ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	-0.1	-2.3	-2.4
Mining & Logging	0	0	0	0	0.0	-0.8	-2.1	-3.0
Construction	0	0	0	0	0.0	-29.9	-1.9	-31.8
Manufacturing	0	0	0	0	0.0	-3.0	-15.5	-18.6
Transportation, Warehousing & Utilities	-1	0	0	-1	-315.8	-3.0	-14.9	-333.7
Wholesale Trade	0	0	0	0	0.0	-0.8	-12.7	-13.5
Retail Trade	0	0	0	0	0.0	-0.9	-33.4	-34.3
Information	0	0	0	0	0.0	-2.2	-9.0	-11.2
Financial Activities	0	0	0	0	0.0	-9.7	-88.6	-98.4
Services	0	0	-1	-1	0.0	-26.2	-99.0	-125.2
Government	0	0	0	0	0.0	-0.2	-4.3	-4.5
Total	**-1**	**-1**	**-2**	**-4**	**-315.8**	**-77.0**	**-283.5**	**-676.3**

Note: In 2012 dollars

Regional Changes to Recreational Opportunities

Recreational opportunities would be similar at San Luis Reservoir under Alternative 3 as compared to the Second Basis of Comparison, as described in Chapter 15, Recreation Resources. Recreational opportunities related to Striped Bass fishing would initially be increased when Alternative 3 is implemented. However, by 2030, Striped Bass fishing opportunities would be reduced under Alternative 3 as compared to the Second Basis of Comparison due to actions to reduce predation. Therefore, it is anticipated that recreational economic factors would be reduced under Alternative 3 as compared to the Second Basis of Comparison.

Effects Related to Cross Delta Water Transfers

Potential effects to socioeconomic factors could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions would occur during implementation of cross Delta water transfers under Alternative 3 and the Second Basis of Comparison, and that impacts on socioeconomic factors could be adverse in the seller's service area.

Under Alternative 3 and Second Basis of Comparison, water could be transferred throughout the year without an annual volumetric limit. Overall, the potential for cross Delta water transfers would be similar under Alternative 3 as compared to the Second Basis of Comparison.

San Francisco Bay Area Region

Regional Changes to Irrigated Agriculture

It is anticipated that as in the Central Valley Region, reductions in CVP and SWP water supplies within the San Francisco Bay Area Region would not result in reductions in long-term irrigated acreage or land use changes due to the use of other water supplies. However, there could be a reduction in irrigated acreage in dry and critical dry years under Alternative 3 as compared to the Second Basis of Comparison.

Regional Changes to Municipal and Industrial Water Supplies

As described in Chapter 5, Surface Water Resources and Water Supplies, CVP and SWP water supplies would be less under Alternative 3 than under the Second Basis of Comparison. The analysis assumed CVP and SWP water deliveries, as described in Chapter 5, and determined the need for new water supplies, changes in water storage and groundwater pumping, water transfers, water shortage costs, and excess water savings. The factors and basis of the analysis is described in detail in Appendix 19A, CWEST Model. The analysis assumes that no new annual transfer supplies would be implemented until shortages were greater than 5 percent. The costs of these shortages are included in the analysis.

The average annual water supply operating expenses over the 81-year hydrologic period for M&I water supplies would increase by $2.16 million, or 0.52 percent, as presented in Table 19.102; and therefore, the results would be similar under Alternative 3 and the Second Basis of Comparison.

Table 19.102 Changes in Municipal and Industrial Water Supply Costs for the San Francisco Bay Area Region under Alternative 3 as Compared to the Second Basis of Comparison

Differences in Total	Alternative 3	Second Basis of Comparison	Changes
Average Annual CVP/SWP Deliveries (TAF)	431	445	-14
Delivery Cost ($1,000)	$12,096	$12,515	-$419
Assumed New Supply Deliveries (TAF)	18	16	2
Annualized New Supply Costs ($1,000)	$575	$234	$342
Water Storage Costs ($1,000)	$2,303	$1,963	$340
Lost Water Sales Revenues ($1,000)	$2,381	$1,595	$786
Transfer Costs ($1,000)	$1,826	$1,154	$672
Shortage Costs ($1,000)	$743	$523	$221
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) ($1,000)	-$726	-$792	$66
Excess Water Savings ($1,000)	-$393	-$549	$156
Average Annual Changes in Water Supply Costs ($1,000)	**$18,806**	**$16,643**	**$2,163**

Note: In 2012 dollars

The changes in M&I water supply costs would result in changes to employment and regional economic output, as summarized in Table 19.103.

Table 19.103 Changes in Municipal and Industrial Water Supply Related Employment and Regional Economic Output for the San Francisco Bay Area Region under Alternative 3 as Compared to the Second Basis of Comparison

Economic Sectors	Employment				Economic Output ($ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	0.0	1.9	1.9
Mining & Logging	0	0	0	0	0.0	0.3	1.2	1.5
Construction	0	0	0	0	0.0	28.0	9.0	36.9
Manufacturing	0	0	0	0	0.0	5.1	114.4	119.5
Transportation, Warehousing & Utilities	1	0	0	1	262.6	2.0	44.3	308.9
Wholesale Trade	0	0	0	0	0.0	0.9	81.9	82.8
Retail Trade	0	0	2	2	0.0	0.7	138.5	139.3
Information	0	0	0	0	0.0	3.0	73.5	76.4
Financial Activities	0	0	1	1	0.0	9.8	420.2	430.0
Services	0	0	5	5	0.0	23.5	523.1	546.7
Government	0	0	0	0	0.0	0.1	13.3	13.4
Total	**1**	**0**	**8**	**10**	**262.6**	**73.3**	**1,421.3**	**1,757.2**

Note: In 2012 dollars

Regional Changes to Recreational Opportunities

Changes in CVP and SWP water supplies and operations under Alternative 3 as compared to the Second Basis of Comparison generally would result in similar reservoir elevations in reservoirs that store CVP and SWP water and similar recreational economic factors under Alternative 3 as compared to the Second Basis of Comparison.

Regional Changes to Salmon Fishing

Commercial and sport ocean salmon fishing would be reduced under Alternative 3 and the Second Basis of Comparison due to increased commercial and sport ocean salmon harvests limits.

Central Coast Region

Regional Changes to Irrigated Agriculture

It is anticipated that as in the Central Valley Region, reductions in CVP and SWP water supplies within the Central Coast Region would not result in reductions in long-term irrigated acreage or land use changes due to the use of other water supplies. However, there could be a reduction in irrigated acreage in dry and critical dry years under Alternative 3 as compared to the Second Basis of Comparison.

Regional Changes to Municipal and Industrial Water Supplies

As described in Chapter 5, Surface Water Resources and Water Supplies, CVP and SWP water supplies would be less under Alternative 3 than under the Second Basis of Comparison. The analysis assumed CVP and SWP water deliveries, as described in Chapter 5, and determined the need for new water supplies, changes in water storage and groundwater pumping, water transfers, water shortage costs, and excess water savings. The factors and basis of the analysis is described in detail in Appendix 19A, CWEST Model. The analysis assumes that no new annual transfer supplies would be implemented until shortages were greater than 5 percent. The costs of these shortages are included in the analysis. It is assumed that some communities that do not have alternative water supplies would utilize water transfers.

The average annual water supply operating expenses over the 81-year hydrologic period for M&I water supplies would increase by $146,000, or 0.38 percent, as presented in Table 19.104; and therefore, the results would be similar under Alternative 3 and the Second Basis of Comparison.

Table 19.104 Changes in Municipal and Industrial Water Supply Costs for the Central Coast Region under Alternative 3 as Compared to the Second Basis of Comparison

Differences in Total	Alternative 3	Second Basis of Comparison	Changes
Average Annual CVP/SWP Deliveries (TAF)	51	54	-2
Delivery Cost ($1,000)	$7,814	$8,174	-$360
Assumed New Supply Deliveries (TAF)	0	0	0
Annualized New Supply Costs ($1,000)	$0	$0	$0
Water Storage Costs ($1,000)	$0	$0	$0
Lost Water Sales Revenues ($1,000)	$0	$0	$0
Transfer Costs ($1,000)	$0	$0	$0
Shortage Costs ($1,000)	$0	$0	$0
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) ($1,000)	-$8,333	-$8,643	$310
Excess Water Savings ($1,000)	-$3,980	-$4,176	$196
Average Annual Changes in Water Supply Costs ($1,000)	**-$4,499**	**-$4,645**	**$146**

Note: In 2012 dollars

The changes in M&I water supply costs would result in changes to employment and regional economic output, as summarized in Table 19.105.

Table 19.105 Changes in Municipal and Industrial Water Supply Related Employment and Regional Economic Output for the Central Coast Region under Alternative 3 as Compared to the Second Basis of Comparison

Economic Sectors	Employment				Economic Output ($ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	-0.1	1.2	1.0
Mining & Logging	0	0	0	0	0.0	-1.5	2.8	1.2
Construction	0	0	0	0	0.0	-48.1	2.9	-45.2
Manufacturing	0	0	0	0	0.0	-6.4	15.4	9.0
Transportation, Warehousing & Utilities	-2	0	0	-2	-359.9	-4.1	16.7	-347.2
Wholesale Trade	0	0	0	0	0.0	-1.2	17.2	16.1
Retail Trade	0	0	0	0	0.0	-1.5	35.5	34.1
Information	0	0	0	0	0.0	-2.9	11.6	8.8
Financial Activities	0	0	0	0	0.0	-16.4	104.9	88.5
Services	0	0	1	1	0.0	-39.8	133.4	93.6
Government	0	0	0	0	0.0	-0.2	3.9	3.7
Total	**-2**	**-1**	**2**	**0**	**-359.9**	**-122.1**	**345.5**	**-136.5**

Note: In 2012 dollars

Regional Changes to Recreational Opportunities

Changes in CVP and SWP water supplies and operations under Alternative 3 as compared to the Second Basis of Comparison generally would result in similar reservoir elevations in reservoirs that store CVP and SWP water and similar recreational economic factors under Alternative 3 as compared to the Second Basis of Comparison.

Southern California Region

Regional Changes to Irrigated Agriculture

It is anticipated that as in the Central Valley Region, reductions in CVP and SWP water supplies within the Southern California Region would not result in reductions in long-term irrigated acreage or land use changes due to the use of other water supplies. However, there could be a reduction in irrigated acreage in dry and critical dry years under Alternative 3 as compared to the Second Basis of Comparison.

Regional Changes to Municipal and Industrial Water Supplies

As described in Chapter 5, Surface Water Resources and Water Supplies, CVP and SWP water supplies would be less under Alternative 3 than under the Second Basis of Comparison. The analysis assumed CVP and SWP water deliveries, as described in Chapter 5, and determined the need for new water supplies, changes in water storage and groundwater pumping, water transfers, water shortage costs, and excess water savings. The factors and basis of the analysis is described in detail in Appendix 19A, CWEST Model. The analysis assumes that no new annual transfer supplies would be implemented until shortages were greater than 5 percent. The costs of these shortages are included in the analysis. It is assumed that some communities that do not have alternative water supplies would utilize water transfers.

The average annual water supply costs over the 81-year hydrologic period for M&I water supplies would increase by 1.83 percent, as presented in Table 19.106; and therefore, the results would be similar under Alternative 3 and the Second Basis of Comparison.

Table 19.106 Changes in Municipal and Industrial Water Supply Costs for the Southern California Region under Alternative 3 as Compared to the Second Basis of Comparison

Differences in Total	Alternative 3	Second Basis of Comparison	Changes
Average Annual CVP/SWP Deliveries (TAF)	2,241	2,394	-153
Delivery Cost ($1,000)	$278,085	$296,795	-$18,710
Assumed New Supply Deliveries (TAF)	40	11	28
Annualized New Supply Costs ($1,000)	$10,584	$4,032	$6,552
Water Storage Costs ($1,000)	$8,154	$2,824	$5,330
Lost Water Sales Revenues ($1,000)	$11,409	$1,119	$10,289
Transfer Costs ($1,000)	$6,181	$3,705	$2,476
Shortage Costs ($1,000)	$12,632	$353	$12,279
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) ($1,000)	-$81,693	-$91,507	$9,814
Excess Water Savings ($1,000)	-$9,005	-$10,573	$1,568
Average Annual Changes in Water Supply Costs ($1,000)	**$236,347**	**$206,749**	**$29,598**

Note: In 2012 dollars

The changes in M&I water supply costs would result in changes to employment and regional economic output, as summarized in Table 19.107.

Table 19.107 Changes in Municipal and Industrial Water Supply Related Employment and Regional Economic Output for the Southern California Region under Alternative 3 as Compared to the Second Basis of Comparison

Economic Sectors	Employment				Economic Output ($ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	1	1	0.0	-2.0	126.3	124.4
Mining & Logging	0	0	1	0	0.0	-25.7	169.2	143.5
Construction	0	-7	1	-5	0.0	-813.9	183.7	-630.2
Manufacturing	0	0	5	4	0.0	-227.1	3,152.0	2,924.9
Transportation, Warehousing & Utilities	-27	0	5	-22	-6,828.3	-92.6	1,213.1	-5,707.8
Wholesale Trade	0	0	9	9	0.0	-43.0	1,933.5	1,890.4
Retail Trade	0	0	27	27	0.0	-26.7	2,418.2	2,391.5
Information	0	0	3	3	0.0	-99.7	1,366.4	1,266.7
Financial Activities	0	-1	24	23	0.0	-395.4	8,301.7	7,906.3
Services	0	-7	99	92	0.0	-866.5	9,538.4	8,671.9
Government	0	0	1	1	0.0	-4.7	272.6	268.0
Total	**-27**	**-17**	**177**	**132**	**-6,828.3**	**-2,597.1**	**28,675.1**	**19,249.7**

Note: In 2012 dollars

Regional Changes to Recreational Opportunities

Changes in CVP and SWP water supplies and operations under Alternative 3 as compared to the Second Basis of Comparison generally would result in similar reservoir elevations in reservoirs that store CVP and SWP water and similar recreational economic factors under Alternative 3 as compared to the Second Basis of Comparison.

19.4.3.5 Alternative 4

The CVP and SWP operations under Alternative 4 are identical to the CVP and SWP operations under the Second Basis of Comparison and Alternative 1, as described in Chapter 3, Description of Alternatives. In addition, Alternative 4 includes Striped Bass predation control which would reduce recreational opportunities. The non-recreational socioeconomic factors under Alternative 4 would be identical to the conditions under the Second Basis of Comparison. Alternative 4 is compared to the No Action Alternative and the Second Basis of Comparison.

19.4.3.5.1 Alternative 4 Compared to the No Action Alternative

The CVP and SWP operations under Alternative 4 are identical to the CVP and SWP operations under the Second Basis of Comparison and Alternative 1. Therefore, changes in non-recreational socioeconomic factors under Alternative 4 as compared to the No Action Alternative would be the similar to impacts described in Section 12.4.3.2.1, Alternative 1 Compared to the No Action

Alternative. Recreational opportunities related to Striped Bass fishing would initially be increased when Alternative 4 is implemented. However, by 2030, Striped Bass fishing opportunities would be reduced under Alternative 4 as compared to the No Action Alternative due to actions to reduce predation. Commercial and sport ocean salmon fishing opportunities would be reduced under Alternative 4 as compared to the No Action Alternative due to increased harvest limitations.

19.4.3.5.2 Alternative 4 Compared to the Second Basis of Comparison

As described in Chapter 3, Description of Alternatives, socioeconomic factors under Alternative 4 are the same as non-recreational socioeconomic factors under the Second Basis of Comparison. Recreational opportunities related to Striped Bass fishing would initially be increased when Alternative 4 is implemented. However, by 2030, Striped Bass fishing opportunities would be reduced under Alternative 4 as compared to the Second Basis of Comparison due to actions to reduce predation. Commercial and sport ocean salmon fishing opportunities would be reduced under Alternative 4 as compared to the Second Basis of Comparison due to increased harvest limitations.

19.4.3.6 Alternative 5

As described in Chapter 3, Description of Alternatives, CVP and SWP operations under Alternative 5 are similar to the No Action Alternative with modified Old and Middle River flow criteria and New Melones Reservoir operations. As described in Chapter 4, Approach to Environmental Analysis, Alternative 5 is compared to the No Action Alternative and the Second Basis of Comparison.

19.4.3.6.1 Alternative 5 Compared to the No Action Alternative

Trinity River Region

Regional Changes to Irrigated Agriculture

There are no agricultural lands irrigated with CVP and SWP water supplies in the Trinity River Region. Therefore, there would be no changes in irrigated lands under Alternative 5 as compared to the No Action Alternative.

Regional Changes to Municipal and Industrial Water Supplies

The CVP would continue to release water in Trinity River for downstream beneficial uses, including water supplies under Alternative 5 as compared to the No Action Alternative. There are no CVP or SWP water contractors in the Trinity River Region.

Regional Changes to Recreational Opportunities

Recreational opportunities would be similar in the Trinity River Region under Alternative 5 as compared to the No Action Alternative as described in Chapter 15, Recreational Resources.

Regional Changes to Salmon Fishing

Trinity River flows would be similar under Alternative 5 as compared to the No Action Alternative. This could result in similar salmon harvest conditions by the Yurok and Hoopa Valley tribes.

Central Valley Region

Regional Changes to Irrigated Agriculture

As described in Chapter 5, Surface Water Resources and Water Supplies, CVP and SWP water supplies would be similar under Alternative 5 and the No Action Alternative. It is anticipated that groundwater use would be similar and sustainable groundwater management plans would not be fully implemented until the 2040s, as discussed in Chapter 12, Agricultural Resources.

The agricultural production value under long-term average conditions would be the same under Alternative 5 as the No Action Alternative. The agricultural production value under dry and critical dry conditions also would be reduced by less than 1 percent ($0.8 million/year increase in the Sacramento Valley and $2.7 million/year decrease in the San Joaquin Valley), although groundwater pumping is not anticipated to change.

The overall decrease in agricultural production values are less than 0.05 percent under long-term conditions; and, changes in employment and regional economic output would be minimal. Therefore, the analysis of employment and regional economic output is focused on dry and critical dry years.

The direct changes in agricultural production would result in changes to employment and regional economic output in the Sacramento and San Joaquin valleys, as summarized in Tables 19.108 and 19.109, respectively.

Table 19.108 Changes in Agricultural-Related Employment and Regional Economic Output for the Sacramento Valley under Alternative 5 as compared to the No Action Alternative in Dry and Critical Dry Years

Economic Sectors	Employment				Economic Output ($ millions)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	3	2	0	4	0.8	0.1	0.0	0.9
Mining & Logging	0	0	0	0	0.0	0.0	0.0	0.0
Construction	0	0	0	0	0.0	0.0	0.0	0.0
Manufacturing	0	0	0	0	0.0	0.0	0.0	0.0
Transportation, Warehousing & Utilities	0	0	0	0	0.0	0.0	0.0	0.0
Wholesale Trade	0	0	0	0	0.0	0.0	0.0	0.0
Retail Trade	0	0	0	0	0.0	0.0	0.0	0.0
Information	0	0	0	0	0.0	0.0	0.0	0.0
Financial Activities	0	0	0	0	0.0	0.1	0.1	0.2
Services	0	0	1	2	0.0	0.0	0.1	0.1
Government	0	0	0	0	0.0	0.0	0.0	0.0
Total	**3**	**2**	**2**	**7**	**0.8**	**0.2**	**0.3**	**1.3**

Note: In 2012 dollars

Table 19.109 Changes in Agricultural-Related Employment and Regional Economic Output for the San Joaquin Valley under Alternative 5 as compared to the No Action Alternative in Dry and Critical Dry Years

Economic Sectors	Employment				Economic Output ($ millions)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	-5	-9	0	-14	-2.7	-0.4	0.0	-3.0
Mining & Logging	0	0	0	0	0.0	0.0	0.0	0.0
Construction	0	0	0	0	0.0	0.0	0.0	0.0
Manufacturing	0	0	0	0	0.0	-0.2	-0.1	-0.2
Transportation, Warehousing & Utilities	0	0	0	-1	0.0	-0.1	0.0	-0.1
Wholesale Trade	0	0	0	0	0.0	0.0	0.0	-0.1
Retail Trade	0	0	-2	-2	0.0	0.0	-0.1	-0.1
Information	0	0	0	0	0.0	0.0	0.0	0.0
Financial Activities	0	-1	-1	-1	0.0	-0.2	-0.3	-0.5
Services	0	-1	-4	-5	0.0	-0.1	-0.4	-0.4
Government	0	0	0	0	0.0	0.0	0.0	0.0
Total	**-5**	**-11**	**-7**	**-24**	**-2.7**	**-0.9**	**-1.0**	**-4.6**

Note: In 2012 dollars

As described in Chapter 11, Geology and Soils Resources, increased groundwater pumping under the long-term average conditions may result in an additional increment of subsidence in those areas within the Central Valley. The additional amount of subsidence and the economic costs associated with it have not been quantified in this EIS. However, total subsidence-related costs have been shown to be substantial, as reported by Borchers et al. (2014) who estimated that the cost of subsidence in San Joaquin Valley between 1955 and 1972 was more than $1.3 billion (in 2013 dollars). These estimates are based on the impacts to major infrastructure in the region including the San Joaquin River, Delta Mendota Canal, Friant-Kern Canal and San Luis Canal in addition to privately owned infrastructure. The incremental subsidence-related costs, expressed on an annual basis, could be an unknown fraction of that cumulative cost.

Regional Changes to Municipal and Industrial Water Supplies

As described in Chapter 5, Surface Water Resources and Water Supplies, CVP and SWP water supplies would be similar in the Sacramento Valley and lower in the San Joaquin Valley under Alternative 5 and the No Action Alternative. The analysis assumed CVP and SWP water deliveries, as described in Chapter 5, and determined the need for new water supplies, changes in water storage and groundwater pumping, water transfers, water shortage costs, and excess water savings. The factors and basis of the analysis is described in detail in Appendix 19A, CWEST Model. The analysis assumes that no new annual transfer supplies would be implemented until shortages were greater than 5 percent. The costs of these shortages are included in the analysis. It is assumed that some communities that do not have alternative water supplies would utilize water transfers.

The average annual water supply costs over the 81-year hydrologic period for M&I water supplies are presented in Tables 19.110 and 19.111 for the Sacramento and San Joaquin Valley, respectively. Average annual water supply operating expenses would be similar (within 0.05 percent change) for the Sacramento Valley, and increase by 0.07 percent in the San Joaquin Valley; and therefore, the results would be similar under Alternative 5 and the No Action Alternative.

Table 19.110 Changes in Municipal and Industrial Water Supply Costs for the Sacramento Valley under Alternative 5 as compared to the No Action Alternative

Differences in Total	Alternative 5	No Action Alternative	Changes
Average Annual CVP/SWP Deliveries (TAF)	447	447	-1
Delivery Cost ($1,000)	$8,022	$8,031	-$8
Assumed New Supply Deliveries (TAF)	0	0	0
Annualized New Supply Costs ($1,000)	$0	$0	$0
Water Storage Costs ($1,000)	$0	$0	$0
Lost Water Sales Revenues ($1,000)	$204	$213	-$9
Transfer Costs ($1,000)	$752	$739	$12
Shortage Costs ($1,000)	$68	$69	-$2
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) ($1,000)	-$3,856	-$3,858	$1
Excess Water Savings ($1,000)	-$2,266	-$2,275	$10
Average Annual Changes in Water Supply Costs ($1,000)	**$2,924**	**$2,919**	**$5**

Note: In 2012 dollars

Table 19.111 Changes in Municipal and Industrial Water Supply Costs for the San Joaquin Valley under Alternative 5 as compared to the No Action Alternative

Differences in Total	Alternative 5	No Action Alternative	Changes
Average Annual CVP/SWP Deliveries (TAF)	211	214	-3
Delivery Cost ($1,000)	$3,411	$3,460	-$49
Assumed New Supply Deliveries (TAF)	2	2	1
Annualized New Supply Costs ($1,000)	$601	$429	$171
Water Storage Costs ($1,000)	$966	$942	$24
Lost Water Sales Revenues ($1,000)	$361	$361	$0
Transfer Costs ($1,000)	$2,661	$2,673	-$12
Shortage Costs ($1,000)	$115	$115	$0
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) ($1,000)	-$15,329	-$15,377	$49
Excess Water Savings ($1,000)	-$996	-$1,029	$33
Average Annual Changes in Water Supply Costs ($1,000)	**-$8,211**	**-$8,427**	**$215**

Note: In 2012 dollars

The changes in M&I water supply costs would result in changes to employment and regional economic output in the Sacramento and San Joaquin valleys, as summarized in Tables 19.112 and 19.113, respectively.

Table 19.112 Changes in Municipal and Industrial Water Supply Related Employment and Regional Economic Output for the Sacramento Valley under Alternative 5 as compared to the No Action Alternative

Economic Sectors	Employment				Economic Output ($ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	0.0	0.0	0.0
Mining & Logging	0	0	0	0	0.0	0.0	0.0	0.0
Construction	0	0	0	0	0.0	-0.8	0.1	-0.7
Manufacturing	0	0	0	0	0.0	-0.1	0.6	0.5
Transportation, Warehousing & Utilities	0	0	0	0	-7.8	-0.1	0.5	-7.4
Wholesale Trade	0	0	0	0	0.0	0.0	0.7	0.7
Retail Trade	0	0	0	0	0.0	0.0	1.2	1.1
Information	0	0	0	0	0.0	-0.1	0.5	0.4
Financial Activities	0	0	0	0	0.0	-0.4	3.7	3.4
Services	0	0	0	0	0.0	-0.8	3.9	3.0
Government	0	0	0	0	0.0	0.0	0.1	0.1
Total	**0**	**0**	**0**	**0**	**-7.8**	**-2.3**	**11.2**	**1.1**

Note: In 2012 dollars

Table 19.113 Changes in Municipal and Industrial Water Supply Related Employment and Regional Economic Output for the San Joaquin Valley under Alternative 5 as compared to the No Action Alternative

Economic Sectors	Employment				Economic Output ($ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	0.1	0.7	0.8
Mining & Logging	0	0	0	0	0.0	0.4	0.7	1.0
Construction	0	0	0	0	0.0	13.9	0.6	14.5
Manufacturing	0	0	0	0	0.0	1.4	4.8	6.2
Transportation, Warehousing & Utilities	1	0	0	1	146.6	1.4	4.6	152.6
Wholesale Trade	0	0	0	0	0.0	0.4	3.9	4.3
Retail Trade	0	0	0	0	0.0	0.4	10.6	11.0
Information	0	0	0	0	0.0	1.0	2.8	3.8
Financial Activities	0	0	0	0	0.0	4.5	27.7	32.3
Services	0	0	0	0	0.0	12.2	31.1	43.3
Government	0	0	0	0	0.0	0.1	1.3	1.5
Total	**1**	**0**	**1**	**1**	**146.6**	**35.8**	**88.8**	**271.2**

Note: In 2012 dollars

Regional Changes to Recreational Opportunities

Recreational opportunities at San Luis Reservoir would be similar under Alternative 5 as compared to the No Action Alternative, as described in Chapter 15, Recreation Resources. Therefore, it is anticipated that recreational economic factors would be similar under Alternative 5 as compared to the No Action Alternative.

Effects Related to Cross Delta Water Transfers

Potential effects to socioeconomic factors could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions would occur during implementation of cross Delta water transfers under Alternative 5 and the No Action Alternative, and that impacts on socioeconomic factors could be adverse in the seller's service area.

Under Alternative 5 and the No Action Alternative, the timing of cross Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Overall, the potential for cross Delta water transfers would be similar under Alternative 5 and the No Action Alternative.

San Francisco Bay Area Region

Regional Changes to Irrigated Agriculture

It is anticipated that as in the Central Valley Region, CVP and SWP water supplies within the San Francisco Bay Area Region would be similar under Alternative 5 and the No Action Alternative, and would not result in changes in irrigated acreage or land use changes due to the use of other water supplies.

Regional Changes to Municipal and Industrial Water Supplies

As described in Chapter 5, Surface Water Resources and Water Supplies, CVP and SWP water supplies would be lower under Alternative 5 and the No Action Alternative. The analysis assumed CVP and SWP water deliveries, as described in Chapter 5, and determined the need for new water supplies, changes in water storage and groundwater pumping, water transfers, water shortage costs, and excess water savings. The factors and basis of the analysis is described in detail in Appendix 19A, CWEST Model. The analysis assumes that no new annual transfer supplies would be implemented until shortages were greater than 5 percent. The costs of these shortages are included in the analysis.

The average annual water supply operating expenses over the 81-year hydrologic period for M&I water supplies would be increase by 0.1 percent, as presented in Table 19.114; and therefore, the results would be similar under Alternative 5 and the No Action Alternative.

Table 19.114 Changes in Municipal and Industrial Water Supply Costs for the San Francisco Bay Area Region under Alternative 5 as compared to the No Action Alternative

Differences in Total	Alternative 5	No Action Alternative	Changes
Average Annual CVP/SWP Deliveries (TAF)	394	396	-3
Delivery Cost ($1,000)	$10,962	$11,044	-$82
Assumed New Supply Deliveries (TAF)	18	18	0
Annualized New Supply Costs ($1,000)	$599	$599	$0
Water Storage Costs ($1,000)	$1,495	$1,577	-$81
Lost Water Sales Revenues ($1,000)	$4,360	$4,286	$74
Transfer Costs ($1,000)	$6,156	$5,722	$434
Shortage Costs ($1,000)	$1,450	$1,410	$40
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) ($1,000)	-$470	-$493	$24
Excess Water Savings ($1,000)	-$225	-$225	$0
Average Annual Changes in Water Supply Costs ($1,000)	**$24,328**	**$23,919**	**$409**

Note: In 2012 dollars

The changes in M&I water supply costs would result in changes to employment and regional economic output, as summarized in Table 19.115.

Table 19.115 Changes in Municipal and Industrial Water Supply Related Employment and Regional Economic Output for the San Francisco Bay Area Region under Alternative 5 as compared to the No Action Alternative

Economic Sectors	Employment				Economic Output ($ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	0.0	0.5	0.5
Mining & Logging	0	0	0	0	0.0	-0.2	0.3	0.1
Construction	0	0	0	0	0.0	-17.4	2.4	-15.0
Manufacturing	0	0	0	0	0.0	-3.2	30.9	27.8
Transportation, Warehousing & Utilities	-1	0	0	-1	-163.1	-1.2	11.8	-152.5
Wholesale Trade	0	0	0	0	0.0	-0.5	22.9	22.4
Retail Trade	0	0	0	0	0.0	-0.5	36.4	35.9
Information	0	0	0	0	0.0	-1.8	19.8	18.0
Financial Activities	0	0	0	0	0.0	-6.1	112.3	106.2
Services	0	0	1	1	0.0	-14.6	139.4	124.8
Government	0	0	0	0	0.0	-0.1	3.6	3.5
Total	**-1**	**0**	**2**	**1**	**-163.1**	**-45.5**	**380.3**	**171.7**

Note: In 2012 dollars

Regional Changes to Recreational Opportunities

Changes in CVP and SWP water supplies and operations under Alternative 5 as compared to the No Action Alternative generally would result in similar reservoir elevations in reservoirs that store CVP and SWP water and similar recreational economic factors under Alternative 5 as compared o the No Action Alternative.

Regional Changes to Salmon Fishing

Changes in commercial and sport ocean salmon fishing primarily would be related to the presence of fall-run Chinook Salmon from Central Valley hatcheries. It is assumed that the production of hatchery fish would be similar under Alternative 15 and the No Action Alternative. However, survival of the fall-run Chinook Salmon hatchery fish to the Pacific Ocean could be related to changes in CVP and SWP operations. As described in Chapter 9, Fish and Aquatic Resources, there would be little change in through-Delta survival by emigrating natural juvenile fall-run Chinook Salmon under Alternative 5 and the No Action Alternative. It is assumed that the survival of the hatchery juvenile fall-run Chinook Salmon would be similar to the survival of the natural juvenile fall-run Chinook Salmon. Therefore, the availability of fish for commercial and sport ocean salmon fishing and the associated economic conditions for the fishing industry would be similar under Alternative 5 and the No Action Alternative.

Central Coast Region

Regional Changes to Irrigated Agriculture

It is anticipated that as in the Central Valley Region, increases in CVP and SWP water supplies within the Central Coast Region would be lower under Alternative 5 and the No Action Alternative, and would not result in changes in irrigated acreage or land use changes due to the use of other water supplies.

Regional Changes to Municipal and Industrial Water Supplies

As described in Chapter 5, Surface Water Resources and Water Supplies, CVP and SWP water supplies would be similar under Alternative 5 and the No Action Alternative. The analysis assumed CVP and SWP water deliveries, as described in Chapter 5, and determined the need for new water supplies, changes in water storage and groundwater pumping, water transfers, water shortage costs, and excess water savings. The factors and basis of the analysis is described in detail in Appendix 19A, CWEST Model. The analysis assumes that no new annual transfer supplies would be implemented until shortages were greater than 5 percent. The costs of these shortages are included in the analysis. It is assumed that some communities that do not have alternative water supplies would utilize water transfers.

The average annual water supply operating expenses over the 81-year hydrologic period for M&I water supplies would increase by 0.06 percent, as presented in Table 19.116; and therefore, the results would be similar under Alternative 5 and the No Action Alternative.

Table 19.116 Changes in Municipal and Industrial Water Supply Costs for the Central Coast Region under Alternative 5 as compared to the No Action Alternative

Differences in Total	Alternative 5	No Action Alternative	Changes
Average Annual CVP/SWP Deliveries (TAF)	43	44	-1
Delivery Cost ($1,000)	$6,567	$6,663	-$97
Assumed New Supply Deliveries (TAF)	0	0	0
Annualized New Supply Costs ($1,000)	$0	$0	$0
Water Storage Costs ($1,000)	$0	$0	$0
Lost Water Sales Revenues ($1,000)	$0	$0	$0
Transfer Costs ($1,000)	$0	$0	$0
Shortage Costs ($1,000)	$0	$0	$0
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) ($1,000)	-$8,018	-$8,068	$50
Excess Water Savings ($1,000)	-$2,899	-$2,970	$70
Average Annual Changes in Water Supply Costs ($1,000)	**-$4,350**	**-$4,374**	**$23**

Note: In 2012 dollars

The changes in M&I water supply costs would result in changes to employment and regional economic output, as summarized in Table 19.117.

Table 19.117 Changes in Municipal and Industrial Water Supply Related Employment and Regional Economic Output for the Central Coast Region under Alternative 5 as compared to the No Action Alternative

Economic Sectors	Employment				Economic Output ($ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	0.0	0.3	0.2
Mining & Logging	0	0	0	0	0.0	-0.4	0.6	0.2
Construction	0	0	0	0	0.0	-13.0	0.7	-12.3
Manufacturing	0	0	0	0	0.0	-1.7	3.5	1.8
Transportation, Warehousing & Utilities	0	0	0	0	-97.1	-1.1	3.9	-94.3
Wholesale Trade	0	0	0	0	0.0	-0.3	4.0	3.7
Retail Trade	0	0	0	0	0.0	-0.4	8.1	7.8
Information	0	0	0	0	0.0	-0.8	2.7	1.9
Financial Activities	0	0	0	0	0.0	-4.4	24.1	19.7
Services	0	0	0	0	0.0	-10.7	30.7	19.9
Government	0	0	0	0	0.0	-0.1	0.9	0.8
Total	**0**	**0**	**1**	**0**	**-97.1**	**-32.9**	**79.5**	**-50.5**

Note: In 2012 dollars

Regional Changes to Recreational Opportunities

Changes in CVP and SWP water supplies and operations under Alternative 5 as compared to the No Action Alternative generally would result in similar reservoir elevations in reservoirs that store CVP and SWP water and similar recreational economic factors under Alternative 5 as compared to the No Action Alternative.

Southern California Region

Regional Changes to Irrigated Agriculture

It is anticipated that as in the Central Valley Region, increases in CVP and SWP water supplies within the Southern California Region would be similar under Alternative 5 and the No Action Alternative, and would not result in changes in irrigated acreage or land use changes due to the use of other water supplies.

Regional Changes to Municipal and Industrial Water Supplies

As described in Chapter 5, Surface Water Resources and Water Supplies, CVP and SWP water supplies would be lower under Alternative 5 and the No Action Alternative. The analysis assumed CVP and SWP water deliveries, as described in Chapter 5, and determined the need for new water supplies, changes in water storage and groundwater pumping, water transfers, water shortage costs, and excess water savings. The factors and basis of the analysis is described in detail in Appendix 19A, CWEST Model. The analysis assumes that no new annual transfer supplies would be implemented until shortages were greater than 5 percent. The costs of these shortages are included in the analysis. It is assumed that some communities that do not have alternative water supplies would utilize water transfers.

The average annual water supply operating expenses over the 81-year hydrologic period for M&I water supplies would be increase by 0.37 percent, as presented in Table 19.118; and therefore, the results would be similar under Alternative 5 and the No Action Alternative.

Table 19.118 Changes in Municipal and Industrial Water Supply Costs for the Southern California Region under Alternative 5 as compared to the No Action Alternative

Differences in Total	Alternative 5	No Action Alternative	Changes
Average Annual CVP/SWP Deliveries (TAF)	1,912	1,932	-20
Delivery Cost ($1,000)	$237,118	$239,692	-$2,575
Assumed New Supply Deliveries (TAF)	81	47	34
Annualized New Supply Costs ($1,000)	$24,191	$12,688	$11,503
Water Storage Costs ($1,000)	$7,474	$7,598	-$124
Lost Water Sales Revenues ($1,000)	$14,206	$14,614	-$408
Transfer Costs ($1,000)	$10,505	$11,484	-$979
Shortage Costs ($1,000)	$16,662	$17,319	-$657
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) ($1,000)	-$58,323	-$57,474	-$849
Excess Water Savings ($1,000)	-$4,588	-$4,629	$41
Average Annual Changes in Water Supply Costs ($1,000)	**$247,243**	**$241,291**	**$5,952**

Note: In 2012 dollars

The changes in M&I water supply costs would result in changes t9o employment and regional economic output, as summarized in Table 19.119.

Table 19.119 Changes in Municipal and Industrial Water Supply Related Employment and Regional Economic Output for the Southern California under Alternative 5 as compared to the No Action Alternative

Economic Sectors	Employment				Economic Output ($ thousands)			
	Direct	**Indirect**	**Induced**	**Total**	**Direct**	**Indirect**	**Induced**	**Total**
Agriculture	0	0	0	0	0.0	2.5	3.3	5.9
Mining & Logging	0	0	0	0	0.0	33.1	3.3	36.4
Construction	0	9	0	9	0.0	1,049.4	5.1	1,054.5
Manufacturing	0	0	0	1	0.0	292.8	80.2	373.0
Transportation, Warehousing & Utilities	35	0	0	36	8,804.2	119.3	37.0	8,960.5
Wholesale Trade	0	0	0	0	0.0	55.5	-0.2	55.3
Retail Trade	0	0	1	2	0.0	34.4	99.3	133.7
Information	0	0	0	0	0.0	128.5	32.2	160.8
Financial Activities	0	2	1	2	0.0	509.8	257.7	767.4
Services	0	9	3	13	0.0	1,117.3	301.8	1,419.1
Government	0	0	0	0	0.0	6.0	7.6	13.6
Total	**35**	**22**	**6**	**63**	**8,804.2**	**3,348.6**	**827.3**	**12,980.1**

Note: In 2012 dollars

Regional Changes to Recreational Opportunities

Changes in CVP and SWP water supplies and operations under Alternative 5 as compared to the No Action Alternative generally would result in similar reservoir elevations in reservoirs that store CVP and SWP water and similar recreational economic factors under Alternative 5 as compared to the No Action Alternative.

19.4.3.6.2 Alternative 5 Compared to the Second Basis of Comparison

Trinity River Region

Regional Changes to Irrigated Agriculture

There are no agricultural lands irrigated with CVP and SWP water supplies in the Trinity River Region. Therefore, there would be no changes in irrigated lands under Alternative 5 as compared to the Second Basis of Comparison.

Regional Changes to Municipal and Industrial Water Supplies

The CVP would continue to release water in Trinity River for downstream beneficial uses, including water supplies under Alternative 5 and the Second Basis of Comparison. There are no CVP or SWP water contractors in the Trinity River Region.

Regional Changes to Recreational Opportunities

Recreational opportunities would be similar in the Trinity River Region under Alternative 5 as compared to the Second Basis of Comparison as described in Chapter 15, Recreational Resources.

Regional Changes to Salmon Fishing

Trinity River flows would be similar under Alternative 5 as compared to the Second Basis of Comparison. This could result in similar salmon harvest conditions by the Yurok and Hoopa Valley tribes.

Central Valley Region

Regional Changes to Irrigated Agriculture

As described in Chapter 5, Surface Water Resources and Water Supplies, CVP and SWP water supplies would be less under Alternative 5 than under the Second Basis of Comparison. It is anticipated that groundwater use would increase in response to reduced CVP and SWP water supplies in 2030 because sustainable groundwater management plans would not be fully implemented until the 2040s, as discussed in Chapter 12, Agricultural Resources.

The agricultural production value under long-term average conditions would be reduced by less than 1 percent ($1.5 million/year in the Sacramento Valley and $0.7 million/year in the San Joaquin Valley) primarily due to an increase in groundwater pumping of approximately 6 percent. The agricultural production value under dry and critical dry conditions also would be reduced by less than 1 percent ($10.5 million/year in the Sacramento Valley and $22.9 million/year in the San Joaquin Valley) primarily due to an increase in groundwater pumping.

The overall reduction in agricultural production values are less than 0.05 percent under long-term conditions; and, changes in employment and regional economic output would be minimal. Therefore, the analysis of employment and regional economic output is focused on dry and critical dry years.

The direct changes in agricultural production would result in changes to employment and regional economic output in the Sacramento and San Joaquin valleys, as summarized in Tables 19.120 and 19.121, respectively.

Table 19.120 Changes in Agricultural-Related Employment and Regional Economic Output for the Sacramento Valley under Alternative 5 as Compared to the Second Basis of Comparison in Dry and Critical Dry Years

Economic Sectors	Employment				Economic Output ($ millions)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	-84	-20	0	-104	-10.5	-1.2	0.0	-11.8
Mining & Logging	0	0	0	0	0.0	0.0	0.0	0.0
Construction	0	-1	0	-1	0.0	-0.1	0.0	-0.1
Manufacturing	0	0	0	0	0.0	-0.1	0.0	-0.1
Transportation, Warehousing & Utilities	0	-1	0	-2	0.0	-0.3	-0.1	-0.5
Wholesale Trade	0	-1	0	-1	0.0	-0.2	-0.1	-0.3
Retail Trade	0	0	-3	-4	0.0	0.0	-0.3	-0.3
Information	0	0	0	0	0.0	0.0	-0.1	-0.1
Financial Activities	0	-7	-2	-8	0.0	-1.6	-0.7	-2.3
Services	0	-3	-10	-13	0.0	-0.3	-0.9	-1.1
Government	0	0	0	0	0.0	-0.1	0.0	-0.1
Total	**-84**	**-34**	**-17**	**-135**	**-10.5**	**-4.0**	**-2.2**	**-16.8**

Note: In 2012 dollars

Table 19.121 Changes in Agricultural-Related Employment and Regional Economic Output for the San Joaquin Valley under Alternative 5 as Compared to the Second Basis of Comparison in Dry and Critical Dry Years

Economic Sectors	Employment				Economic Output ($ millions)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	-145	-61	0	-206	-22.9	-2.7	-0.1	-25.7
Mining & Logging	0	-1	0	-1	0.0	-0.3	0.0	-0.4
Construction	0	-2	0	-2	0.0	-0.2	0.0	-0.2
Manufacturing	0	-1	-1	-2	0.0	-2.0	-0.4	-2.4
Transportation, Warehousing & Utilities	0	-3	-1	-4	0.0	-0.9	-0.3	-1.2
Wholesale Trade	0	-2	-1	-3	0.0	-0.4	-0.2	-0.6
Retail Trade	0	0	-9	-9	0.0	0.0	-0.7	-0.8
Information	0	0	0	-1	0.0	-0.1	-0.2	-0.2
Financial Activities	0	-13	-4	-16	0.0	-2.8	-1.8	-4.6
Services	0	-6	-25	-31	0.0	-0.6	-2.1	-2.7
Government	0	-1	0	-1	0.0	-0.2	-0.1	-0.3
Total	**-145**	**-90**	**-42**	**-277**	**-22.9**	**-10.2**	**-5.9**	**-39.0**

Note: In 2012 dollars

As described in Chapter 11, Geology and Soils Resources, increased groundwater pumping under the long-term average conditions may result in an additional increment of subsidence in those areas within the Central Valley. The additional amount of subsidence and the economic costs associated with it have not been quantified in this EIS. However, total subsidence-related costs have been shown to be substantial, as reported by Borchers et al. (2014) who estimated that the cost of subsidence in San Joaquin Valley between 1955 and 1972 was more than $1.3 billion (in 2013 dollars). These estimates are based on the impacts to major infrastructure in the region including the San Joaquin River, Delta Mendota Canal, Friant-Kern Canal and San Luis Canal in addition to privately owned infrastructure. The incremental subsidence-related costs, expressed on an annual basis, could be an unknown fraction of that cumulative cost.

Regional Changes to Municipal and Industrial Water Supplies

As described in Chapter 5, Surface Water Resources and Water Supplies, CVP and SWP water supplies would be less under Alternative 5 than under the Second Basis of Comparison. The analysis assumed CVP and SWP water deliveries, as described in Chapter 5, and determined the need for new water supplies, changes in water storage and groundwater pumping, water transfers, water shortage costs, and excess water savings. The factors and basis of the analysis is described in detail in Appendix 19A, CWEST Model. The analysis assumes that no new annual transfer supplies would be implemented until shortages were greater than 5 percent. The costs of these shortages are included in the analysis. It is assumed that some communities that do not have alternative water supplies would utilize water transfers.

The average annual water supply costs over the 81-year hydrologic period for M&I water supplies are presented in Tables 19.122 and 19.123 for the Sacramento and San Joaquin Valley, respectively. Average annual water supply operating expenses would increase by 0.11 and 0.47 percent in the Sacramento Valley and the San Joaquin Valley, respectively; and therefore, the results would be similar under Alternative 5 and the Second Basis of Comparison.

Table 19.122 Changes in Municipal and Industrial Water Supply Costs for the Sacramento Valley under Alternative 5 as Compared to the Second Basis of Comparison

Differences in Total	Alternative 5	Second Basis of Comparison	Changes
Average Annual CVP/SWP Deliveries (TAF)	447	463	-16
Delivery Cost ($1,000)	$8,022	$8,317	-$295
Assumed New Supply Deliveries (TAF)	0	0	0
Annualized New Supply Costs ($1,000)	$0	$0	$0
Water Storage Costs ($1,000)	$0	$0	$0
Lost Water Sales Revenues ($1,000)	$204	$207	-$3
Transfer Costs ($1,000)	$752	$517	$235
Shortage Costs ($1,000)	$68	$68	-$1
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) ($1,000)	-$3,856	-$3,916	$60
Excess Water Savings ($1,000)	-$2,266	-$2,563	$298
Average Annual Changes in Water Supply Costs ($1,000)	**$2,924**	**$2,630**	**$293**

Note: In 2012 dollars

Table 19.123 Changes in Municipal and Industrial Water Supply Costs for the San Joaquin Valley under Alternative 5 as Compared to the Second Basis of Comparison

Differences in Total	Alternative 5	Second Basis of Comparison	Changes
Average Annual CVP/SWP Deliveries (TAF)	211	237	-26
Delivery Cost ($1,000)	$3,411	$3,854	-$443
Assumed New Supply Deliveries (TAF)	2	0	2
Annualized New Supply Costs ($1,000)	$601	$15	$585
Water Storage Costs ($1,000)	$966	$820	$146
Lost Water Sales Revenues ($1,000)	$361	$322	$39
Transfer Costs ($1,000)	$2,661	$2,623	$38
Shortage Costs ($1,000)	$115	$102	$13
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) ($1,000)	-$15,329	-$16,011	$683
Excess Water Savings ($1,000)	-$996	-$1,318	$322
Average Annual Changes in Water Supply Costs ($1,000)	**-$8,211**	**-$9,593**	**$1,381**

Note: In 2012 dollars

The changes in M&I water supply costs would result in changes to employment and regional economic output in the Sacramento and San Joaquin valleys, as summarized in Tables 19.124 and 19.125, respectively.

Table 19.124 Changes in Municipal and Industrial Water Supply Related Employment and Regional Economic Output for the Sacramento Valley under Alternative 5 as Compared to the Second Basis of Comparison

Economic Sectors	Employment				Economic Output ($ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	-0.1	1.7	1.6
Mining & Logging	0	0	0	0	0.0	-0.4	0.3	-0.1
Construction	0	0	0	0	0.0	-29.9	2.6	-27.3
Manufacturing	0	0	0	0	0.0	-3.2	22.7	19.5
Transportation, Warehousing & Utilities	-1	0	0	-1	-295.2	-2.9	18.4	-279.6
Wholesale Trade	0	0	0	0	0.0	-1.0	27.8	26.8
Retail Trade	0	0	1	1	0.0	-0.9	47.7	46.8
Information	0	0	0	0	0.0	-3.5	21.1	17.6
Financial Activities	0	0	0	0	0.0	-13.4	151.3	137.9
Services	0	0	2	1	0.0	-31.8	158.5	126.8
Government	0	0	0	0	0.0	-0.2	3.9	3.8
Total	**-1**	**-1**	**3**	**1**	**-295.2**	**-87.3**	**456.1**	**73.6**

Note: In 2012 dollars

Table 19.125 Changes in Municipal and Industrial Water Supply Related Employment and Regional Economic Output for the San Joaquin Valley under Alternative 5 as Compared to the Second Basis of Comparison

Economic Sectors	Employment				Economic Output ($ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	0.1	7.4	7.5
Mining & Logging	0	0	0	0	0.0	0.8	7.1	7.8
Construction	0	0	0	0	0.0	27.2	6.1	33.4
Manufacturing	0	0	0	0	0.0	2.8	51.3	54.1
Transportation, Warehousing & Utilities	1	0	0	1	287.4	2.8	49.4	339.5
Wholesale Trade	0	0	0	0	0.0	0.7	42.9	43.6
Retail Trade	0	0	1	1	0.0	0.8	107.9	108.7
Information	0	0	0	0	0.0	2.0	29.8	31.8
Financial Activities	0	0	1	1	0.0	8.9	291.4	300.3
Services	0	0	4	4	0.0	23.9	323.4	347.2
Government	0	0	0	0	0.0	0.2	14.2	14.5
Total	**1**	**1**	**6**	**8**	**287.4**	**70.1**	**930.8**	**1,288.4**

Note: In 2012 dollars

Regional Changes to Recreational Opportunities

Recreational opportunities would decrease by 6 to 9 percent under Alternative 5 as compared to the Second Basis of Comparison, depending upon water year type, , as described in Chapter 15, Recreation Resources. Therefore, it is anticipated that recreational economic factors would be reduced under Alternative 5 as compared to the Second Basis of Comparison.

Effects Related to Cross Delta Water Transfers

Potential effects to socioeconomic factors could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions would occur during implementation of cross Delta water transfers under Alternative 5 and the Second Basis of Comparison, and that impacts on socioeconomic factors could be adverse in the seller's service area.

Under Alternative 5, the timing of cross Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Under Second Basis of Comparison, water could be transferred throughout the year without an annual volumetric limit. Overall, the potential for cross Delta water transfers would be decreased under Alternative 5 as compared to the Second Basis of Comparison.

San Francisco Bay Area Region

Regional Changes to Irrigated Agriculture

It is anticipated that as in the Central Valley Region, reductions in CVP and SWP water supplies within the San Francisco Bay Area Region would not result in reductions in long-term irrigated acreage or land use changes due to the use of other water supplies. However, there could be a reduction in irrigated acreage in dry and critical dry years under Alternative 5 as compared to the Second Basis of Comparison.

Regional Changes to Municipal and Industrial Water Supplies

As described in Chapter 5, Surface Water Resources and Water Supplies, CVP and SWP water supplies would be less under Alternative 5 than under the Second Basis of Comparison. The analysis assumed CVP and SWP water deliveries, as described in Chapter 5, and determined the need for new water supplies, changes in water storage and groundwater pumping, water transfers, water shortage costs, and excess water savings. The factors and basis of the analysis is described in detail in Appendix 19A, CWEST Model. The analysis assumes that no new annual transfer supplies would be implemented until shortages were greater than 5 percent. The costs of these shortages are included in the analysis.

The average annual water supply costs over the 81-year hydrologic period for M&I water supplies would increase by 1.85 percent, as presented in Table 19.126; and therefore, the results would be similar under Alternative 5 and the Second Basis of Comparison.

Table 19.126 Changes in Municipal and Industrial Water Supply Costs for the San Francisco Bay Area Region under Alternative 5 as Compared to the Second Basis of Comparison

Differences in Total	Alternative 5	Second Basis of Comparison	Changes
Average Annual CVP/SWP Deliveries (TAF)	394	445	-51
Delivery Cost ($1,000)	$10,962	$12,515	-$1,553
Assumed New Supply Deliveries (TAF)	18	16	2
Annualized New Supply Costs ($1,000)	$599	$234	$365
Water Storage Costs ($1,000)	$1,495	$1,963	-$467
Lost Water Sales Revenues ($1,000)	$4,360	$1,595	$2,765
Transfer Costs ($1,000)	$6,156	$1,154	$5,002
Shortage Costs ($1,000)	$1,450	$523	$927
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) ($1,000)	-$470	-$792	$322
Excess Water Savings ($1,000)	-$225	-$549	$324
Average Annual Changes in Water Supply Costs ($1,000)	**$24,328**	**$16,643**	**$7,686**

Note: In 2012 dollars

The changes in M&I water supply costs would result in changes to employment and regional economic output, as summarized in Table 19.127.

Table 19.127 Changes in Municipal and Industrial Water Supply Related Employment and Regional Economic Output for the San Francisco Bay Area Region under Alternative 5 as Compared to the Second Basis of Comparison

Economic Sectors	Employment				Economic Output ($ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	-0.1	8.4	8.3
Mining & Logging	0	0	0	0	0.0	-1.7	5.3	3.5
Construction	0	-1	0	-1	0.0	-176.1	39.5	-136.6
Manufacturing	0	0	1	0	0.0	-32.0	509.0	477.0
Transportation, Warehousing & Utilities	-6	0	1	-5	-1,654.5	-12.4	195.3	-1,471.6
Wholesale Trade	0	0	2	1	0.0	-5.5	373.6	368.1
Retail Trade	0	0	7	7	0.0	-4.7	603.7	599.0
Information	0	0	1	1	0.0	-18.6	326.5	307.9
Financial Activities	0	0	5	5	0.0	-61.9	1,853.1	1,791.2
Services	0	-1	22	20	0.0	-148.2	2,302.6	2,154.4
Government	0	0	0	0	0.0	-0.7	58.7	57.9
Total	**-6**	**-3**	**37**	**29**	**-1,654.5**	**-462.0**	**6,275.6**	**4,159.1**

Note: In 2012 dollars

Regional Changes to Recreational Opportunities

Changes in CVP and SWP water supplies and operations under Alternative 5 as compared to the Second Basis of Comparison generally would result in lower reservoir elevations in reservoirs that store CVP and SWP water (up to 10 to 18 percent); and would result in decreased recreational economic factors under Alternative 5 as compared to the Second Basis of Comparison.

Regional Changes to Salmon Fishing

Changes in commercial and sport ocean salmon fishing primarily would be related to the presence of fall-run Chinook Salmon from Central Valley hatcheries. It is assumed that the production of hatchery fish would be similar under Alternative 5 and the Second Basis of Comparison. However, survival of the fall-run Chinook Salmon hatchery fish to the Pacific Ocean could be related to changes in CVP and SWP operations. As described in Chapter 9, Fish and Aquatic Resources, there would be little change in through-Delta survival by emigrating natural juvenile fall-run Chinook Salmon under Alternative 5 as compared to the Second Basis of Comparison. It is assumed that the survival of the hatchery juvenile fall-run Chinook Salmon would be similar to the survival of the natural juvenile fall-run Chinook Salmon. Therefore, the availability of fish for commercial and sport ocean salmon fishing and the associated economic conditions for the fishing industry would be similar under Alternative 5 and the Second Basis of Comparison.

Central Coast Region

Regional Changes to Irrigated Agriculture

It is anticipated that as in the Central Valley Region, reductions in CVP and SWP water supplies within the Central Coast Region would not result in reductions in long-term irrigated acreage or land use changes due to the use of other water supplies. However, there could be a reduction in irrigated acreage in dry and critical dry years under Alternative 5 as compared to the Second Basis of Comparison.

Regional Changes to Municipal and Industrial Water Supplies

As described in Chapter 5, Surface Water Resources and Water Supplies, CVP and SWP water supplies would be less under Alternative 5 than under the Second Basis of Comparison. The analysis assumed CVP and SWP water deliveries, as described in Chapter 5, and determined the need for new water supplies, changes in water storage and groundwater pumping, water transfers, water shortage costs, and excess water savings. The factors and basis of the analysis is described in detail in Appendix 19A, CWEST Model. The analysis assumes that no new annual transfer supplies would be implemented until shortages were greater than 5 percent. The costs of these shortages are included in the analysis. It is assumed that some communities that do not have alternative water supplies would utilize water transfers.

The average annual water supply operating expenses over the 81-year hydrologic period for M&I water supplies would increase by 0.77 percent, as presented in Table 19.128; and therefore, the results would be similar under Alternative 5 and the Second Basis of Comparison.

Table 19.128 Changes in Municipal and Industrial Water Supply Costs for the Central Coast Region under Alternative 5 as Compared to the Second Basis of Comparison

Differences in Total	Alternative 5	Second Basis of Comparison	Changes
Average Annual CVP/SWP Deliveries (TAF)	43	54	-11
Delivery Cost ($1,000)	$6,567	$8,174	-$1,607
Assumed New Supply Deliveries (TAF)	0	0	0
Annualized New Supply Costs ($1,000)	$0	$0	$0
Water Storage Costs ($1,000)	$0	$0	$0
Lost Water Sales Revenues ($1,000)	$0	$0	$0
Transfer Costs ($1,000)	$0	$0	$0
Shortage Costs ($1,000)	$0	$0	$0
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) ($1,000)	-$8,018	-$8,643	$625
Excess Water Savings ($1,000)	-$2,899	-$4,176	$1,277
Average Annual Changes in Water Supply Costs ($1,000)	**-$4,350**	**-$4,645**	**$295**

Note: In 2012 dollars

The changes in M&I water supply costs would result in changes to employment and regional economic output, as summarized in Table 19.129.

Table 19.129 Changes in Municipal and Industrial Water Supply Related Employment and Regional Economic Output for the Central Coast Region under Alternative 5 as Compared to the Second Basis of Comparison

Economic Sectors	Employment				Economic Output ($ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	-0.6	4.3	3.7
Mining & Logging	0	0	0	0	0.0	-6.8	9.9	3.1
Construction	0	-2	0	-2	0.0	-214.8	10.4	-204.4
Manufacturing	0	0	0	0	0.0	-28.6	55.4	26.8
Transportation, Warehousing & Utilities	-7	0	0	-7	-1,606.9	-18.1	60.1	-1,565.0
Wholesale Trade	0	0	0	0	0.0	-5.1	62.7	57.5
Retail Trade	0	0	1	1	0.0	-6.5	126.7	120.2
Information	0	0	0	0	0.0	-12.8	41.7	29.0
Financial Activities	0	0	1	1	0.0	-73.3	376.2	303.0
Services	0	-2	5	3	0.0	-177.8	478.2	300.4
Government	0	0	0	0	0.0	-1.0	14.1	13.1
Total	**-7**	**-4**	**9**	**-2**	**-1,606.9**	**-545.3**	**1,239.6**	**-912.6**

Note: In 2012 dollars

Regional Changes to Recreational Opportunities

Changes in CVP and SWP water supplies and operations under Alternative 5 as compared to the Second Basis of Comparison generally would result in lower reservoir elevations in reservoirs that store CVP and SWP water (up to 10 to 18 percent); and would result in decreased recreational economic factors under Alternative 5 as compared to the Second Basis of Comparison.

Southern California Region

Regional Changes to Irrigated Agriculture

It is anticipated that as in the Central Valley Region, reductions in CVP and SWP water supplies within the Southern California Region would not result in reductions in long-term irrigated acreage or land use changes due to the use of other water supplies. However, there could be a reduction in irrigated acreage in dry and critical dry years under Alternative 5 as compared to the Second Basis of Comparison.

Regional Changes to Municipal and Industrial Water Supplies

As described in Chapter 5, Surface Water Resources and Water Supplies, CVP and SWP water supplies would be less under Alternative 5 than under the Second Basis of Comparison. The analysis assumed CVP and SWP water deliveries, as described in Chapter 5, and determined the need for new water supplies, changes in water storage and groundwater pumping, water transfers, water shortage costs, and excess water savings. The factors and basis of the analysis is described in detail in Appendix 19A, CWEST Model. The analysis assumes that no new annual transfer supplies would be implemented until shortages were greater than 5 percent. The costs of these shortages are included in the analysis. It is assumed that some communities that do not have alternative water supplies would utilize water transfers.

The average annual water supply operating expenses over the 81-year hydrologic period for M&I water supplies would increase by 2.5 percent, as presented in Table 19.130; and therefore, the results would be similar under Alternative 5 and the Second Basis of Comparison.

Table 19.130 Changes in Municipal and Industrial Water Supply Costs for the Southern California Region under Alternative 5 as Compared to the Second Basis of Comparison

Differences in Total	Alternative 5	Second Basis of Comparison	Changes
Average Annual CVP/SWP Deliveries (TAF)	1,912	2,394	-482
Delivery Cost ($1,000)	$237,118	$296,795	-$59,677
Assumed New Supply Deliveries (TAF)	81	11	70
Annualized New Supply Costs ($1,000)	$24,191	$4,032	$20,159
Water Storage Costs ($1,000)	$7,474	$2,824	$4,649
Lost Water Sales Revenues ($1,000)	$14,206	$1,119	$13,087
Transfer Costs ($1,000)	$10,505	$3,705	$6,800
Shortage Costs ($1,000)	$16,662	$353	$16,309
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) ($1,000)	-$58,323	-$91,507	$33,183
Excess Water Savings ($1,000)	-$4,588	-$10,573	$5,985
Average Annual Changes in Water Supply Costs ($1,000)	**$247,243**	**$206,749**	**$40,495**

Note: In 2012 dollars

The changes in M&I water supply costs would result in changes to employment and regional economic output, as summarized in Table 19.131.

Table 19.131 Changes in Municipal and Industrial Water Supply Related Employment and Regional Economic Output for the Southern California Region under Alternative 5 as Compared to the Second Basis of Comparison

Economic Sectors	Employment				Economic Output ($ thousands)			
	Direct	**Indirect**	**Induced**	**Total**	**Direct**	**Indirect**	**Induced**	**Total**
Agriculture	0	0	2	1	0.0	-10.0	276.1	266.1
Mining & Logging	0	0	1	1	0.0	-131.1	372.3	241.2
Construction	0	-35	3	-32	0.0	-4,156.1	400.7	-3,755.4
Manufacturing	0	-2	10	9	0.0	-1,159.8	6,894.7	5,734.9
Transportation, Warehousing & Utilities	-140	-2	12	-130	-34,869.2	-472.7	2,639.9	-32,702.0
Wholesale Trade	0	-1	20	19	0.0	-219.8	4,338.8	4,119.1
Retail Trade	0	-2	59	58	0.0	-136.2	5,205.5	5,069.3
Information	0	-1	7	6	0.0	-509.0	2,994.4	2,485.4
Financial Activities	0	-7	52	45	0.0	-2,019.0	18,055.5	16,036.5
Services	0	-37	215	178	0.0	-4,424.9	20,732.4	16,307.5
Government	0	0	3	3	0.0	-23.8	594.9	571.1
Total	**-140**	**-86**	**384**	**158**	**-34,869.2**	**-13,262.4**	**62,505.2**	**14,373.6**

Note: In 2012 dollars

Regional Changes to Recreational Opportunities

Changes in CVP and SWP water supplies and operations under Alternative 5 as compared to the Second Basis of Comparison generally would result in lower reservoir elevations in reservoirs that store CVP and SWP water (up to 10 to 18 percent); and would result in decreased recreational economic factors under Alternative 5 as compared to the Second Basis of Comparison.

19.4.3.7 Summary of Environmental Consequences

The results of the environmental consequences of implementation of Alternatives 1 through 5 as compared to the No Action Alternative and the Second Basis of Comparison are presented in Tables 19.132 and 19.133.

Table 19.132 Comparison of Alternatives 1 through 5 to No Action Alternative

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	Agricultural and M&I water-related employment would be similar. M&I water supply operating expenses would be similar. Recreational economic factors would increase or be similar related to use of reservoirs that store CVP and SWP water.	None needed
Alternative 2	No effects on socioeconomic factors.	None needed
Alternative 3	Agricultural and M&I water-related employment would be similar. M&I water supply operating expenses would be similar. Recreational economic factors would increase or be similar related to use of reservoirs that store CVP and SWP water. Reduced recreational economic factors related to Striped Bass fishing. Reduced commercial and sport ocean salmon fishing due to increased harvest limitations.	None identified at this time to reduce economic effects of reduced Striped Bass fishing and ocean salmon.
Alternative 4	Same effects as described for Alternative 1 compared to the No Action Alternative for non-recreational economic factors. Reduced recreational economic factors related to Striped Bass fishing. Reduced commercial and sport ocean salmon fishing due to increased harvest limitations.	None identified at this time to reduce economic effects of reduced Striped Bass fishing or ocean salmon fishing.
Alternative 5	Agricultural and M&I water-related employment would be similar. M&I water supply operating expenses would be similar. Recreational economic factors would be similar related to use of reservoirs that store CVP and SWP water.	None needed

Note: Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools, incremental differences of 5 percent or less between alternatives and the No Action Alternative are considered to be “similar.”

Table 19.133 Comparison of No Action Alternative and Alternatives 1 through 5 to Second Basis of Comparison

Alternative	Potential Change	Consideration for Mitigation Measures
No Action Alternative	Agricultural and M&I water-related employment would be similar. M&I water supply operating expenses would be similar. Recreational economic factors would decrease at San Luis Reservoir and at of reservoirs that store CVP and SWP water in the San Francisco Bay Area and Central Coast regions.	Not considered for this comparison.
Alternative 1	No effects on socioeconomic factors.	Not considered for this comparison.
Alternative 2	Same effects as described for No Action Alternative as compared to the Second Basis of Comparison.	Not considered for this comparison.
Alternative 3	Agricultural and M&I water-related employment would be similar. M&I water supply operating expenses would be similar. Recreational economic factors would be similar related to use of reservoirs that store CVP and SWP water. Reduced recreational economic factors related to Striped Bass fishing. Reduced commercial and sport ocean salmon fishing due to increased harvest limitations. Recreational economic factors would be similar.	Not considered for this comparison.
Alternative 4	No effects on non-recreational socioeconomic factors. Reduced recreational economic factors related to Striped Bass fishing. Reduced commercial and sport ocean salmon fishing due to increased harvest limitations.	Not considered for this comparison.
Alternative 5	Agricultural and M&I water-related employment would be similar. M&I water supply operating expenses would be similar. Recreational economic factors would decrease at San Luis Reservoir and at of reservoirs that store CVP and SWP water in the San Francisco Bay Area, Central Coast, and Southern California regions. Reduced recreational economic factors related to Striped Bass fishing. Reduced commercial and sport ocean salmon fishing due to increased harvest limitations.	Not considered for this comparison.

Note: Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools, incremental differences of 5 percent or less between alternatives and the No Action Alternative are considered to be “similar.”

19.4.3.8 Potential Mitigation Measures

Mitigation measures are presented in this section to avoid, minimize, rectify, reduce, eliminate, or compensate for adverse environmental effects of Alternatives 1 through 5 as compared to the No Action Alternative. Mitigation measures were not included to address adverse impacts under the alternatives as compared to the Second Basis of Comparison because this analysis was included in this EIS for information purposes only.

Changes in CVP and SWP operations under Alternatives 1 through 5 as compared to the No Action Alternative would not result in adverse changes in socioeconomic factors related to the average annual agricultural production or M&I water supply operating expenses as compared to the No Action Alternative. However, implementation of Alternatives 3 and 4 would result in adverse changes in recreational Striped Bass and sport ocean salmon fishing opportunities.

19.4.3.8.1 Recreational Fishing Opportunities

Under Alternatives 3 and 4, fishing opportunities for Striped Bass and commercial and sport ocean salmon fishing would be reduced as compared to the No Action Alternative. Mitigation measures are not identified at this time to reduce the impact to the Striped Bass and ocean salmon fishing opportunities.

19.4.3.9 Cumulative Effects Analysis

As described in Chapter 3, the cumulative effects analysis considers projects, programs, and policies that are not speculative; and are based upon known or reasonably foreseeable long-range plans, regulations, operating agreements, or other information that establishes them as reasonably foreseeable.

The cumulative effects analysis Alternatives 1 through 5 for Socioeconomics are summarized in Table 19.134.

Table 19.134 Summary of Cumulative Effects on Socioeconomics of Alternatives 1 through 5 as Compared to the No Action Alternative

Scenarios	Actions	Cumulative Effects of Actions
Past & Present, and Future Actions included in the No Action Alternative and in all Alternatives in Year 2030	Consistent with Affected Environment conditions plus: Actions in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the Biological Opinions, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives), including climate change and sea level rise Actions not included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the Biological Opinions, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives): • Implementation of Federal and state policies and programs, including Clean Water Act (e.g., Total Maximum Daily Loads); Safe Drinking Water Act; Clean Air Act; and flood management programs • General plans for 2030. • Trinity River Restoration Program. • Central Valley Project Improvement Act programs • Folsom Dam Water Control Manual Update • FERC Relicensing for the Middle Fork of the American River Project • San Joaquin River Restoration Program • Contra Loma Recreation Resource Management Plan • San Luis Reservoir State Recreation Area Resource Management Plan/General Plan	<u>These effects would be the same in all alternatives.</u> Climate change and sea level rise and development under the general plans are anticipated to reduce carryover storage in reservoirs in a manner that would reduce CVP and SWP water supply availability and recreational opportunities at some reservoirs that store CVP and SWP water, and could reduce the opportunities for ocean salmon fishing. Other actions, including restoration projects, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to improve recreational opportunities and salmon populations that could improve ocean salmon fishing.
Future Actions considered as Cumulative Effects Actions in all Alternatives in Year 2030	Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives): • Bay-Delta Water Quality Control Plan Update • FERC Relicensing Projects • Bay Delta Conservation Plan (including the California WaterFix alternative) • Shasta Lake Water Resources, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations	<u>These effects would be the same in all alternatives.</u> Some of the future reasonably foreseeable actions to improve water quality and FERC Relicensing projects could improve recreational opportunities and salmon populations that could improve ocean salmon fishing. Other actions, such as expanded or new reservoirs would improve water supply availability and recreational opportunities.

Scenarios	Actions	Cumulative Effects of Actions
	• El Dorado Water and Power Authority Supplemental Water Rights Project • Semitropic Water Storage District Delta Wetlands • North Bay Aqueduct Alternative Intake • Irrigated Lands Regulatory Program	
No Action Alternative with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO	Implementation of No Action Alternative would result in changes stream flows. Changes in stream flows would in turn in changes in water supply availability, recreational opportunities, and salmon populations. Changes in salmon populations would affect ocean salmon fishing as compared to historical conditions prior to the BOs.
Alternative 1 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternative 1 with reasonably foreseeable actions would result in similar agricultural and M&I water supply economics, and similar or improved reservoir recreational opportunities compared to the No Action Alternative with these added actions.
Alternative 2 with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions No implementation of structural improvements or other actions that require further study to develop a more detailed action description.	Implementation of Alternative 2 with reasonably foreseeable actions for recreational opportunities would be the same as for the No Action Alternative with these added actions.
Alternative 3 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant) Slight increase in positive Old and Middle River flows in the winter and spring months Increased bag limits for Striped Bass and Pikeminnow Increased ocean salmon fishing harvest limitations	Implementation of Alternative 3 with reasonably foreseeable actions would result in similar agricultural and M&I water supply economics, and similar or improved reservoir recreational opportunities as for the No Action Alternative with tjese added actions. Recreational opportunities related to Striped Bass fishing would initially be increased; however by 2030 recreational fishing related to Striped Bass would be reduced. Opportunities related to commercial and sport ocean salmon fishing would be reduced.

Scenarios	Actions	Cumulative Effects of Actions
Alternative 4 with Associated Cumulative Effects in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant) Increased bag limits for Striped Bass and Pikeminnow Increased ocean salmon fishing harvest limitations	Implementation of Alternative with these reasonably foreseeable actions would result in similar agricultural and M&I water supply economics, and similar or improved reservoir recreational opportunities as for the No Action Alternative with these added actions. Recreational opportunities related to Striped Bass fishing would initially be increased; however by 2030 recreational fishing related to Striped Bass would be reduced. Opportunities related to commercial and sport ocean salmon fishing would be reduced.
Alternative 5 with Associated Cumulative Effects in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO Positive Old and Middle River flows and increased Delta outflow in spring months	Implementation of Alternative 5 with reasonably foreseeable actions would result in similar agricultural and M&I water supply economics, and similar reservoir recreational opportunities as for the No Action Alternative with these added actions.

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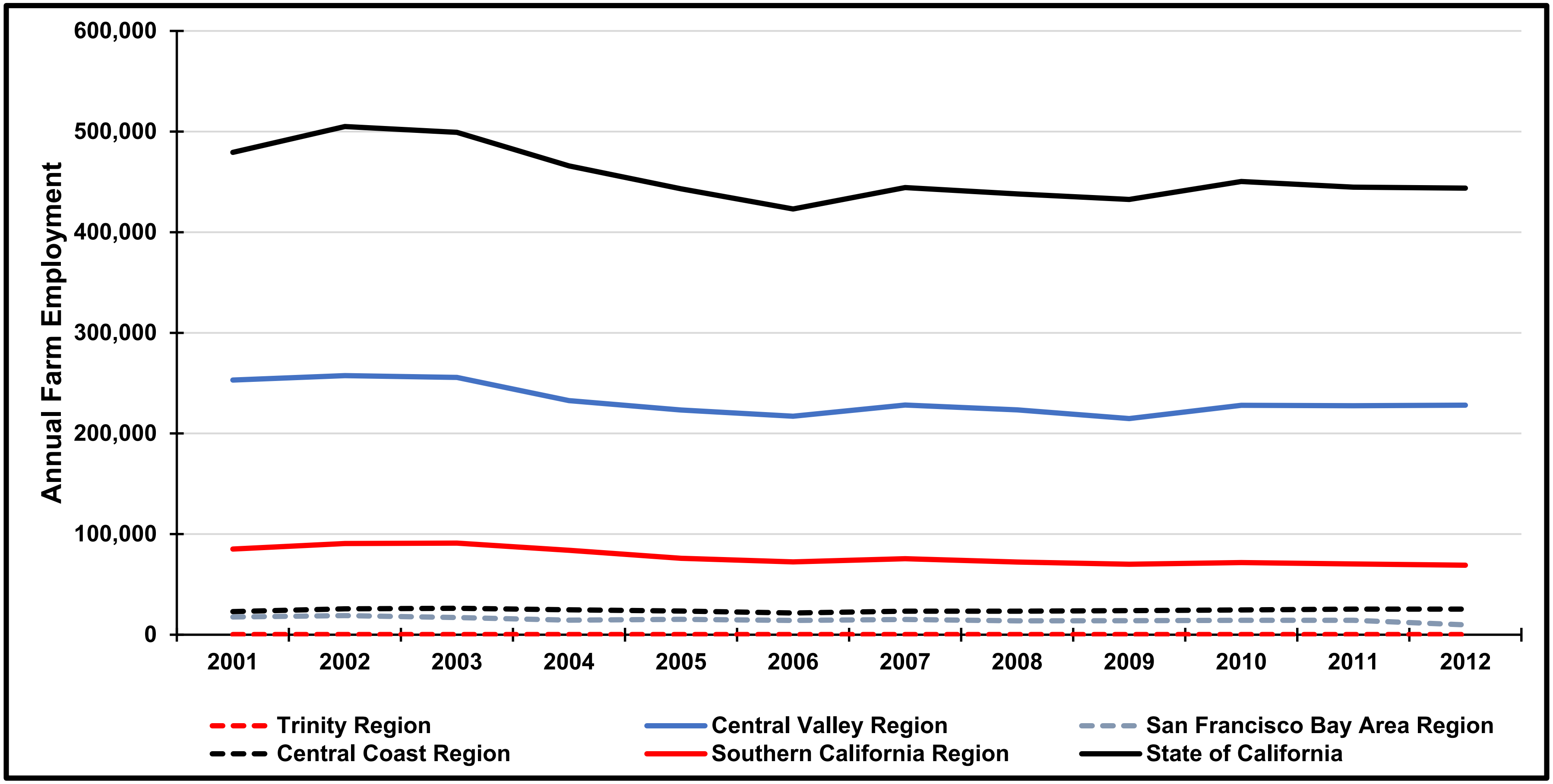

Figure 19.1 Farm Employment in Counties within the Study Area

Source: BEA 2014a

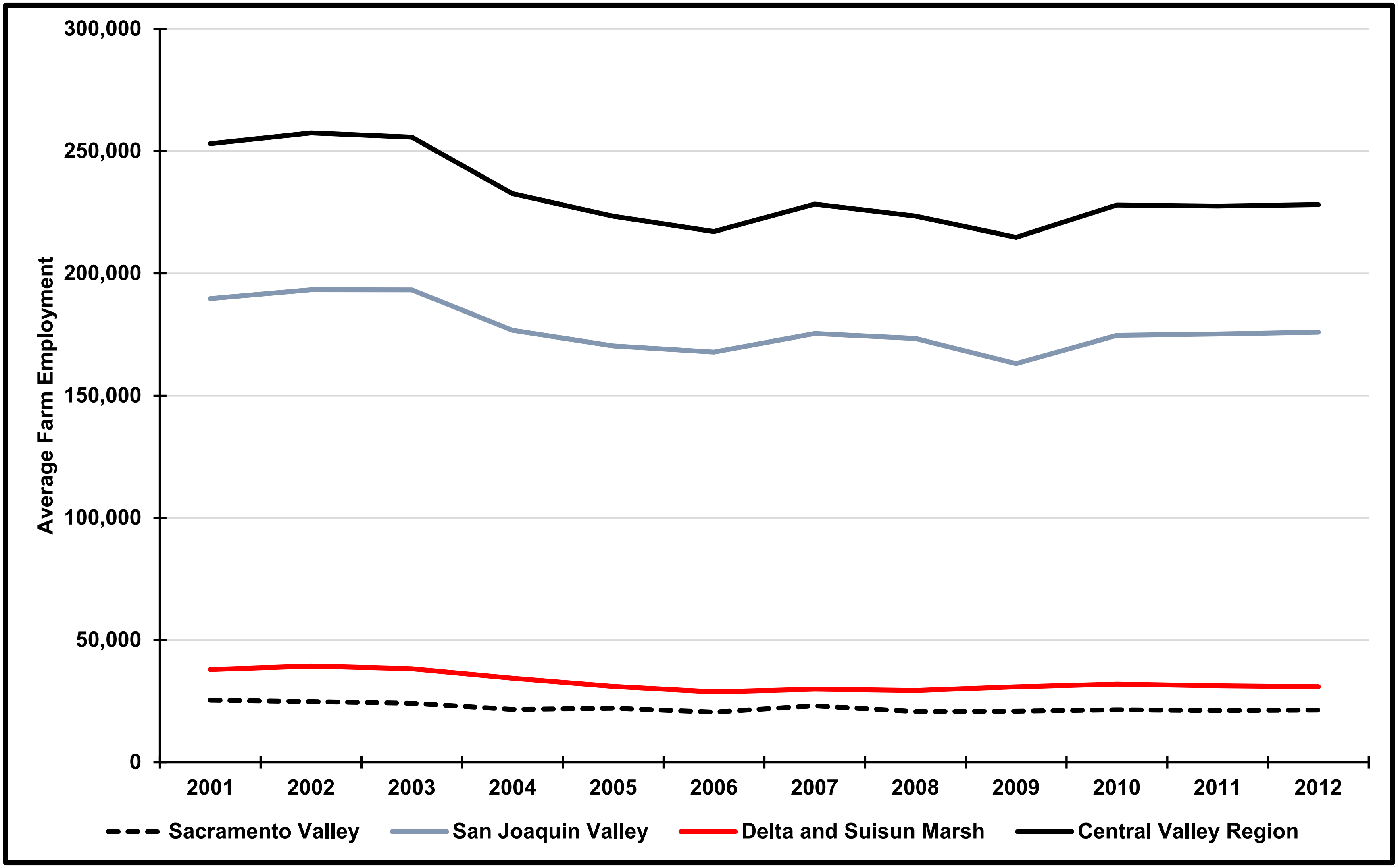

Figure 19.2 Farm Employment in Counties within the Central Valley Region

Source: BEA 2014a

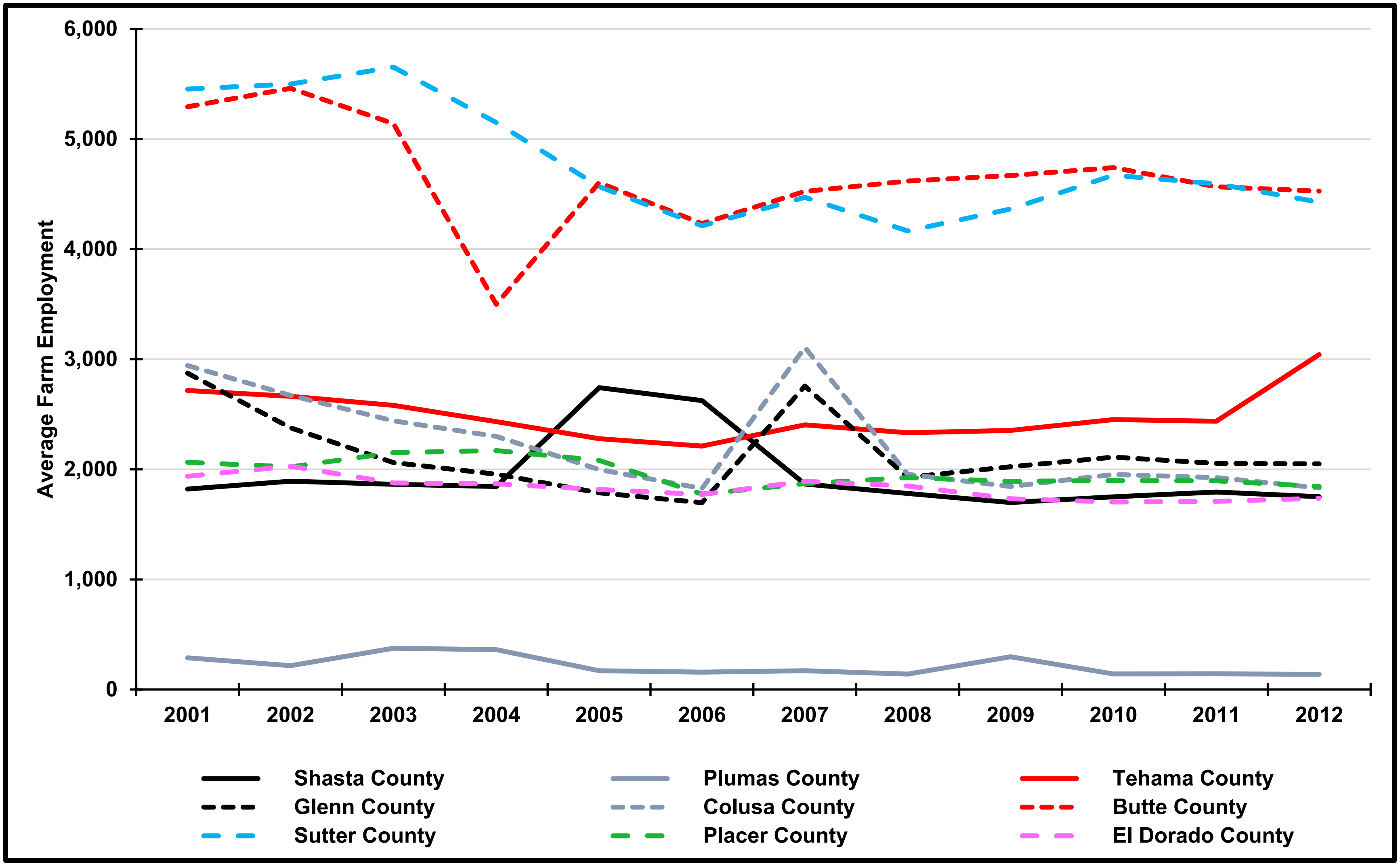

Figure 19.3 Farm Employment in Counties within the Sacramento Valley Portion of the Central Valley Region

Source: BEA 2014a

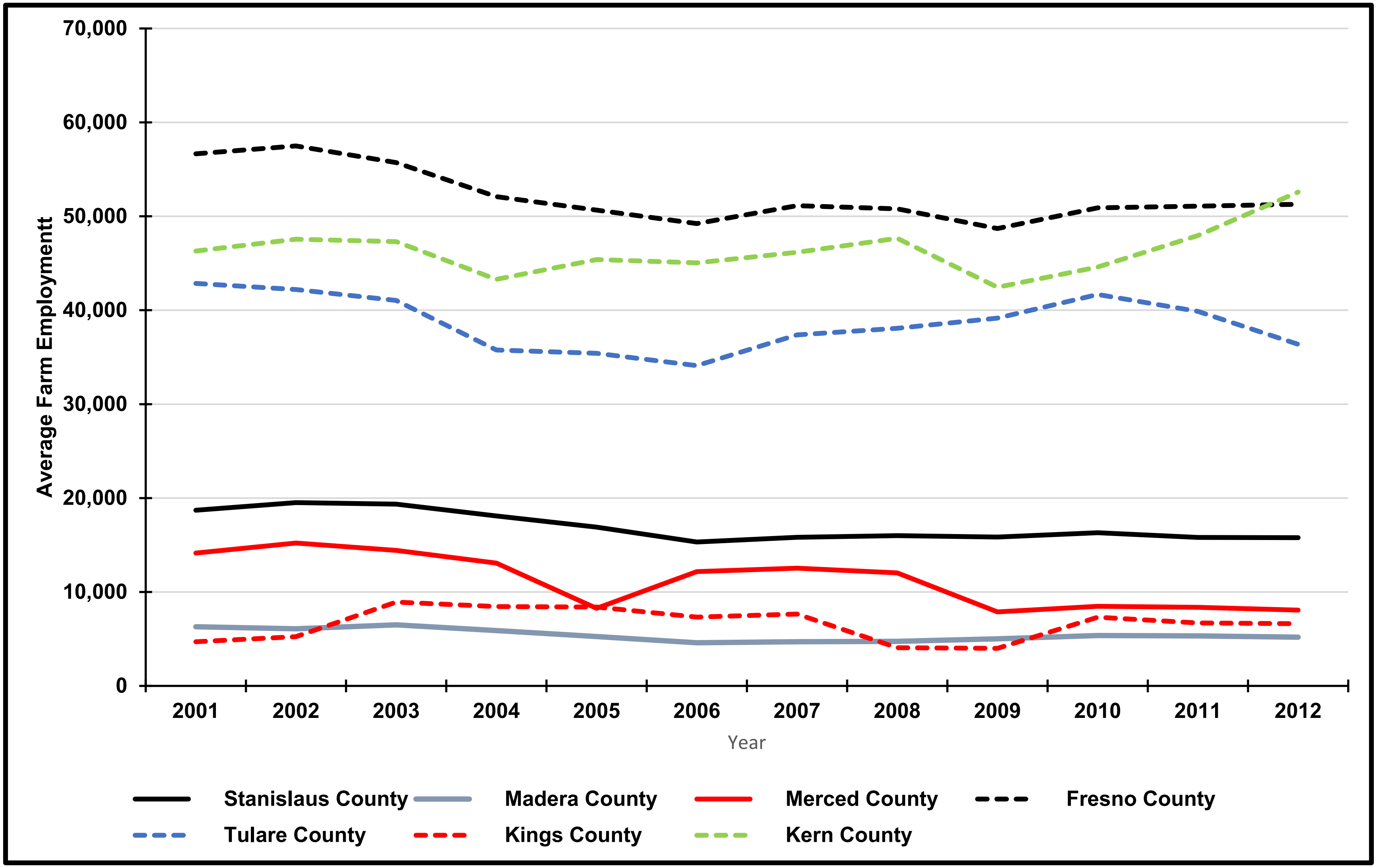

Figure 19.4 Farm Employment in Counties within the San Joaquin Valley Portion of the Central Valley Region

Source: BEA 2014a

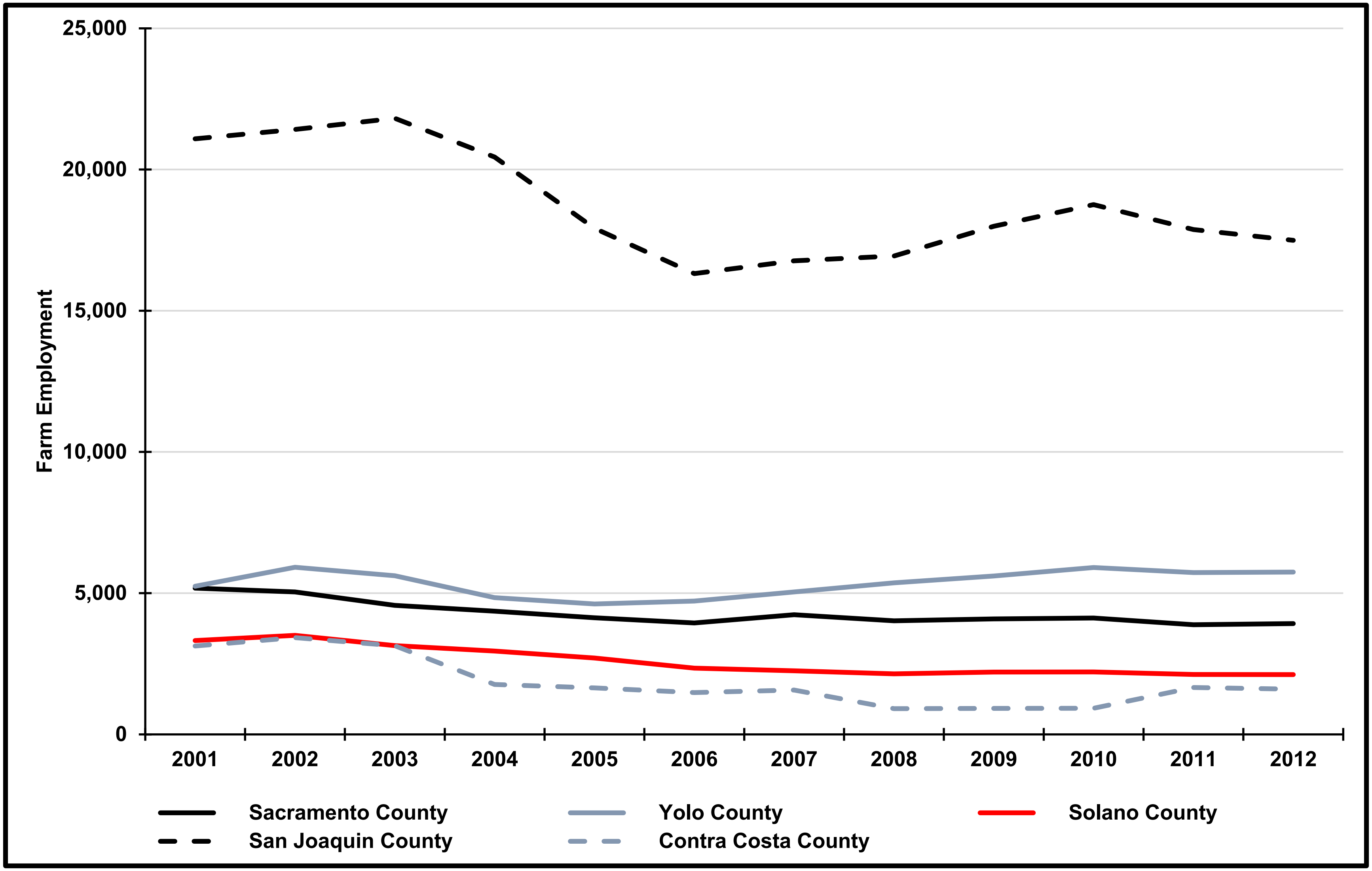

Figure 19.5 Farm Employment in Counties within the Delta and Suisun Marsh Portion of the Central Valley Region

Source: BEA 2014a

Chapter 20

Indian Trust Assets

20.1 Introduction

This chapter describes Indian Trust Assets (ITAs) in the study area and potential changes that could occur as a result of implementing the alternatives evaluated in this Environmental Impact Statement (EIS). Implementation of the alternatives could affect ITAs through potential changes to the operation of the Central Valley Project (CVP) and State Water Project (SWP) and ecosystem restoration.

20.2 Regulatory Environment and Compliance Requirements

Potential actions that could be implemented under the alternatives evaluated in this EIS could affect ITAs in the areas along the rivers and reservoirs directly impacted by changes in the operation of CVP or SWP reservoirs and in the vicinity of lands served by CVP and SWP water supplies. Actions located on public agency lands, or implemented, funded, or approved by Federal and state agencies, would need to be compliant with appropriate Federal and state agency policies and regulations, as summarized in Chapter 4, Approach to Environmental Analyses.

The Federal Indian Trust Asset policies, summarized below and in Chapter 4, have been used to identify potential areas of change to ITAs that could occur due to changes in long-term operation of the CVP and/or SWP facilities.

The 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 U.S. is the trustee. By definition, ITAs cannot be sold, leased, or otherwise encumbered without approval of the U.S. The characterization and application of the U.S. 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," Bureau of Reclamation (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 government-to-government level when its actions affect ITAs (Federal Register, Vol. 59, No. 85, May 4, 1994, pages 22951-22952). The U.S. Department of the Interior (DOI) Departmental Manual Part 512.2 ascribes the responsibility for ensuring protection of ITAs to the heads of bureaus and offices. DOI is required to carry out activities in a manner that protects ITAs and avoids adverse effects whenever possible.

20.3 Affected Environment

The U.S. Government's trust responsibility for Indian resources requires Reclamation and other agencies to take measures to protect and maintain trust resources. These responsibilities include taking reasonable actions to preserve and restore tribal resources.

In compliance with 36 Code of Federal Register 800.4(a) (4), Reclamation sent letters to the federally-recognized Indian tribes in the study area, including most of the tribes listed in Table 20.1, to request their input regarding the identification of any properties to which they might attach religious and cultural significance to within the area of potential effect.

Table 20.1 Federally Recognized Tribes in the Vicinity of the Study Area

Federally Recognized Tribe	EIS Geographical Region	County	In the Vicinity of this Community
Hoopa Valley Tribal Council	Trinity River	Trinity and Humboldt	Hoopa
Resighini Rancheria Tribe	Trinity River	Del Norte	Klamath
Yurok Tribe of the Yurok Reservation	Trinity River	Trinity, Humboldt, and Del Norte	Klamath
Pit River Tribe	Central Valley	Shasta	Burney
Redding Rancheria Tribe	Central Valley	Shasta	Redding
Paskenta Band of Nomlaki Indians of California	Central Valley	Tehama and Glenn	Corning and Orland
Grindstone Indian Rancheria of Wintun-Wailaki Indians of California	Central Valley	Glenn	Elk Creek

Federally Recognized Tribe	EIS Geographical Region	County	In the Vicinity of this Community
Cachil Dehe Band of Wintun Indians of the Colusa Indian Community of the Colusa Rancheria	Central Valley	Colusa	Colusa
Cortina Indian Rancheria of Wintun Indians of California	Central Valley	Colusa	Williams
Tyme Maidu of Berry Creek Rancheria	Central Valley	Butte	Oroville
Konkow Maidu of Mooretown Rancheria	Central Valley	Butte	Oroville
Enterprise Rancheria of Maidu Indians of California	Central Valley	Butte	Oroville
Mechoopda Indian Tribe of Chico Rancheria	Central Valley	Butte	Chico
Miwok Maidu United Auburn Indian Community of the Auburn Rancheria	Central Valley	Placer	Placer
United Auburn Indian Community of the Auburn Rancheria of California	Central Valley	Placer	Rocklin
Shingle Springs Band of Miwok Indians, including Shingle Springs Rancheria	Central Valley	El Dorado and Nevada County	Shingle Springs
Buena Vista Rancheria of Me-Wuk	Central Valley	Sacramento	Sacramento
Wilton Miwok Indians of the Wilton Rancheria	Central Valley	Sacramento	Elk Grove
Yocha Dehe Wintun Nation	Central Valley	Yolo	Brooks
Northfork Rancheria of Mono Indians of California	Central Valley	Madera	North Fork
Picayune Rancheria of Chukchansi Indians of California	Central Valley	Madera	Coarsegold
California Valley Miwok Tribe	Central Valley	San Joaquin	Stockton
Big Sandy Rancheria of Mono Indians of California	Central Valley	Fresno	Auberry

Federally Recognized Tribe	EIS Geographical Region	County	In the Vicinity of this Community
Table Mountain Rancheria	Central Valley	Fresno	Friant
Santa Rosa Indian Community of Santa Rosa Rancheria	Central Valley	Kings	Lemoore
Tule River Indian Tribe of the Tule River Reservation of the Yokut Indians	Central Valley	Tulare	Porterville
Santa Ynez Band of Chumash Mission Indians of Santa Ynez Reservation	Central Coast	Santa Barbara	Santa Ynez
Cahuilla Band of Mission Indians of the Cahuilla Reservation	Southern California	San Diego	Anza
Campo Band of Diegueno Mission Indians of the Campo Indian Reservation	Southern California	San Diego	Campo
Capitan Grande Band of Diegueno Mission Indians of California (Barona Reservation and Viejas Reservation)	Southern California	San Diego	Alpine
Ewiiaapaayp Band of Kumeyaay Indians	Southern California	San Diego	Alpine
Iipay Nation of Santa Ysabel	Southern California	San Diego	Santa Ysabel
Inaja Band of Diegueno Mission Indians of the Inaja and Cosmit Reservation	Southern California	San Diego	Escondido
Jamul Indian Village of California	Southern California	San Diego	Jamul
La Jolla Band of Luiseño Indians	Southern California	San Diego	Pauma Valley
La Posta Band of Diegueno Mission Indians of the La Posta Indian Reservation	Southern California	San Diego	Boulevard
Los Coyotes Band of Cahuilla and Cupeno Indians	Southern California	San Diego	Warner Springs

Federally Recognized Tribe	EIS Geographical Region	County	In the Vicinity of this Community
Manzanita Band of Diegueno Mission Indians of the Manzanita Reservation	Southern California	San Diego	Boulevard
Mesa Grande Band of Diegueno Mission Indians of the Mesa Grande Reservation	Southern California	San Diego	Santa Ysabel
Pala Band of Luiseño Mission Indians of the Pala Reservation	Southern California	San Diego	Pala
Pauma Band of Luiseño Mission Indians of the Pauma & Yuima Reservation	Southern California	San Diego	Pauma Valley
Rincon Band of Luiseño Mission Indians of the Rincon Reservation	Southern California	San Diego	Valley Center
San Pasqual Band of Diegueno Mission Indians of California	Southern California	San Diego	Valley Center
Sycuan Band of the Kumeyaay Nation	Southern California	San Diego	El Cajon
Agua Caliente Band of Cahuilla Indians of the Agua Caliente Indian Reservation	Southern California	Riverside	Palm Springs
Augustine Band of Cahuilla Indians	Southern California	Riverside	Coachella
Cabazon Band of Mission Indians	Southern California	Riverside	Indio
Morongo Band of Mission Indians	Southern California	Riverside	Banning
Pechanga Band of Luiseño Mission Indians of the Pechanga Reservation	Southern California	Riverside	Temecula
Ramona Band of Cahuilla	Southern California	Riverside	Anza
Santa Rosa Band of Cahuilla Indians	Southern California	Riverside	Mountain Center
Soboba Band of Luiseño Indians	Southern California	Riverside	San Jacinto

Federally Recognized Tribe	EIS Geographical Region	County	In the Vicinity of this Community
Torres-Martinez Desert Cahuilla Indians	Southern California	Riverside	Thermal
Twenty-Nine Palms Band of Mission Indians of California	Southern California	Riverside and San Bernardino	Coachella
Chemehuevi Indian Tribe of the Chemehuevi Reservation	Southern California	San Bernardino	Needles
San Manuel Band of Mission Indians	Southern California	San Bernardino	Highland
Big Lagoon Rancheria	Not within study area	Humboldt	Arcata
Blue Lake Rancheria	Not within study area	Humboldt	Blue Lake
Karuk Tribe	Not within study area	Siskiyou	Happy Camp
Greenville Rancheria of Maidu Indians	Not within study area	Plumas and Tehama	Greenville
Susanville Indian Rancheria	Not within study area	Lassen	Susanville
Lytton Rancheria	Not within study area	Sonoma	Santa Rosa
Chicken Ranch Rancheria of Me-Wuk Indians of California	Not within study area	Tuolumne	Jamestown
Cold Springs Rancheria of Mono Indians	Not within study area	Fresno	Tollhouse
Colorado River Indian Tribes of the Colorado River Indian Reservation	Not within study area	Riverside	Parker, Arizona

20.4 Impact Analysis

This section describes the potential mechanisms for change to ITAs, quantitative and qualitative analytical methods, effects of the analyses, potential mitigation measures, and cumulative effects.

20.4.1 Potential Mechanisms for Change and Analytical Tools

As described in Chapter 4, Approach to Environmental Analysis, the environmental consequences assessment considers changes in conditions related to changes in CVP and SWP operation under the alternatives as compared to the No Action Alternative and Second Basis of Comparison.

Changes in CVP and SWP operation under the alternatives as compared to the No Action Alternative and Second Basis of Comparison could change water elevations within the CVP and SWP reservoirs, flow patterns in the rivers downstream of CVP and SWP reservoirs, and CVP and SWP water deliveries. Impacts to existing ITAs would be considered adverse if the action:

- Interfered with the exercise of a federally reserved water right, or degrade water quality where there is a federally reserved water right
- Interfered with the use, value, occupancy, character or enjoyment of an ITA
- Failed to protect ITAs from loss, damage, waste, depletion, or other negative effects

20.4.1.1 Changes in CVP and SWP Reservoir Elevation

There are no ITAs within any of the reservoir inundation areas (DWR 2005; Reclamation 2010, 2012, 2013a, 2014a; Reclamation et al. 2011; USACE et al. 2012). Therefore, the changes in reservoir elevations would not affect ITAs and are not analyzed in this EIS.

20.4.1.2 Changes in Rivers Downstream of CVP and SWP Reservoirs

There are no ITAs within the rivers downstream of CVP and SWP reservoirs (DWR 2005; Reclamation 2010, 2012, 2013a, 2014a; Reclamation et al. 2011; USACE et al. 2012). Therefore, changes in river flow patterns would not directly affect any ITAs. However, changes in river flow patterns in the Trinity River could indirectly affect several ITAs, including the Hoopa Valley Tribe, Resighini Rancheria Tribe, and Yurok Tribe of the Yurok Reservation. Changes in the river flow patterns could affect use of the Trinity River for boats, access to adjacent lands, and fish in the Trinity River that are important to the tribes.

As described in Chapter 5, Surface Water Resources and Water Supplies, implementation of Alternatives 1 through 5 as compared to the No Action Alternative and the Second Basis of Comparison, and the No Action Alternative as compared to the Second Basis of Comparison could affect change river flow patterns in the Trinity River.

20.4.1.3 Changes due to CVP and SWP Water Deliveries

There are no ITAs that directly receive CVP or SWP water. As described in Chapter 19, Socioeconomics, municipalities that use CVP or SWP water supplies, including agencies that serve ITAs, would continue to meet water demands in 2030 if CVP and SWP water supplies are reduced through the increased use of non-CVP and SWP water supplies. Therefore, changes in CVP and SWP water deliveries would not affect water supplies to ITAs and are not analyzed in this EIS.

20.4.1.4 Effects Related to Cross Delta Water Transfers

Cross Delta water transfers involving the CVP and SWP facilities or water supplies would be required to be implemented in accordance with all existing regulations and requirements, including not causing adverse impacts to other water users in accordance with the requirements of Reclamation, California Department of Water Resources (DWR), and the State Water Resources Control Board (SWRCB).

Reclamation recently prepared a long-term regional water transfer environmental document which evaluated potential changes in surface water conditions related to water transfer actions (Reclamation 2014d). Results from this analysis were used to inform the impact assessment of potential effects of water transfers under the alternatives as compared to the No Action Alternative and the Second Basis of Comparison.

The transfers could change flow patterns in rivers downstream of CVP and SWP reservoirs. Surface water elevations in CVP and SWP reservoirs due to transfer programs under the alternatives and Second Basis of Comparison could be affected for a short-time during a water year; however, because the transferred water would have been released for the seller’s use, the end of September storage elevations would be similar with or without the transfer.

20.4.2 Conditions in Year 2030 without Implementation of Alternatives 1 through 5

The impact analysis in this EIS is based upon the comparison of the alternatives to the No Action Alternative and the Second Basis of Comparison in the Year 2030. Many of the changed conditions would occur in the same manner under both the No Action Alternative and the Second Basis of Comparison (e.g., climate change, sea-level rise, general plan development, and implementation of reasonable and foreseeable projects). Due to these changes, especially climate change and sea-level rise, it is anticipated that reservoir elevations at the end of September would be lower and flows patterns in the rivers downstream of the reservoirs would be different than under recent condition, as described in Chapter 5, Surface Water Resources and Water Supplies.

20.4.3 Evaluation of Alternatives

As described in Chapter 4, Approach to Environmental Analysis, Alternatives 1 through 5 have been compared to the No Action Alternative, and the No Action Alternative and Alternatives 1 through 5 have been compared to the Second Basis of Comparison. The evaluation of alternatives is focused on the Trinity River Region because, as discussed above, potential changes that could affect ITAs are located along the Trinity River.

During review of the numerical modeling analyses used in this EIS, an error was determined in the CalSim II model assumptions related to the Stanislaus River operation for the Second Basis of Comparison, Alternative 1, and Alternative 4 model runs. Appendix 5C includes a comparison of the CalSim II model run results presented in this chapter and CalSim II model run results with the error corrected. Appendix 5C also includes a discussion of changes in the comparison of four alternative analyses:

- No Action Alternative compared to the Second Basis of Comparison
- Alternative 1 compared to the No Action Alternative
- Alternative 3 compared to the Second Basis of Comparison
- Alternative 5 compared to the Second Basis of Comparison

20.4.3.1 No Action Alternative

As described in Chapter 4, Approach to Environmental Analysis, the No Action Alternative is compared to the Second Basis of Comparison.

20.4.3.1.1 Potential Changes in Trinity River downstream of Lewiston Dam

As described in Chapter 5, Surface Water Resources and Water Supplies, the following changes would occur on the Trinity River under the No Action Alternative as compared to the Second Basis of Comparison.

- Over long-term conditions (over the 82-year analysis period), flows would be similar (within 5 percent) from March through November, and reduced from December through February (up to 9.5 percent; 70 cubic feet per second [cfs]).
- In wet years, flows would be similar from April through November, and reduced from December through March (up to 11.2 percent; 160 cfs).
- In above normal years, flows would be similar from March through November, and reduced in January and February (up to 19.9 percent; 74 cfs).
- In below normal years, flows would be similar from March through January, and reduced in February (30.4 percent, 192 cfs).
- In dry and Critical dry years, flows would be similar all months.

The changes in river flows would occur in the winter months of wetter years when potential use of the rivers would be less for transportation and ceremonies (USFWS et al. 1999). As described in Chapter 9, Fish and Aquatic Resources, these changes in river flows would result in similar conditions for salmonids using Trinity River. Therefore, there would be no effect the ITAs.

20.4.3.1.2 Effects Related to Cross Delta Water Transfers

As described in Chapter 5, Surface Water Resources and Water Supplies, and Chapter 7, Groundwater Resources and Groundwater Quality, potential effects on surface water resources could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento Valley to San Joaquin Valley (Reclamation 2014d). Potential effects were identified as reduced surface water storage in upstream reservoirs; changes in flow patterns in rivers downstream of the reservoirs if water was released from the reservoirs in patterns that were different than would have been used by the sellers; and groundwater elevation reductions if groundwater substitution was used to provide the water for the transfers. All water transfers would be required to avoid adverse impacts on other water users and biological resources; and water transfer programs would include groundwater mitigation and monitoring plans (see Section 3.A.6.3, Transfers). Therefore, water transfer programs would need to be implemented in a manner that would avoid impacts associated with changes in Trinity Lake storage, Trinity River flow patterns, and groundwater elevation reductions in the Central Valley that could affect ITAs. For the purposes of this EIS, it is anticipated that similar conditions would occur due to cross Delta water transfers under the No Action Alternative as compared to the Second Basis of Comparison, and there would be no effect on the ITAs due to cross Delta water transfers.

20.4.3.2 Alternative 1

Alternative 1 is identical to the Second Basis of Comparison. Alternative 1 is compared to the No Action Alternative and the Second Basis of Comparison. However, because conditions under Alternative 1 are identical to conditions under the Second Basis of Comparison, Alternative 1 is only compared to the No Action Alternative.

20.4.3.2.1 Alternative 1 Compared to the No Action Alternative

Potential Changes in Trinity River downstream of Lewiston Dam

As described in Chapter 5, Surface Water Resources and Water Supplies, the following changes would occur on the Trinity River under Alternative 1 and the No Action Alternative.

- Over long-term conditions, flows would be similar from March through November, and increased from December through February (up to 10.5 percent, 86 cfs).
- In wet years, flows would be similar from April through November, and increased from December through March (up to 12.6 percent, 160 cfs).
- In above normal years, flows would be similar from March through November, and increased in January and February (up to 24.8 percent; 74 cfs).
- In below normal years, flows would be similar from March through January, and increased in February (30.4 percent, 192 cfs).
- In dry and critical dry years, flows would be similar all months.

The changes in river flows would increase flows in the Trinity River under Alternative 1 as compared to the No Action Alternative. As described in Chapter 9, Fish and Aquatic Resources, these changes in river flows would result in similar conditions for salmonids using Trinity River. Therefore, there would be no effect on the ITAs.

Effects Related to Cross Delta Water Transfers

As described in Chapter 5, Surface Water Resources and Water Supplies, and Chapter 7, Groundwater Resources and Groundwater Quality, potential effects on surface water resources could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014d). Potential effects were identified as reduced surface water storage in upstream reservoirs; changes in flow patterns in rivers downstream of the reservoirs if water was released from the reservoirs in patterns that were different than would have been used by the seller; and groundwater elevation reductions if groundwater substitution was used to provide the water for the transfers. All water transfers would be required to avoid adverse impacts on other water users and biological resources; and water transfer programs would include groundwater mitigation and monitoring plans (see Section 3.A.6.3, Transfers). Therefore, water transfer programs would need to be implemented in a manner that would avoid impacts associated with changes in Trinity Lake storage, Trinity River flow patterns, and groundwater elevation reductions in the Central Valley that could affect ITAs. For the purposes of this EIS, it is anticipated that similar conditions would occur due to cross Delta water transfers under Alternative 1 as compared to the No Action Alternative, and there would be no effect on the ITAs due to cross Delta water transfers.

20.4.3.2.2 Alternative 1 Compared to the Second Basis of Comparison

Alternative 1 is identical to the Second Basis of Comparison.

20.4.3.3 Alternative 2

The ITA conditions under Alternative 2 would be identical to the conditions under the No Action Alternative; therefore, Alternative 2 is only compared to the Second Basis of Comparison.

20.4.3.3.1 Alternative 2 Compared to the Second Basis of Comparison

Changes to ITAs under Alternative 2 as compared to the Second Basis of Comparison would be the same as the impacts described in Section 20.4.3.1, No Action Alternative.

20.4.3.4 Alternative 3

CVP and SWP operation under Alternative 3 are similar to the Second Basis of Comparison with modified Old and Middle River flow criteria and New Melones Reservoir operation.

Alternative 3 would include changed water demands for American River water supplies as compared to the No Action Alternative and Second Basis of Comparison. Alternative 3 would provide water supplies of up to 17 thousand acre feet (TAF)/year under a Warren Act Contract for El Dorado Irrigation District and 15 TAF/year under a CVP water service contract for El Dorado County Water Agency. These demands are not included in the analysis presented in this section of the EIS. A sensitivity analysis comparing the results of the analysis with and without these demands is presented in Appendix 5B of this EIS.

20.4.3.4.1 Alternative 3 Compared to the No Action Alternative

Potential Changes in Trinity River downstream of Lewiston Dam

As described in Chapter 5, Surface Water Resources and Water Supplies, the following changes would occur on the Trinity River under Alternative 3 as compared to the No Action Alternative.

- Over long-term conditions, flows would be similar from March through November, and increased from December through February (up to 11.8 percent, 79 cfs).
- In wet years, flows would be similar from April through October, reduced in November (7.0 percent, 36 cfs), and increased from December through March (up to 15.0 percent, 193 cfs).
- In above normal years, flows would be similar from March through November, and increased in January and February (up to 24.8 percent; 74 cfs).
- In dry years, flows would be similar in all months.

However, as described in Chapter 9, Fish and Aquatic Resources, these changes in river flows would result in similar conditions for salmonids using Trinity River, and there would be no effect on the ITAs.

- In above normal years, flows would be similar from March through December, and increased in January and February (up to 22.5 percent; 67 cfs).
- In below normal years, flows would be similar from March through January, and increased in February (43.3 percent, 192 cfs).
- In dry years, flows would be similar all months.
- In Critical dry years, flows would be similar from December through October, and increased in November (20.0 percent, 50 cfs).

The changes in river flows would increase flows in the Trinity River under Alternative 3 as compared to the No Action Alternative. As described in Chapter 9, Fish and Aquatic Resources, these changes in river flows would result in similar conditions for salmonids using Trinity River. Therefore, there would be no effect on the ITAs.

Effects Related to Cross Delta Water Transfers

As described in Chapter 5, Surface Water Resources and Water Supplies, and Chapter 7, Groundwater Resources and Groundwater Quality, potential effects on surface water resources could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014d). Potential effects were identified as: reduced surface water storage in upstream reservoirs; changes in flow patterns in river downstream of the reservoirs if water was released from the reservoirs in patterns that were different than would have been used by the sellers; and groundwater elevation reductions if groundwater substitution was used to provide the water for the transfers. All water transfers would be required to avoid adverse impacts on other water users and biological resources; and water transfer programs would include groundwater mitigation and monitoring plans (see Section 3.A.6.3, Transfers). Therefore, water transfer programs would need to be implemented in a manner that would avoid impacts associated with changes in Trinity Lake storage, Trinity River flow patterns, and groundwater elevation reductions in the Central Valley that could affect ITAs. For the purposes of this EIS, it is anticipated that similar conditions would occur due to cross Delta water transfers under Alternative 3 as compared to the No Action Alternative, and there would be no effect on the ITAs due to cross Delta water transfers.

20.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison

Potential Changes in Trinity River downstream of Lewiston Dam

As described in Chapter 5, Surface Water Resources and Water Supplies, under Alternative 3 as compared to the Second Basis of Comparison, flows would be similar under long-term conditions and all water year types. As described in Chapter 9, Fish and Aquatic Resources, there would be similar conditions for salmonids using Trinity River. Therefore, there would be no effect on the ITAs.

Effects Related to Cross Delta Water Transfers

As described in Chapter 5, Surface Water Resources and Water Supplies, and Chapter 7, Groundwater Resources and Groundwater Quality, potential effects on surface water resources could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014d). Potential effects were identified as: reduced surface water storage in upstream reservoirs; changes in flow patterns in river downstream of the reservoirs if water was released from the reservoirs in patterns that were different than would have been used by the sellers; and groundwater elevation reductions if groundwater substitution was used to provide the water for the transfers. All water transfers would be required to avoid adverse impacts on other water users and biological resources; and water transfer programs would include groundwater mitigation and monitoring plans (see Section 3.A.6.3, Transfers). Therefore, water transfer programs would need to be implemented in a manner that would avoid impacts associated with changes in Trinity Lake storage, Trinity River flow patterns, and groundwater elevation reductions in the Central Valley that could affect ITAs. For the purposes of this EIS, it is anticipated that similar conditions would occur due to cross Delta water transfers under Alternative 3 as compared to the Second Basis of Comparison, and there would be no effect on the ITAs due to cross Delta water transfers.

20.4.3.5 Alternative 4

The ITA conditions under Alternative 4 would be identical to the ITA conditions under the Second Basis of Comparison; therefore, Alternative 4 is only compared to the No Action Alternative.

20.4.3.5.1 Alternative 4 Compared to the No Action Alternative

Changes in ITA conditions under Alternative 4 as compared to the No Action Alternative would be the same as the impacts described in Section 20.4.3.2.1, Alternative 1 Compared to the No Action Alternative.

20.4.3.6 Alternative 5

The CVP and SWP operation under Alternative 5 are similar to the No Action Alternative with modified Old and Middle River flow criteria and New Melones Reservoir operation. Alternative 5 would include changed water demands for American River water supplies as compared to the No Action Alternative or Second Basis of Comparison. Alternative 5 would provide water supplies of up to 17 TAF/year under a Warren Act Contract for El Dorado Irrigation District and 15 TAF/year under a CVP water service contract for El Dorado County Water Agency. These demands are not included in the analysis presented in this section of the EIS. A sensitivity analysis comparing the results of the analysis with and without these demands is presented in Appendix 5B of this EIS.

20.4.3.6.1 Alternative 5 Compared to the No Action Alternative

Potential Changes in Trinity River downstream of Lewiston Dam

As described in Chapter 5, Surface Water Resources and Water Supplies, flows under Alternative 5 and the No Action Alternative would be similar under long-term conditions and all water year types. As described in Chapter 9, Fish and Aquatic Resources, there would be similar conditions for salmonids using Trinity River. Therefore, there would be no effect on the ITAs.

Effects Related to Cross Delta Water Transfers

As described in Chapter 5, Surface Water Resources and Water Supplies, and Chapter 7, Groundwater Resources and Groundwater Quality, potential effects on surface water resources could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014d). Potential effects were identified as: reduced surface water storage in upstream reservoirs; changes in flow patterns in river downstream of the reservoirs if water was released from the reservoirs in patterns that were different than would have been used by the sellers; and groundwater elevation reductions if groundwater substitution was used to provide the water for the transfers. All water transfers would be required to avoid adverse impacts on other water users and biological resources; and water transfer programs would include groundwater mitigation and monitoring plans (see Section 3.A.6.3, Transfers). Therefore, water transfer programs would need to be implemented in a manner that would avoid impacts associated with changes in Trinity Lake storage, Trinity River flow patterns, and groundwater elevation reductions in the Central Valley that could affect ITAs. For the purposes of this EIS, it is anticipated that similar conditions would occur due to cross Delta water transfers under Alternative 5 as compared to the No Action Alternative, and there would be no effect on the ITAs due to cross Delta water transfers.

20.4.3.6.2 Alternative 5 Compared to the Second Basis of Comparison

Potential Changes in Trinity River downstream of Lewiston Dam

As described in Chapter 5, Surface Water Resources and Water Supplies, the following changes would occur on the Trinity River flows under Alternative 5 and Second Basis of Comparison

- Over long-term conditions, flows would be similar from March through November and January, and reduced in December and February (up to 9.6 percent, 200 cfs).
- In wet years, flows would be similar from April through November, and reduced in December through March (up to 13.9 percent).
- In above normal years, flows would be similar from April through December, and reduced in January and February (up to 19.9 percent, 74 cfs).
- In below normal years, flows would be similar from March through January, and reduced in February (up to 21.5 percent, 135 cfs).
- In dry and critical dry years, flows would be similar in all months.

However, as described in Chapter 9, Fish and Aquatic Resources, these changes in river flows would result in similar conditions for salmonids using Trinity River; and there would be no effect the ITAs.

Effects Related to Cross Delta Water Transfers

As described in Chapter 5, Surface Water Resources and Water Supplies, and Chapter 7, Groundwater Resources and Groundwater Quality, potential effects on surface water resources could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014d). Potential effects were identified as reduced surface water storage in upstream reservoirs and changes in flow patterns in river downstream of the reservoirs if water was released from the reservoirs in patterns that were different than would have been used by the water seller's; and groundwater elevation reductions if groundwater substitution was used to provide the water for the transfers. All water transfers would be required to avoid adverse impacts on other water users and biological resources; and water transfer programs would include groundwater mitigation and monitoring plans (see Section 3.A.6.3, Transfers). Therefore, water transfer programs would need to be implemented in a manner that would avoid impacts associated with changes in Trinity Lake storage, Trinity River flow patterns, and groundwater elevation reductions in the Central Valley that could affect ITAs. For the purposes of this EIS, it is anticipated that similar conditions would occur due to cross Delta water transfers under Alternative 5 as compared to the Second Basis of Comparison, and there would be no effect on the ITAs due to cross Delta water transfers.

20.4.3.7 Summary of Impact Analysis

The results of the impact analysis of implementation of Alternatives 1 through 5 as compared to the No Action Alternative and the Second Basis of Comparison are presented in Tables 20.2 and 20.3.

Table 20.2 Comparison of Alternatives 1 through 5 to No Action Alternative

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	No effects to ITAs	None needed
Alternative 2	No effects to ITAs	None needed
Alternative 3	No effects to ITAs	None needed
Alternative 4	No effects to ITAs	None needed
Alternative 5	No effects to ITAs	None needed

Table 20.3 Comparison of No Action Alternative and Alternatives 1 through 5 to Second Basis of Comparison

Alternative	Potential Change	Consideration for Mitigation Measures
No Action Alternative	No effects to ITAs	None needed
Alternative 1	No effects to ITAs	None needed
Alternative 2	No effects to ITAs	None needed
Alternative 3	No effects to ITAs	None needed
Alternative 4	No effects to ITAs	None needed
Alternative 5	No effects to ITAs	None needed

20.4.3.8 Potential Mitigation Measures

Mitigation measures are presented in this section to avoid, minimize, rectify, reduce, eliminate, or compensate for adverse environmental effects of Alternatives 1 through 5 as compared to the No Action Alternative. Mitigation measures were not included to address adverse impacts under the alternatives as compared to the Second Basis of Comparison because this analysis was included in this EIS for information purposes only.

Changes under Alternatives 1 through 5 as compared to the No Action Alternative would result in similar or increased flows in the Trinity River, and implementation of cross Delta water transfers would not result in adverse impacts to ITAs. Therefore, there would be no adverse impacts to ITAs, and no mitigation measures are needed.

20.4.3.9 Cumulative Effects Analysis

As described in Chapter 3, the cumulative effects analysis considers projects, programs, and policies that are not speculative, and are based upon known or reasonably foreseeable long-range plans, regulations, operating agreements, or other information that establishes them as reasonably foreseeable.

The cumulative effects analysis for Alternatives 1 through 5 to Indian Trust Assets are summarized in Table 20.4. As described in this chapter, potential changes to Indian Trust Assets would be associated with changes in flows in the Trinity River.

Table 20.4 Summary of Cumulative Effects on Indian Trust Assets with Implementation of Alternatives 1 through 5 as Compared to the No Action Alternative

Scenarios	Actions	Cumulative Effects of Actions
Past & Present, and Future Actions included in the No Action Alternative and All Alternatives in Year 2030	Consistent with Affected Environment conditions plus: Actions in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives), including climate change and sea level rise Actions not included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives): - Trinity River Restoration Program. - Central Valley Project Improvement Act programs	<u>These effects would be the same under all alternatives.</u> Climate change and sea level rise are anticipated to reduce carryover storage in reservoirs, including Trinity Lake, and changes in stream flow patterns, including Trinity River, in a manner that would change beneficial use of the Trinity River, including salmon fishing. Other ongoing actions, including Trinity River Restoration Program, would improve water quality and/or habitat along the Trinity River.
Future Actions considered as Cumulative Effects Actions in All Alternatives in Year 2030	Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives): - Bay-Delta Water Quality Control Plan Update - FERC Relicensing Projects - Bay Delta Conservation Plan (including the California WaterFix alternative) - Shasta Lake Water Resources, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations - El Dorado Water and Power Authority Supplemental Water Rights Project - Semitropic Water Storage District Delta Wetlands - North Bay Aqueduct Alternative Intake	<u>These effects would be the same under all alternatives.</u> Based upon environmental documents prepared for these programs, changes to the Trinity River flows are not anticipated due to implementation of these programs.

Scenarios	Actions	Cumulative Effects of Actions
No Action Alternative with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO	Implementation of No Action Alternative with reasonably foreseeable actions would result in changes Trinity Lake carryover storage and Trinity River flows which would result in changes to beneficial use opportunities for Indian Trust Assets as compared to historical conditions prior to the BOs.
Alternative 1 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternative 1 with reasonably foreseeable actions would result in similar conditions for Indian Trust Assets as for the No Action Alternative with the added actions.
Alternative 2 with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions No implementation of structural improvements or other actions that require further study to develop a more detailed action description.	Implementation of Alternative 2 with reasonably foreseeable actions would result in similar conditions for Indian Trust Assets as for the No Action Alternative with the added actions.
Alternative 3 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant) Slight increase in positive Old and Middle River flows in the winter and spring months	Implementation of Alternative 3 with reasonably foreseeable actions would result in similar conditions for Indian Trust Assets as for the No Action Alternative with the added actions.
Alternative 4 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternative 4 with reasonably foreseeable actions would result in similar conditions for Indian Trust Assets as for the No Action Alternative with the added actions.
Alternative 5 with Associated Cumulative Effects Actions in Year 20530	Full implementation of the 2008 USFWS BO and 2009 NMFS BO Positive Old and Middle River flows and increased Delta outflow in spring months	Implementation of Alternative 5 with reasonably foreseeable actions would result in similar conditions for Indian Trust Assets as for the No Action Alternative with the added actions.

20.5 References

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Chapter 21

Environmental Justice

21.1 Introduction

This chapter describes the presence of environmental justice populations in the study area and potential changes that could have disproportionately high and adverse human health or environmental effects on minority and/or low-income populations as a result of implementing the alternatives evaluated in this Environmental Impact Statement (EIS). Implementation of the alternatives could affect conditions through potential changes in operation of the Central Valley Project (CVP) and State Water Project (SWP) and ecosystem restoration.

21.2 Regulatory Environment and Compliance Requirements

This chapter was prepared in compliance with Presidential Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, dated February 11, 1994 and Title VI of the Civil Rights Act of 1964.

Potential actions that could be implemented under the alternatives evaluated in this EIS could have disproportionately high and adverse human health or environmental effects on minority and/or low-income populations. Actions located on public agency lands; or implemented, funded, or approved by Federal and state agencies would need to be compliant with appropriate Federal and state agency policies and regulations, as summarized in Chapter 4, Approach to Environmental Analyses.

21.3 Affected Environment

This section describes changes that could result in disproportionately high and adverse human health or environmental effects on minority and/or low-income populations due to changes in CVP and SWP operations. The conditions described in this chapter are related to the distribution of minority populations and populations below poverty levels.

21.3.1 Area of Analysis

A summary of conditions are described in this section of the EIS for the following regions that could be affected by implementation of alternatives analyzed in this EIS, as described in Chapter 4, Approach to Environmental Analysis.

- Trinity River Region
- Central Valley Region

- San Francisco Bay Area Region
- Central Coast Region
- Southern California Region

21.3.2 Characterization of Conditions Considered in the Environmental Justice Analysis

Characterization of the conditions within the Study Area is based upon publically available data from government websites and other data sources. The data sources used include the 2010 U.S. Census Bureau data on minority populations and the 2010 American Community Survey (ACS) 5-year population estimates on populations below the poverty level.

21.3.2.1 Determination of Minority Populations

The U.S. Census Bureau provides a total population value for each county, which are also used by the State Department of Finance, as presented in Chapter 14, Socioeconomics. The U.S. Census Bureau also provides a definition of minority and low income populations. Minority populations are defined by the U.S. Census as racial and ethnic minorities. Racial minorities, as defined by the U.S. Census, include people who identified themselves in the census as belonging to one of the following categories:

- Single Race
    - Black/African American
    - American Indian and Alaskan Native
    - Asian
    - Native Hawaiian and Other Pacific Islander
    - Some Other Race
- Two or More Races (inclusive the races listed above and White).

Ethnic minorities, as defined by the U.S. Census, include individuals who identified themselves as being of Hispanic or Latino origin by responding to one of the following categories in the census:

- Mexican
- Mexican American
- Chicano
- Puerto Rican
- Cuban
- Other Spanish/Hispanic/Latino

Individuals who identified themselves of Hispanic or Latino origin maybe of one or more races according to the U.S. Census.

21.3.2.2 Determination of Populations below the Poverty Level

Populations below the Federal poverty level can be identified using several methodologies. The information presented in this chapter has been developed in ACS reports by the U.S. Census Bureau based upon 48 different sets of dollar value thresholds related to family size and ages. The poverty level is assigned at the family-level and affects every member of the family. The thresholds are consistent throughout the United States and do not consider geographic differentials. The thresholds are updated each year based on the Consumer Price Index. For the five-year ACS reporting period used in this chapter, separate thresholds are applied to each year in this continuous survey. Other federal agencies rely upon different poverty statistics including the Current Population Survey Annual Social and Economic Supplement and the U.S. Department of Health and Human Services poverty guidelines.

The population for whom poverty level is estimated by ACS is smaller value than the total population values presented in Chapter 14, Socioeconomics, for each county and the equivalent population values used for the distribution of the population by race and ethnicity. The population values to determine poverty rates do not include institutionalized individuals (e.g., military personnel that live in group quarters, students that live in college dormitories, and prison inmates. The U.S. Census Bureau designates geographical areas with poverty rates at and above 20 percent as “poverty areas.”

21.3.2.3 Social Services

The need for and delivery of social services within each county is another indication of social conditions, including Federal grants to the state and local agencies for Medicaid, other health related activities, and nutrition and family welfare; and Federal direct payments made to individuals under the CalFresh (previously referred to as “Food Stamps”) and supplemental social security income.

21.3.2.4 Limited English Proficiency

Another consideration related to environmental justice is the ability of the Federal government to provide access to federally conducted and assisted programs and activities to all people who, as a result of their national origin, are limited in their English proficiency (LEP). These individuals are not able to speak, read, write, or understand the English language at a level that permits them to interact effectively with Federal employees who provide Federal services. Therefore, these individuals are often excluded from Federal programs, do not receive all available Federal services, and/or experience delays when interacting with Federal programs. The Executive Order 13166 became effective on August 11, 2000 to ensure meaningful participation by individuals who have limited English proficiency in federally conducted and federally assisted programs and activities. This information is compiled and reported by the U.S. Census Bureau.

21.3.3 Trinity River Region

The Trinity River Region includes the area in Trinity County along the Trinity River from Trinity Lake to the confluence with the Klamath River; and in Humboldt and Del Norte counties along the Lower Klamath River from the confluence with the Trinity River to the Pacific Ocean. Tribal lands along the Trinity or Lower Klamath River within the Trinity River Region include the

Hoopa Valley Indian Reservation, Yurok Indian Reservation, and Resighini Rancheria.

21.3.3.1 Minority Populations

As recorded in the 2010 Census, the Trinity River Region had a total population of 177,019 (U.S. Census 2014a). About 24.3 percent of this population identified themselves as a racial minority and/or of Hispanic or Latino origin, regardless of race, as presented in Table 21.1 (U.S. Census 2014a, 2014b, 2014c, 2014d). There are fewer minorities in the Trinity River Region than in the entire State of California.

21.3.3.2 Poverty Levels

Poverty levels presented in Table 21.2 are calculated on a subset of the total population of a county, as described above in section 21.3.2, Characterization of Conditions Considered in the Environmental Justice Analysis. Of the total population for whom poverty is determined in the Trinity River Region, 167,987 individuals (or 18.2 percent) were below the poverty level based on the 2006–2010 ACS 5-year dataset (U.S. Census 2014e). The U.S. Census Bureau defines geographical areas with more than 20 percent of the population below the poverty level as a “poverty areas.” Both Humboldt and Del Norte counties are defined as poverty areas.

Poverty rates based upon the 2000 census were reported as 40 percent for Indians on the Yurok Indian Reservation, 34 percent of the Indians on the Hoopa Valley Indian Reservation, and 54 percent of the Indians on and off Karuk Reservation trust lands (NMFS 2012a, 2012b, 2012c). The Yurok Tribe has reported an average poverty rate of 80 percent of the Indians on the Yurok Indian Reservation (Yurok Tribe 2014a). Average per capita income of residents on the Resighini Rancheria (not limited to Resighini Rancheria members) in 1999 was reported to be approximately 46 percent of the average per capita income in Del Norte County (NMFS 2012d).

21.3.3.3 Social Services

Federal grants to the state and local agencies for Medicaid, other health related activities, and nutrition and family welfare; and Federal direct payments made to individuals under the CalFresh (previously referred to as “Food Stamps”) and supplemental social security income within counties in the Trinity River Region are summarized in Table 21.3.

Social services to tribal members are funded by the tribe and/or the federal government (DOI and DFG 2012). The Hoopa Valley Tribe provides food distribution and other social services, including Temporary Assistance for Needy Families (TANF) which receives some assistance from Humboldt County social services to provide cash assistance, utility billing assistance, childcare, educational assistance, job development, substance abuse assistance, and family assistance (Hoopa Tribe 2014 a, 2014b). The Yurok Tribe provides a wide range of services, including general assistance, food distribution, Indian Child welfare, low income energy assistance, Yurok Youth Program, emergency and temporary assistance, and Yurok Domestic Violence/Sexual Assault Project (Yurok Tribe 2014b).

21.3.3.4 Limited English Proficiency

The percent of the population that speaks English and other languages at home and the percent of the population that speak English “less than very well” based on the language they speak at home are presented in Tables 21.4 and 21.5.

21.3.4 Central Valley Region

The Central Valley Region includes the Sacramento Valley, San Joaquin Valley, and Delta and Suisun Marsh subregions.

21.3.4.1 Sacramento Valley

The Sacramento Valley includes the counties of Shasta, Plumas, Tehama, Glenn, Colusa, Butte, Sutter, Yuba, Nevada, Placer, and El Dorado counties. Sacramento, Yolo, and Solano counties also are located within the Sacramento Valley; however, these counties are discussed below as part of the Delta and Suisun Marsh subsection. Other counties in this region are not anticipated to be affected by changes in CVP and SWP operations, and are not discussed here, including: Alpine, Sierra, Lassen, and Amador counties.

21.3.4.1.1 Minority Populations

As recorded in the 2010 U.S. Census, the Sacramento Valley portion of the Central Valley Region had a total population of 1,325,380 in 2010. About 25.8 percent of this population identified themselves as a racial minority and/or of Hispanic or Latino origin, regardless of race, as presented in Table 21.6. The table also shows the minority population distribution for the entire Central Valley Region and the State of California.

Table 21.1 Minority Population Distribution in Trinity River Region in 2010

Areas	Total Population	Races							Hispanic or Latino Origin	Total Minority[a]
		White	Black/ African American	American Indian and Native Alaskan	Asian	Native Hawaiian and Other Pacific Islander	Some Other Race	Two or More Races		
Trinity County	13,786	87.3%	0.4%	4.8%	0.7%	0.1%	1.6%	5.2%	7.0%	16.5%
Humboldt County	134,623	81.7%	1.1%	5.7%	2.2%	0.3%	3.7%	5.3%	9.8%	22.8%
Del Norte County	28,610	73.7%	3.5%	7.8%	3.4%	0.1%	6.9%	4.5%	17.8%	35.3%
Trinity River Region	177,019	80.8%	1.4%	6.0%	2.3%	0.2%	4.1%	5.2%	10.9%	24.3%
STATE OF CALIFORNIA	**37,253,956**	**57.6%**	**6.2%**	**1.0%**	**13.0%**	**0.4%**	**17.0%**	**4.9%**	**40.1%**	**59.9%**

Sources: U.S. Census 2014a, 2014b, 2014c, 2014d

Note:

a. Total Minority is an aggregation of all non-white racial groups and includes all individuals of Hispanic or Latino origin, regardless of race.

Table 21.2 Population below Poverty Level in Trinity River Region, 2006–2010

Areas	Total Population[a]	Population Below Poverty Level	Percent of Population Below Poverty Level
Trinity County	13,225	1,993	15.1%
Humboldt County	129,592	22,973	17.7%
Del Norte County	25,170	5,526	22.0%
Trinity River Region	167,987	30,492	18.2%
STATE OF CALIFORNIA	**35,877,036**	**4,919,945**	**13.7%**

Source: U.S. Census 2014e

Note: a. Population numbers are only those for whom poverty status was determined and exclude institutionalized individuals

Table 21.3 Federal Funds Distributed for Social Programs in Trinity River Region in 2010

	Grants (millions of dollars)		Distributed to Individuals (millions of dollars)
Areas	Medicaid and Other Health-Related Items	Nutrition and Family Welfare	CalFresh Benefits and Supplemental Security Income
Trinity County	$12.5	$4.9	$6.6
Humboldt County	$167.8	$36.0	$65.6
Del Norte County	$28.8	$10.1	$19.1
Trinity River Region	$209.1	$51.0	$91.3
STATE OF CALIFORNIA	**$41,931.1**	**$11,743.7**	**$12,469.4**

Source: Gaquin and Ryan 2013

Table 21.4 Top Five Non-English Languages Spoken at Home as a Proportion of the Total Population Five Years and Older in the Trinity River Region, 2006–2010

Areas	Only English	Spanish/ Spanish Creole	Portuguese/ Portuguese Creole	German	Tagalog	Hmong	Total Excluding English
Trinity County	93.9%	3.8%	0.0%	0.3%	0.1%	0.0%	4.2%
Humboldt County	90.8%	5.7%	0.4%	0.3%	0.3%	0.0%	6.8%
Del Norte County	83.3%	11.6%	0.1%	0.5%	0.5%	1.6%	14.2%
Trinity River Region	89.8%	6.5%	0.4%	0.3%	0.3%	0.3%	7.8%
STATE OF CALIFORNIA	**57.0%**	**28.5%**	**0.2%**	**0.3%**	**2.2%**	**0.2%**	**31.4%**

Source: U.S. Census 2014f

Table 21.5 Percent of Population Speaking One of the Top Five Non-English Languages Spoken at Home in the Trinity River Region that Speaks English "Less than Very Well" as a Proportion of the Total Population Five Years and Older, 2006–2010

Areas	Spanish/ Spanish Creole	Portuguese/ Portuguese Creole	German	Tagalog	Hmong
Trinity County	1.4%	0.0%	0.0%	0.0%	0.0%
Humboldt County	2.3%	0.2%	0.1%	0.1%	0.0%
Del Norte County	3.1%	0.0%	0.1%	0.1%	0.6%
Trinity River Region	2.4%	0.1%	0.1%	0.1%	0.1%
STATE OF CALIFORNIA	**13.6%**	**0.1%**	**0.05%**	**0.7%**	**0.1%**

Source: U.S. Census 2014f

Table 21.6 Minority Population Distribution in the Central Valley Region–Sacramento Valley in 2010

Areas	Total Population	Races							Hispanic or Latino Origin	Total Minority[a]
		White	Black/ African American	American Indian and Native Alaskan	Asian	Native Hawaiian and Other Pacific Islander	Some Other Race	Two or More Races		
Shasta County	177,223	86.7%	0.9%	2.8%	2.5%	0.2%	2.5%	4.4%	8.4%	17.6%
Plumas County	20,007	89.0%	1.0%	2.7%	0.7%	0.1%	3.0%	3.6%	8.0%	15.0%
Tehama County	63,463	81.5%	0.6%	2.6%	1.0%	0.1%	9.9%	4.3%	21.9%	28.1%
Glenn County	28,122	71.1%	0.8%	2.2%	2.6%	0.1%	19.6%	3.6%	37.5%	44.1%
Colusa County	21,419	64.7%	0.9%	2.0%	1.3%	0.3%	27.3%	3.6%	55.1%	60.2%
Butte County	220,000	81.9%	1.6%	2.0%	4.1%	0.2%	5.5%	4.7%	14.1%	24.8%
Yuba County	72,155	68.4%	3.3%	2.3%	6.7%	0.4%	11.8%	7.1%	25.0%	41.2%
Nevada County	98,764	91.4%	0.4%	1.1%	1.2%	0.1%	2.7%	3.2%	8.5%	13.5%
Sutter County	94,737	61.0%	2.0%	1.4%	14.4%	0.3%	15.3%	5.6%	28.8%	49.6%
Placer County	348,432	83.5%	1.4%	0.9%	5.9%	0.2%	3.8%	4.3%	12.8%	23.9%
El Dorado County	181,058	86.6%	0.8%	1.1%	3.5%	0.2%	4.0%	3.8%	12.1%	20.1%
Sacramento Valley Subtotal	1,325,380	81.7%	1.3%	1.6%	4.7%	0.2%	6.1%	4.5%	23.1%	25.8%
Central Valley Region	8,379,045	61.4%	6.3%	1.3%	9.5%	0.4%	15.7%	5.4%	42.6%	53.5%
STATE OF CALIFORNIA	**37,253,956**	**57.6%**	**6.2%**	**1.0%**	**13.0%**	**0.4%**	**17.0%**	**4.9%**	**37.6%**	**59.9%**

Sources: U.S. Census 2014a, 2014g, 2014h, 2014i, 2014j, 2014k, 2014l, 2014m, 2014n, 2014o, 2014p, 2014q

Note:

a. Total Minority is an aggregation of all non-white racial groups and includes all individuals of Hispanic or Latino origin, regardless of race.

21.3.4.1.2 Poverty Levels

Poverty levels presented in Table 21.7 are calculated on a subset of the total population of a county, as described above in section 21.3.2, Characterization of Conditions Considered in the Environmental Justice Analysis. Of the total population for whom poverty status is determined within the Sacramento Valley portion of the Central Valley Region, 1,288,594 individuals, 12.6 percent were below the poverty level based on the 2006–2010 ACS 5-year dataset (U.S. Census 2014e).

The U.S. Census Bureau defines geographical areas with more than 20 percent of the population below the poverty level as a "poverty areas." There are no counties in this area defined as poverty areas; although, 20 percent of the populations in Tehama and Yuba counties are below the poverty level.

21.3.4.1.3 Social Services

Federal grants to the state and local agencies for Medicaid, other health related activities, and nutrition and family welfare; and Federal direct payments made to individuals under the CalFresh and supplemental social security income within counties in the Sacramento Valley portion of the Central Valley Region are summarized in Table 21.8.

21.3.4.1.4 Limited English Proficiency

The percent of the population that speaks English and other languages at home and the percent of the population that speak English "less than very well" based on the language they speak at home are presented in Tables 21.9 and 21.10.

21.3.4.2 San Joaquin Valley

The San Joaquin Valley includes the counties of Stanislaus, Merced, Madera, Fresno, Kings, Tulare, and Kern counties. San Joaquin County also is located within the San Joaquin Valley; however, this county is discussed below as part of the Delta and Suisun Marsh subsection. Other counties in this region are not anticipated to be affected by changes in CVP and SWP operations, and are not discussed here, including: Calaveras, Mariposa, and Tuolumne counties.

21.3.4.2.1 Minority Populations

As recorded in the 2010 U.S. Census, the San Joaquin Valley portion of the Central Valley Region had a total population of 3,286,353 in 2010. About 63.3 percent of this population identified themselves as a racial minority and/or of Hispanic or Latino origin, regardless of race, as presented in Table 21.11. The table also shows the minority population distribution for the entire Central Valley Region and the State of California.

Table 21.7 Population below Poverty Level in the Central Valley Region–Sacramento Valley, 2006–2010

Areas	Total Population[a]	Population Below Poverty Level	Percent of Population Below Poverty Level
Shasta County	174,180	28,772	16.5%
Plumas County	20,179	2,437	12.1%
Tehama County	61,201	12,397	20.3%
Glenn County	27,853	4,875	17.5%
Colusa County	20,768	3,107	15.0%
Butte County	213,501	39,290	18.4%
Yuba County	68,848	13,760	20.0%
Nevada County	97,209	8,740	9.0%
Sutter County	92,477	13,194	14.3%
Placer County	334,718	22,090	6.6%
El Dorado County	177,660	14,003	7.9%
Sacramento Valley Subtotal	1,288,594	162,665	12.6%
Central Valley Region	8,025,054	1,268,984	15.8%
STATE OF CALIFORNIA	**35,877,036**	**4,919,945**	**13.7%**

Source: U.S. Census 2014e

Note: a. Population numbers are only those for whom poverty status was determined and exclude institutionalized individuals

Table 21.8 Federal Funds Distributed for Social Programs in the Central Valley Region – Sacramento Valley in 2010

Areas	Grants (millions of dollars)		Distributed to Individuals (millions of dollars)
	Medicaid and Other Health-Related Items	Nutrition and Family Welfare	CalFresh Benefits and Supplemental Security Income
Shasta County	$199.0	$50.8	$93.5
Plumas County	$19.3	$7.9	$5.9
Tehama County	$61.6	$17.5	$23.1
Glenn County	$25.3	$10.6	$11.3
Colusa County	$18.6	$8.2	$6.5
Butte County	$263.4	$44.7	$104.9
Yuba County	$125.0	$21.8	$45.2
Nevada County	$53.8	$15.4	$16.1
Sutter County	$76.4	$20.1	$28.8
Placer County	$139.2	$44.8	$43.2
El Dorado County	$62.5	$32.4	$29.0
Sacramento Valley Subtotal	$1,044.1	$274.2	$407.5
Central Valley Region	$8,759.9	$4,308.9	$3,179.8
STATE OF CALIFORNIA	**$41,931.1**	**$11,743.7**	**$12,469.4**

Source: Gaquin and Ryan 2013

Table 21.9 Top Five Non-English Languages Spoken at Home as a Proportion of the Total Population Five Years and Older in the Central Valley Region – Sacramento Valley, 2006–2010

Areas	Only English	Spanish/ Spanish Creole	Tagalog	German	Chinese	Hmong	Total Excluding English
Shasta County	91.5%	4.6%	0.3%	0.6%	0.3%	0.01%	5.7%
Plumas County	92.4%	5.9%	0.1%	0.4%	0.6%	0.0%	7.0%
Tehama County	80.4%	16.9%	0.1%	0.4%	0.2%	0.02%	17.7%
Glenn County	67.4%	29.6%	0.1%	0.2%	0.0%	0.0%	29.8%
Colusa County	54.3%	44.1%	0.4%	0.1%	0.3%	0.0%	44.8%
Butte County	85.4%	9.3%	0.3%	0.3%	0.5%	1.3%	11.7%
Yuba County	74.4%	17.8%	0.8%	0.4%	0.3%	3.1%	22.3%
Nevada County	93.4%	4.1%	0.1%	0.8%	0.1%	0.0%	5.1%
Sutter County	65.5%	20.5%	0.5%	0.4%	0.5%	0.1%	21.9%
Placer County	86.1%	6.3%	1.3%	0.4%	0.7%	0.1%	8.7%
El Dorado County	88.2%	7.3%	0.4%	0.6%	0.5%	0.02%	9.0%
Sacramento Valley Subtotal	84.4%	9.7%	0.6%	0.5%	0.5%	0.4%	11.6%
Central Valley Region	66.2%	23.1%	1.7%	0.3%	1.2%	0.8%	27.1%
STATE OF CALIFORNIA	**57.0%**	**28.5%**	**2.2%**	**0.3%**	**2.9%**	**0.2%**	**34.1%**

Source: U.S. Census 2014f

Table 21.10 Percent of Population Speaking One of the Top Five Non-English Languages Spoken at Home in the Central Valley Region – Sacramento Valley that Speaks English "Less than Very Well" as a Proportion of the Total Population Five Years and Older, 2006–2010

Areas	Spanish/ Spanish Creole	Tagalog	German	Chinese	Hmong
Shasta County	1.4%	0.1%	0.05%	0.1%	0.01%
Plumas County	1.8%	0.0%	0.00%	0.6%	0.0%
Tehama County	8.0%	0.1%	0.04%	0.1%	0.0%
Glenn County	13.3%	0.0%	0.1%	0.0%	0.0%
Colusa County	24.7%	0.0%	0.02%	0.3%	0.0%
Butte County	3.8%	0.1%	0.04%	0.4%	0.8%
Yuba County	9.2%	0.2%	0.1%	0.2%	2.1%
Nevada County	2.1%	0.1%	0.1%	0.06%	0.0%
Sutter County	12.3%	0.1%	0.02%	0.2%	0.03%
Placer County	2.7%	0.4%	0.05%	0.3%	0.07%
El Dorado County	3.3%	0.1%	0.1%	0.2%	0.0%
Sacramento Valley Subtotal	4.6%	0.2%	0.06%	0.2%	0.3%
Central Valley Region	10.8%	0.5%	0.04%	0.06%	0.4%
STATE OF CALIFORNIA	**13.6%**	**0.7%**	**0.04%**	**1.6%**	**0.1%**

Source: U.S. Census 2014f

Table 21.11 Minority Population Distribution in the Central Valley Region – San Joaquin Valley in 2010

Areas	Total Population	Races							Hispanic or Latino Origin	Total Minority[a]
		White	Black/ African American	American Indian and Native Alaskan	Asian	Native Hawaiian and Other Pacific Islander	Some Other Race	Two or More Races		
Stanislaus County	514,453	65.6%	2.9%	1.1%	5.1%	0.7%	19.3%	5.4%	41.9%	53.3%
Madera County	150,865	62.6%	3.7%	2.7%	1.9%	0.1%	24.8%	4.2%	53.7%	62.0%
Merced County	255,793	58.0%	3.9%	1.4%	7.4%	0.2%	24.5%	4.7%	54.9%	68.1%
Fresno County	930,450	55.4%	5.3%	1.7%	9.6%	0.2%	23.3%	4.5%	50.3%	67.3%
Tulare County	442,179	60.1%	1.6%	1.6%	3.4%	0.1%	29.0%	4.2%	60.6%	67.4%
Kings County	152,982	54.3%	7.2%	1.7%	3.7%	0.2%	28.1%	4.9%	50.9%	64.8%
Kern County	839,631	59.5%	5.8%	1.5%	4.2%	0.1%	24.3%	4.5%	49.2%	61.4%
San Joaquin Valley Subtotal	3,286,353	59.1%	4.5%	1.6%	5.9%	0.2%	24.1%	4.6%	50.6%	63.3%
Central Valley Region	8,379,045	61.4%	6.3%	1.3%	9.5%	0.4%	15.7%	5.4%	42.6%	53.5%
STATE OF CALIFORNIA	37,253,956	57.6%	6.2%	1.0%	13.0%	0.4%	17.0%	4.9%	37.6%	59.9%

Sources: U.S. Census 2014a, 2014r, 2014s, 2014t, 2014u, 2014v, 2014w, 2014x

Note:

a. Total Minority is an aggregation of all non-white racial groups and includes all individuals of Hispanic or Latino origin, regardless of race.

21.3.4.2.2 Poverty Levels

Poverty levels presented in Table 21.12 are calculated on a subset of the total population of a county, as described above in section 21.3.2, Characterization of Conditions Considered in the Environmental Justice Analysis. Of the total population for whom poverty status is determined within the San Joaquin Valley portion of the Central Valley Region, 3,111,943 individuals, 20.8 percent, were below the poverty level based on the 2006–2010 ACS 5-year dataset (U.S. Census 2014e). The U.S. Census Bureau defines geographical areas with more than 20 percent of the population below the poverty level as a “poverty areas.” Merced, Fresno, Tulare, and Kern counties are defined as poverty areas because more than 20 percent of the populations in these counties are below the poverty level.

21.3.4.2.3 Social Services

Distribution of social services varies for each county. Federal grants to the state and local agencies for Medicaid, other health related activities, and nutrition and family welfare; and Federal direct payments made to individuals under the CalFresh and supplemental social security income within counties in the San Joaquin Valley portion of the Central Valley Region are summarized in Table 21.13.

21.3.4.2.4 Limited English Proficiency

The percent of the population that speaks English and other languages at home and the percent of the population that speak English “less than very well” based on the language they speak at home are presented in Tables 21.14 and 21.15.

21.3.4.2.5 Effects of Recent Drought in Two San Joaquin Valley Communities

The San Joaquin Valley portion of the Central Valley Region includes about 8.8 percent of the state’s total population, 9.3 percent of the state’s population that identified themselves as a racial minority and/or of Hispanic or Latino origin, and about 13.1 percent of the state’s population below the poverty level. Merced, Fresno, and Tulare counties had the highest concentration of total minority populations and the highest concentration of individuals living below the poverty level. There are communities within these counties that have higher concentrations of minority populations and/or populations below the poverty level. These communities are mainly farming communities that have been impacted by loss in agricultural employment, as described in Chapter 12, Agricultural Resources, and Chapter 19, Socioeconomics. The impacts have increased recently during the current drought.

Table 21.12 Population below Poverty Level in the Central Valley Region – San Joaquin Valley, 2006–2010

Areas	Total Population[a]	Population Below Poverty Level	Percent of Population Below Poverty Level
Stanislaus County	502,108	82,480	16.4%
Madera County	138,151	26,656	19.3%
Merced County	246,260	53,738	21.8%
Fresno County	890,694	200,288	22.5%
Tulare County	423,902	97,012	22.9%
Kings County	133,206	25,713	19.3%
Kern County	777,622	159,967	20.6%
San Joaquin Valley Subtotal	3,111,943	645,854	20.8%
Central Valley Region	8,025,054	1,268,984	15.8%
STATE OF CALIFORNIA	**35,877,036**	**4,919,945**	**13.7%**

Source: U.S. Census 2014e

Note:

a. Population numbers are only those for whom poverty status was determined and exclude institutionalized individuals

Table 21.13 Federal Funds Distributed for Social Programs in the Central Valley Region – San Joaquin Valley in 2010

Areas	Grants (millions of dollars)		Distributed to Individuals (millions of dollars)
	Medicaid and Other Health-Related Items	Nutrition and Family Welfare	CalFresh Benefits and Supplemental Security Income
Stanislaus County	$535.9	$145.3	$198.7
Madera County	$144.3	$33.6	$45.6
Merced County	$260.0	$73.7	$126.0
Fresno County	$992.0	$274.8	$468.5
Tulare County	$569.1	$116.0	$196.5
Kings County	$129.2	$37.8	$49.3
Kern County	$712.0	$203.4	$328.6
San Joaquin Valley Subtotal	$3,342.5	$884.6	$1,413.2
Central Valley Region	$8,759.9	$4,308.9	$3,179.8
STATE OF CALIFORNIA	**$41,931.1**	**$11,743.7**	**$12,469.4**

Source: Gaquin and Ryan 2013

Table 21.14 Top Five Non-English Languages Spoken at Home as a Proportion of the Total Population Five Years and Older in the Central Valley Region – San Joaquin Valley, 2006–2010

Areas	Speaks Only English	Spanish and Spanish Creole	Tagalog	Chinese	Portuguese/ Portuguese Creole	Hmong	Total Excluding English
Stanislaus County	59.8%	30.6%	0.7%	0.4%	0.9%	0.1%	32.8%
Madera County	58.0%	38.6%	0.3%	0.1%	0.2%	0.3%	39.5%
Merced County	48.5%	41.5%	0.7%	0.5%	2.2%	2.5%	47.4%
Fresno County	57.4%	32.5%	0.7%	0.6%	0.1%	2.7%	36.6%
Tulare County	53.2%	42.5%	0.7%	0.2%	0.7%	0.2%	44.4%
Kings County	57.4%	37.9%	1.6%	0.4%	1.0%	0.0%	40.9%
Kern County	59.0%	36.4%	1.1%	0.3%	0.0%	0.0%	37.8%
San Joaquin Valley Subtotal	57.0%	35.8%	0.8%	0.4%	0.5%	1.0%	38.5%
Central Valley Region	66.2%	23.1%	1.7%	1.2%	0.3%	0.8%	27.1%
STATE OF CALIFORNIA	**57.0%**	**28.5%**	**2.2%**	**2.9%**	**0.2%**	**0.2%**	**34.0%**

Source: U.S. Census 2014f

Table 21.15 Percent of Population Speaking One of the Top Five Non-English Languages Spoken at Home in the Central Valley Region – San Joaquin Valley that Speaks English "Less than Very Well" as a Proportion of the Total Population Five Years and Older, 2006–2010

Areas	Spanish and Spanish Creole	Tagalog	Chinese	Portuguese/ Portuguese Creole	Hmong
Stanislaus County	13.1%	0.2%	0.3%	0.4%	0.0%
Madera County	17.7%	0.1%	0.0%	0.1%	0.1%
Merced County	19.4%	0.2%	0.2%	0.9%	1.2%
Fresno County	14.7%	0.2%	0.3%	0.0%	1.3%
Tulare County	21.4%	0.3%	0.1%	0.3%	0.1%
Kings County	19.4%	0.6%	0.3%	0.3%	0.0%
Kern County	16.4%	0.4%	0.2%	0.0%	0.0%
San Joaquin Valley Subtotal	16.5%	0.3%	0.2%	0.2%	0.5%
Central Valley Region	10.8%	0.5%	0.6%	0.1%	0.4%
STATE OF CALIFORNIA	**13.6%**	**0.7%**	**1.6%**	**0.1%**	**0.1%**

Source: U.S. Census 2014f

Conditions in this geographic area have been the focus of recent newspaper articles describing conditions in these communities. According to AgAlert (2014), a weekly newspaper for California agriculture, increased levels of land fallowing on irrigated cropland in the San Joaquin Valley has resulted in significant economic losses in small farming communities. Higher than typical unemployment rates has resulted in increased food insecurity. As a result, food banks are facing increased demand. Another article in the Fresno Bee Newspaper (2014) described the food insecurity issue in the City of Mendota, a community in Fresno County.

Although there are emergency programs such as those administered through the U.S. Department of Agriculture (USDA), many of these programs are specific in their targets, require a long time to implement, or are of limited duration. For example, the 2014 Farm Bill includes $100 million in livestock disaster assistance; $15 million in assistance to farmers and ranchers to implement water conservation practices; and $60 million for food banks in the State of California (USDA 2014a). The USDA February 14, 2014 news release announcing these programs acknowledges that previous implementation of assistance programs were hampered by long processing times and emphasizes that the USDA is committed to reduce the response times by more than 80 percent. The USDA also is working with California Department of Education to expand the number of Summer Food Service Program meal sites. The U.S. Department of Homeland Security also provides assistance with food and related expenses through the Emergency Food and Shelter National Board Program (USDHS 2014); however this assistance is limited to one month. There also are many California-based programs, including the California Department of Social Services that provided in 2014 up to $25 million in food assistance for counties affected by employment losses due to the drought that has reduced agriculturally-related jobs (CDSS 2014). This program is specifically targeted for counties where the unemployment rate in 2013 was higher than the statewide average, including Fresno, Merced, and Tulare counties. This aid includes pre-packaged food boxes to be delivered to local food banks. Families and individuals that expected to experience long-term impacts due to the drought also were provided assistance to apply for the CalFresh Program to supplement funding for the food budget.

Huron and Mendota

The cities of Huron and Mendota are both located in Fresno County. Economic activities in both cities and surrounding communities are based on agriculture. Of the 25 major employers in Fresno County, only one, Stamoules Produce Company, is located in the City of Mendota (CEDD 2013). None of the 25 major employers in Fresno County are located in Huron. Another major employer in the City of Mendota is a medium security Federal prison for men (BOP 2014).

In 2010, the number of people that identified themselves as a racial minority and/or of Hispanic or Latino origin and the portion of the population below the poverty level in these two cities were significantly higher than the distribution of these populations in Fresno County and the State of California, as presented in Tables 21.16 and 21.17. Although the two communities became more racially diverse in 2010 than they were in the 2000 Census, both communities became poorer. While Huron and Mendota have experienced increases in poverty levels, the proportion of the population below the poverty level has been relatively stable in Fresno County.

Table 21.16 Racial and Ethnic Minority Population in Huron and Mendota in 2010

Areas	Total Population	Racial Minority	Hispanic or Latino Origin	Below Poverty Level
Huron City	6,754	65.9%	96.6%	54.5%
Mendota City	11,014	47.1%	96.6%	44.6%
Fresno County	930,450	44.6%	50.3%	22.5%
State of California	**37,253,956**	**42.4%**	**37.6%**	**13.7%**

Source: U.S. Census Bureau, 2013a, 2013b, 2014e, 2014u

Table 21.17 Racial and Ethnic Minority Population in Huron and Mendota in 2000

Areas	Total Population	Racial Minority	Hispanic or Latino Origin	Below Poverty Level
Huron City	6,306	79.6%	98.3%	39.4%
Mendota City	7,890	72.7%	94.7%	41.9%
Fresno County	799,407	45.7%	44.0%	22.9%
State of California	**33,871,648**	**40.5%**	**32.4%**	**14.2%**

Sources: U.S. Census Bureau, 2013c, 2013d, 2013e, 2013f

Other Indicators of Economic Conditions

Other indicators of economic struggles within these communities are the number of individuals who are on poverty alleviation programs, including CalFresh, the Federal Supplemental Nutrition Assistance Program administered by the State of California, California Work Opportunity and Responsibility to Kids (CalWORKs), and National School Lunch Program (NSLP).

Both CalFresh and CalWORKs are administered by the California Department of Social Services. The CalFresh Program issues monthly electronic benefits that can be used to buy most foods. The program’s purpose is to help improve the health and well-being of qualified households and individuals. CalWORKs is a social welfare program that provides cash aid and services to eligible needy California families. Figure 21.1 shows the trend in the average annual population on public assistance (both the CalFresh Program and CalWORKs program) between 2006 and 2012, the years for which electronic data were available for the cities of Huron and Mendota. The populations in Huron and Mendota have higher levels of participations in the two public assistance programs compared to the levels in Fresno County and the state. Additionally, the rates of participation in the two communities have been growing at a faster rate than growth in these programs in Fresno County and the state. Eligibility in the CalFresh Program is based upon several factors, including a poverty threshold requirement and citizenship/immigration status. Eligibility for CalWORKs is determined on the basis of citizenship, age, income, resources, assets and other factors (CDSS 2013j).

The NSLP program includes students that are eligible for assistance under CalFresh and other federal assistance programs, such as the Temporary Assistance for Needy Families and the Food Distribution Program on Indian Reservations; and students who are eligible under the Other Source Categorically Eligible Programs. A student is eligible under the Other Source Categorically Eligible Programs if that student is: (1) homeless, runaway or migrant; (2) a foster child; or (3) enrolled in a Federally-funded Head Start Program or a comparable State-funded Head Start Program or pre-kindergarten programs, or in an Even Start Program (USDA 2014b). Students enrolled in the NSLP are eligible for either free or reduced price meals (FRPM). Figure 21.2 shows the proportion of students enrolled in the FRPM program in the two communities, Fresno County, and the state. Participation on FRPM in Fresno County is higher than in the entire state; and lower than within Huron and Mendota.

Relatively large participation in the social services programs is related to low employment in Huron and Mendota. Annual unemployment rates in Huron and Mendota between 2006 and 2012 have consistently remained higher than for Fresno County and the state, as presented in Figure 21.3. The pattern of unemployment has been similar to unemployment patterns in Fresno County, and increased following the economic recession that started in 2007. The increase in unemployment also occurred at a time when both agricultural cultivated acreage and farm employment in the area declined; and included five consecutive years with reduced water availability, as described in Chapter 12, Agricultural Resources, and Chapter 19, Socioeconomics.

21.3.4.3 Delta and Suisun Marsh

The Delta and Suisun Marsh portion of the Central Valley Region includes Sacramento, Yolo, Solano, San Joaquin, and Contra Costa counties.

21.3.4.3.1 Minority Populations

As recorded in the 2010 U.S. Census, the Delta and Suisun Marsh portion of the Central Valley Region had a total population of 2,718,287 in 2010. About 54.8 percent of this population identified themselves as a racial minority and/or of Hispanic or Latino origin, regardless of race, as presented in Table 21.18. The table also shows the minority population distribution for the entire Central Valley Region and the State of California.

21.3.4.3.2 Poverty Levels

Poverty levels presented in Table 21.19 are calculated on a subset of the total population of a county, as described above in section 21.3.2, Characterization of Conditions Considered in the Environmental Justice Analysis.

Table 21.18 Minority Population Distribution in the Central Valley Region – Delta and Suisun Marsh in 2010

Areas	Total Population	Races							Hispanic or Latino Origin	Total Minority[a]
		White	Black/ African American	American Indian and Native Alaskan	Asian	Native Hawaiian and Other Pacific Islander	Some Other Race	Two or More Races		
Sacramento County	1,418,788	57.5%	10.4%	1.0%	14.3%	1.0%	9.3%	6.6%	21.6%	51.6%
Yolo County	200,849	63.2%	2.6%	1.1%	13.0%	0.5%	13.9%	5.8%	30.3%	50.1%
Solano County	413,344	51.0%	14.7%	0.8%	14.6%	0.9%	10.5%	7.6%	24.0%	59.2%
San Joaquin County	685,306	51.0%	7.6%	1.1%	14.4%	0.5%	19.1%	6.4%	38.9%	64.1%
Contra Costa County	1,049,025	58.6%	9.3%	0.6%	14.4%	0.5%	10.7%	5.9%	24.4%	52.2%
Total Delta and Suisun Marsh Valley	3,767,312	56.2%	9.6%	0.9%	14.3%	0.7%	11.9%	6.4%	26.2%	54.8%
Central Valley Region	8,379,045	61.4%	6.3%	1.3%	9.5%	0.4%	15.7%	5.4%	42.6%	53.5%
STATE OF CALIFORNIA	37,253,956	57.6%	6.2%	1.0%	13.0%	0.4%	17.0%	4.9%	37.6%	59.9%

Sources: U.S. Census 2014a, 2014y, 2014z, 2014aa, 2014ab, 2014ac

Note:

a. Total Minority is an aggregation of all non-white racial groups and includes all individuals of Hispanic or Latino origin, regardless of race.

Table 21.19 Population below Poverty Level in the Central Valley Region – Delta and Suisun Marsh, 2006–2010

Areas	Total Population[a]	Population Below Poverty Level	Percent of Population Below Poverty Level
Sacramento County	1,368,693	190,768	13.9%
Yolo County	186,800	31,895	17.1%
Solano County	397,576	41,158	10.4%
San Joaquin County	657,594	105,502	16.0%
Contra Costa County	1,013,854	91,142	9.0%
Total Delta and Suisun Marsh Valley	3,624,517	460,465	12.7%
Central Valley Region	8,025,054	1,268,984	15.8%
STATE OF CALIFORNIA	**35,877,036**	**4,919,945**	**13.7%**

Source: U.S. Census 2014e

Note:

a. Population numbers are only those for whom poverty status was determined and exclude institutionalized individuals

Of the total population for whom poverty status is determined within the Delta and Suisun Marsh portion of the Central Valley Region, 3,624,517 individuals, 12.7 percent were below the poverty level based on the 2006–2010 ACS 5-year dataset (U.S. Census 2014e). The U.S. Census Bureau defines geographical areas with more than 20 percent of the population below the poverty level as a “poverty areas.” None of the counties in this area are defined as poverty areas.

21.3.4.3.3 Social Services

Distribution of social services varies for each county. Federal grants to the state and local agencies for Medicaid, other health related activities, and nutrition and family welfare; and Federal direct payments made to individuals under the CalFresh and supplemental social security income within counties in the Delta and Suisun Marsh portion of the Central Valley Region are summarized in Table 21.20.

21.3.4.3.4 Limited English Proficiency

The percent of the population that speaks English and other languages at home and the percent of the population that speak English “less than very well” based on the language they speak at home are presented in Tables 21.21 and 21.22.

21.3.5 San Francisco Bay Area Region

The San Francisco Bay Area Region includes portions of Napa, Alameda, Santa Clara, and San Benito counties that are within the CVP and SWP service areas. Contra Costa County also is part of the San Francisco Bay Area Region. However, for this chapter, Contra Costa County is discussed under Section 14.3.4.3, Delta Suisun Marsh.

21.3.5.1 Minority Populations

As recorded in the 2010 U.S. Census, the San Francisco Bay Area Region had a total population of 3,483,666 in 2010. About 64.4 percent of this population identified themselves as a racial minority and/or of Hispanic or Latino origin, regardless of race, as presented in Table 21.23. The table also shows the minority population distribution for the State of California.

21.3.5.2 Poverty Levels

Poverty levels presented in Table 21.24 are calculated on a subset of the total population of a county, as described above in section 21.3.2, Characterization of Conditions Considered in the Environmental Justice Analysis. Of the total population for whom poverty status is determined within the San Francisco Bay Area Region, 3,344,994 individuals, 10.1 percent were below the poverty level based on the 2006–2010 ACS 5-year dataset (U.S. Census 2014e). The U.S. Census Bureau defines geographical areas with more than 20 percent of the population below the poverty level as a "poverty areas." None of the counties in the San Francisco Bay Area Region are defined as poverty areas.

Table 21.20 Federal Funds Distributed for Social Programs in the Central Valley Region – Delta and Suisun Marsh in 2010

	Grants (millions of dollars)		**Distributed to Individuals (millions of dollars)**
Areas	**Medicaid and Other Health-Related Items**	**Nutrition and Family Welfare**	**CalFresh Benefits and Supplemental Security Income**
Sacramento County	$2,115.5	$2,695.9	$659.1
Yolo County	$504.8	$39.7	$55.2
Solano County	$264.2	$71.7	$118.6
San Joaquin County	$739.1	$153.5	$287.4
Contra Costa County	$749.7	$189.3	$238.8
Total Delta and Suisun Marsh Valley	$4,373.3	$3,150.1	$1,359.1
Central Valley Region	$8,759.9	$4,308.9	$3,179.8
STATE OF CALIFORNIA	**$41,931.1**	**$11,743.7**	**$12,469.4**

Source: Gaquin and Ryan 2013

Table 21.21 Top Five Non-English Languages Spoken at Home as a Proportion of the Total Population Five Years and Older in the Central Valley Region – Delta and Suisun Marsh, 2006 – 2010

Areas	Speaks Only English	Spanish and Spanish Creole	Chinese	Tagalog	Vietnamese	Russian	Total Excluding English
Sacramento County	69.8%	13.2%	2.2%	2.0%	1.5%	1.6%	20.5%
Yolo County	65.8%	20.2%	3.3%	0.8%	0.9%	1.6%	26.9%
Solano County	70.6%	15.9%	0.8%	6.8%	0.6%	0.1%	24.1%
San Joaquin County	0.0%	25.1%	1.0%	2.8%	1.0%	0.0%	29.9%
Contra Costa County	67.6%	17.3%	2.9%	2.8%	0.6%	0.6%	24.2%
Total Delta and Suisun Marsh Valley	56.5%	17.2%	2.1%	2.8%	1.0%	0.9%	24.0%
Central Valley Region	66.2%	23.1%	1.2%	1.7%	0.6%	0.5%	27.1%
STATE OF CALIFORNIA	**57.0%**	**28.5%**	**2.9%**	**2.2%**	**1.4%**	**0.4%**	**35.4%**

Source: U.S. Census 2014f

Table 21.22 Percent of Population Speaking One of the Top Five Non-English Languages Spoken at Home in the Central Valley Region – Delta and Suisun Marsh that Speaks English "Less than Very Well" as a Proportion of the Total Population Five Years and Older, 2006–2010

Areas	Spanish and Spanish Creole	Chinese	Tagalog	Vietnamese	Russian
Sacramento County	6.0%	1.3%	0.7%	0.9%	0.9%
Yolo County	9.5%	1.5%	0.2%	0.3%	1.0%
Solano County	7.4%	0.4%	2.2%	0.3%	0.0%
San Joaquin County	12.3%	0.6%	1.0%	0.6%	0.0%
Contra Costa County	8.4%	1.3%	0.7%	0.3%	0.3%
Total Delta and Suisun Marsh Valley	8.1%	1.1%	0.9%	0.6%	0.5%
Central Valley Region	10.8%	0.6%	0.5%	0.3%	0.2%
STATE OF CALIFORNIA	**13.6%**	**1.6%**	**0.7%**	**0.9%**	**0.2%**

Source: U.S. Census 2014f

Table 21.23 Minority Population Distribution in the San Francisco Bay Area Region in 2010

Areas	Total Population	Races							Hispanic or Latino Origin	Total Minority[a]
		White	Black/ African American	American Indian and Native Alaskan	Asian	Native Hawaiian and Other Pacific Islander	Some Other Race	Two or More Races		
Alameda County	1,510,271	43.0%	12.6%	0.6%	26.1%	0.8%	10.8%	6.0%	22.5%	65.9%
Santa Clara County	1,781,642	47.0%	2.6%	0.7%	32.0%	0.4%	12.4%	4.9%	26.9%	64.8%
San Benito County	55,269	63.7%	0.9%	1.6%	2.6%	0.2%	26.2%	4.9%	56.4%	61.7%
Napa County	136,484	71.5%	2.0%	0.8%	6.8%	0.3%	14.7%	4.1%	32.2%	43.6%
San Francisco Bay Area Region	3,483,666	46.5%	6.9%	0.7%	28.0%	0.6%	12.0%	5.4%	25.7%	64.4%
STATE OF CALIFORNIA	**37,253,956**	**57.6%**	**6.2%**	**1.0%**	**13.0%**	**0.4%**	**17.0%**	**4.9%**	**37.6%**	**59.9%**

Sources: U.S. Census 2014a, 2014ad, 2014ae, 2014af, 2014ag

Note:

a. Total Minority is an aggregation of all non-white racial groups and includes all individuals of Hispanic or Latino origin, regardless of race.

Table 21.24 Population below Poverty Level in the San Francisco Bay Area Region, 2006–2010

Areas	Total Population[a]	Population Below Poverty Level	Percent of Population Below Poverty Level
Alameda County	1,450,546	165,417	11.4
Santa Clara County	1,710,231	152,066	8.9
San Benito County	54,160	6,323	11.7
Napa County	130,057	12,948	10.0
San Francisco Bay Area Region	3,344,994	336,754	10.1
STATE OF CALIFORNIA	**35,877,036**	**4,919,945**	**13.7%**

Source: U.S. Census 2014e

Note:

a. Population numbers are only those for whom poverty status was determined and exclude institutionalized individuals

21.3.5.3 Social Services

Distribution of social services varies for each county. Federal grants to the state and local agencies for Medicaid, other health related activities, and nutrition and family welfare; and Federal direct payments made to individuals under the CalFresh and supplemental social security income within counties in the San Francisco Bay Area Region are summarized in Table 21.25.

21.3.5.4 Limited English Proficiency

The percent of the population that speaks English and other languages at home and the percent of the population that speak English “less than very well” based on the language they speak at home are presented in Tables 21.26 and 21.27.

21.3.6 Central Coast Region

The Central Coast Region includes portions of San Luis Obispo and Santa Barbara counties served by the SWP. SWP water supplies are used directly by municipal and industrial water users, and as part of groundwater replenishment plans to meet municipal, industrial, and agricultural water demands.

21.3.6.1 Minority Populations

As recorded in the 2010 U.S. Census, the Central Coast Region had a total population of 693,532 in 2010. About 43.1 percent of this population identified themselves as a racial minority and/or of Hispanic or Latino origin, regardless of race, as presented in Table 21.28. The table also shows the minority population distribution for the State of California.

21.3.6.2 Poverty Levels

Poverty levels presented in Table 21.29 are calculated on a subset of the total population of a county, as described above in section 21.3.2, Characterization of Conditions Considered in the Environmental Justice Analysis. Of the total population for whom poverty status is determined within the Central Coast

Region, 649,348 individuals, 13.8 percent were below the poverty level based on the 2006–2010 ACS 5-year dataset (U.S. Census 2014e). The U.S. Census Bureau defines geographical areas with more than 20 percent of the population below the poverty level as a "poverty areas." None of the counties in the Central Coast Region are defined as poverty areas.

21.3.6.3 Social Services

Distribution of social services varies for each county. Federal grants to the state and local agencies for Medicaid, other health related activities, and nutrition and family welfare; and Federal direct payments made to individuals under the CalFresh and supplemental social security income within counties in the Central Coast Region are summarized in Table 21.30.

Table 21.25 Federal Funds Distributed for Social Programs in the San Francisco Bay Area Region in 2010

	Grants (millions of dollars)		**Distributed to Individuals (millions of dollars)**
Areas	**Medicaid and Other Health-Related Items**	**Nutrition and Family Welfare**	**CalFresh Benefits and Supplemental Security Income**
Alameda County	$2,556.4	$318.6	$529.6
Santa Clara County	$2,000.2	$334.3	$466.3
San Benito County	$27.1	$12.5	$8.2
Napa County	$102.5	$32.0	$21.3
San Francisco Bay Area Region	$4,686.2	$697.4	$1,025.4
STATE OF CALIFORNIA	**$41,931.1**	**$11,743.7**	**$12,469.4**

Source: Gaquin and Ryan 2013

Table 21.26 Top Five Non-English Languages Spoken at Home as a Proportion of the Total Population Five Years and Older in the San Francisco Bay Area Region, 2006–2010

Areas	Speaks Only English	Spanish and Spanish Creole	Chinese	Tagalog	Vietnamese	Hindi	Total Excluding English
Alameda County	57.4%	16.8%	8.2%	3.8%	1.8%	1.6%	32.2%
Santa Clara County	49.3%	19.1%	7.4%	3.3%	6.5%	1.5%	37.8%
San Benito County	60.1%	37.3%	0.1%	0.7%	0.2%	0.0%	38.3%
Napa County	66.5%	26.2%	0.4%	2.4%	0.2%	0.1%	29.3%
San Francisco Bay Area Region	53.7%	18.6%	7.3%	3.4%	4.1%	1.5%	35.0%
STATE OF CALIFORNIA	**57.0%**	**28.5%**	**2.9%**	**2.2%**	**1.4%**	**0.4%**	**35.4%**

Source: U.S. Census 2014f

Table 21.27 Percent of Population Speaking One of the Top Five Non-English Languages Spoken at Home in the San Francisco Bay Area Region that Speaks English “Less than Very Well” as a Proportion of the Total Population Five Years and Older, 2006–2010

Areas	Spanish and Spanish Creole	Chinese	Tagalog	Vietnamese	Hindi
Alameda County	8.2%	4.8%	1.1%	1.1%	0.3%
Santa Clara County	8.9%	3.6%	1.1%	4.0%	0.2%
San Benito County	20.4%	0.1%	0.3%	0.2%	0.0%
Napa County	14.6%	0.2%	0.9%	0.2%	0.04%
San Francisco Bay Area Region	9.0%	3.9%	1.1%	2.5%	0.2%
STATE OF CALIFORNIA	**13.6%**	**1.6%**	**0.7%**	**0.9%**	**0.1%**

Source: U.S. Census 2014f

Table 21.28 Minority Population Distribution in the Central Coast Region in 2010

Areas	Total Population	Races							Hispanic or Latino Origin	Total Minority[a]
		White	Black/ African American	American Indian and Native Alaskan	Asian	Native Hawaiian and Other Pacific Islander	Some Other Race	Two or More Races		
San Luis Obispo County	269,637	82.6%	2.1%	0.9%	3.2%	0.1%	7.3%	3.8%	20.8%	28.9%
Santa Barbara County	423,895	69.6%	2.0%	1.3%	4.9%	0.2%	17.4%	4.6%	42.8%	52.1%
Central Coast Region	693,532	74.7%	2.0%	1.2%	4.2%	0.2%	13.5%	4.3%	34.3%	43.1%
STATE OF CALIFORNIA	**37,253,956**	**57.6%**	**6.2%**	**1.0%**	**13.0%**	**0.4%**	**17.0%**	**4.9%**	**37.6%**	**59.9%**

Sources: U.S. Census 2014a, 2014ah, 2014ai

Note:

a. Total Minority is an aggregation of all non-white racial groups and includes all individuals of Hispanic or Latino origin, regardless of race.

Table 21.29 Population below Poverty Level in the Central Coast Region, 2006–2010

Areas	Total Population[a]	Population Below Poverty Level	Percent of Population Below Poverty Level
San Luis Obispo County	248,764	32,183	12.9%
Santa Barbara County	400,584	57,463	14.3%
Central Coast Region	649,348	89,646	13.8%
STATE OF CALIFORNIA	**35,877,036**	**4,919,945**	**13.7%**

Source: U.S. Census 2014e

Note:

a. Population numbers are only those for whom poverty status was determined and exclude institutionalized individuals

Table 21.30 Federal Funds Distributed for Social Programs in the Central Coast Region in 2010

Areas	Grants (millions of dollars)		Distributed to Individuals (millions of dollars)
	Medicaid and Other Health-Related Items	Nutrition and Family Welfare	CalFresh Benefits and Supplemental Security Income
San Luis Obispo County	$176.0	$70.7	$44.5
Santa Barbara County	$332.1	$93.3	$91.6
Central Coast Region	$508.1	$164.0	$136.1
STATE OF CALIFORNIA	$41,931.1	$11,743.7	$12,469.4

Source: Gaquin and Ryan 2013

21.3.6.4 Limited English Proficiency

The percent of the population that speaks English and other languages at home and the percent of the population that speak English “less than very well” based on the language they speak at home are presented in Tables 21.31 and 21.32.

21.3.7 Southern California Region

The Southern California Region includes portions of Ventura, Los Angeles, Orange, San Diego, Riverside, and San Bernardino counties served by the SWP.

21.3.7.1 Minority Populations

As recorded in the 2010 U.S. Census, the Southern California Region had a total population of 20,972,319 in 2010. About 64.2 percent of this population identified themselves as a racial minority and/or of Hispanic or Latino origin, regardless of race, as presented in Table 21.33. The table also shows the minority population distribution for the State of California.

21.3.7.2 Poverty Levels

Poverty levels presented in Table 21.34 are calculated on a subset of the total population of a county, as described above in section 21.3.2, Characterization of Conditions Considered in the Environmental Justice Analysis. Of the total population for whom poverty status is determined within the Southern California Region, 20,296,879 individuals, 13.8 percent, were below the poverty level based on the 2006–2010 ACS 5-year dataset (U.S. Census 2014e). The U.S. Census Bureau defines geographical areas with more than 20 percent of the population below the poverty level as a “poverty areas.” None of the counties in the Southern California Region are defined as poverty areas.

21.3.7.3 Social Services

Distribution of social services varies for each county. Federal grants to the state and local agencies for Medicaid, other health related activities, and nutrition and family welfare; and Federal direct payments made to individuals under the CalFresh and supplemental social security income within counties in the Southern California Region are summarized in Table 21.35.

21.3.7.4 Limited English Proficiency

The percent of the population that speaks English and other languages at home and the percent of the population that speak English “less than very well” based on the language they speak at home are presented in Tables 21.36 and 21.37.

Table 21.31 Top Five Non-English Languages Spoken at Home as a Proportion of the Total Population Five Years and Older in the Central Coast Region, 2006–2010

Areas	Speaks Only English	Spanish and Spanish Creole	Chinese	Tagalog	French (including Patois and Cajun)	German	Total Excluding English
San Luis Obispo County	83.3%	13.1%	0.3%	0.5%	0.3%	0.4%	14.7%
Santa Barbara County	61.3%	31.9%	0.8%	0.9%	0.6%	0.6%	34.7%
Central Coast Region	70.0%	24.5%	0.6%	0.8%	0.5%	0.5%	26.8%
STATE OF CALIFORNIA	**57.0%**	**28.5%**	**2.9%**	**2.2%**	**0.4%**	**0.3%**	**34.3%**

Source: U.S. Census 2014f

Table 21.32 Percent of Population Speaking One of the Top Five Non-English Languages Spoken at Home in the Central Coast Region that Speaks English "Less than Very Well" as a Proportion of the Total Population Five Years and Older, 2006–2010

Areas	Spanish and Spanish Creole	Chinese	Tagalog	French (including Patois and Cajun)	German
San Luis Obispo County	5.5%	0.1%	0.2%	0.04%	0.04%
Santa Barbara County	16.5%	0.4%	0.4%	0.1%	0.1%
Central Coast Region	12.2%	0.3%	0.4%	0.1%	0.1%
STATE OF CALIFORNIA	**13.6%**	**1.6%**	**0.7%**	**0.1%**	**0.04%**

Source: U.S. Census 2014f

Table 21.33 Minority Population Distribution in the Southern California Region in 2010

Areas	Total Population	Races							Hispanic or Latino Origin	Total Minority[a]
		White	Black/ African American	American Indian and Native Alaskan	Asian	Native Hawaiian and Other Pacific Islander	Some Other Race	Two or More Races		
Ventura County	823,318	68.7%	1.8%	1.0%	6.7%	0.2%	17.0%	4.5%	40.3%	51.3%
Los Angeles County	9,818,605	50.3%	8.7%	0.7%	13.7%	0.3%	21.8%	4.5%	47.7%	72.2%
Orange County	3,010,232	60.8%	1.7%	0.6%	17.9%	0.3%	14.5%	4.2%	33.7%	55.9%
San Diego County	3,095,313	64.0%	5.1%	0.9%	10.9%	0.5%	13.6%	5.1%	32.0%	51.5%
Riverside County	2,189,641	61.0%	6.4%	1.1%	6.0%	0.3%	20.5%	4.8%	45.5%	60.3%
San Bernardino County	2,035,210	56.7%	8.9%	1.1%	6.3%	0.3%	21.6%	5.0%	49.2%	66.7%
Southern California Region	20,972,319	56.3%	6.7%	0.8%	12.1%	0.3%	19.2%	4.6%	43.1%	64.2%
STATE OF CALIFORNIA	**37,253,956**	**57.6%**	**6.2%**	**1.0%**	**13.0%**	**0.4%**	**17.0%**	**4.9%**	**37.6%**	**59.9%**

Sources: U.S. Census 2014a, 2014aj, 2014ak, 2014al, 2014am, 2014an, 2014ao

Note:

a. Total Minority is an aggregation of all non-white racial groups and includes all individuals of Hispanic or Latino origin, regardless of race.

Table 21.34 Population below Poverty Level in the Southern California Region, 2006–2010

Areas	Total Population[a]	Population Below Poverty Level	Percent of Population Below Poverty Level
Ventura County	798,863	73,842	9.2%
Los Angeles County	9,604,871	1,508,618	15.7%
Orange County	2,925,244	296,846	10.1%
San Diego County	2,930,875	361,248	12.3%
Riverside County	2,075,782	278,358	13.4%
San Bernardino County	1,961,244	291,020	14.8%
Southern California Region	798,863	73,842	9.2%
STATE OF CALIFORNIA	**35,877,036**	**4,919,945**	**13.7%**

Source: U.S. Census 2014e

Note:

a. Population numbers are only those for whom poverty status was determined and exclude institutionalized individuals

Table 21.35 Federal Funds Distributed for Social Programs in the Southern California Region in 2010

	Grants (millions of dollars)		Distributed to Individuals (millions of dollars)
Areas	Medicaid and Other Health-Related Items	Nutrition and Family Welfare	CalFresh Benefits and Supplemental Security Income
Ventura County	$445.3	$153.9	$147.1
Los Angeles County	$13,950.6	$2,840.6	$4,259.6
Orange County	$1,678.3	$610.6	$633.2
San Diego County	$3,866.8	$677.8	$790.1
Riverside County	$966.4	$347.2	$488.0
San Bernardino County	$1,236.2	$390.1	$751.9
Southern California Region	$22,143.6	$5,020.2	$7,069.9
STATE OF CALIFORNIA	**$41,931.1**	**$11,743.7**	**$12,469.4**

Source: Gaquin and Ryan 2013

Table 21.36 Top Five Non-English Languages Spoken at Home as a Proportion of the Total Population Five Years and Older in the Southern California Region, 2006–2010

Areas	Speaks Only English	Spanish and Spanish Creole	Chinese	Tagalog	Vietnamese	Korean	Total Excluding English
Ventura County	62.6%	29.5%	1.0%	1.7%	0.4%	0.4%	33.1%
Los Angeles County	43.6%	39.4%	3.6%	2.5%	0.8%	2.0%	48.3%
Orange County	55.6%	26.2%	2.2%	1.5%	5.4%	2.5%	37.8%
San Diego County	63.7%	24.4%	1.4%	3.1%	1.3%	0.5%	30.6%
Riverside County	60.5%	33.2%	0.5%	1.4%	0.6%	0.4%	36.2%
San Bernardino County	59.5%	33.6%	1.0%	1.4%	0.6%	0.5%	37.1%
Southern California Region	52.3%	33.7%	2.4%	2.2%	1.5%	1.5%	41.3%
STATE OF CALIFORNIA	**57.0%**	**28.5%**	**2.9%**	**2.2%**	**1.4%**	**1.1%**	**36.1%**

Source: U.S. Census 2014f

Table 21.37 Percent of Population Speaking One of the Top Five Non-English Languages Spoken at Home in the Southern California Region that Speaks English "Less than Very Well" as a Proportion of the Total Population Five Years and Older, 2006–2010

Areas	Spanish and Spanish Creole	Chinese	Tagalog	Vietnamese	Korean
Ventura County	14.1%	0.5%	0.5%	0.2%	0.2%
Los Angeles County	19.0%	2.2%	0.8%	0.5%	1.3%
Orange County	13.4%	1.0%	0.4%	3.3%	1.5%
San Diego County	11.0%	0.7%	1.1%	0.8%	0.3%
Riverside County	14.5%	0.3%	0.4%	0.4%	0.2%
San Bernardino County	15.5%	0.5%	0.4%	0.4%	0.3%
Southern California Region	16.0%	1.4%	0.7%	0.9%	0.9%
STATE OF CALIFORNIA	**13.6%**	**1.6%**	**0.7%**	**0.9%**	**0.7%**

Source: U.S. Census 2014f

21.4 Impact Analysis

This section describes the potential mechanisms for change in conditions and analytical methods; results of impact analyses; potential mitigation measures; and cumulative effects.

21.4.1 Potential Mechanisms for Change and Analytical Methods

As described in Chapter 4, Approach to Environmental Analysis, the impact analysis considers changes in factors that affect environmental justice or minority and low-income populations specifically related to changes in CVP and SWP operations under the alternatives as compared to the No Action Alternative and Second Basis of Comparison.

The Council of Environmental Quality (CEQ) and U.S. Environmental Protection Agency (USEPA) established guidelines to assist federal agencies in the analysis of environmental justice defines minority and low-income areas summarized in Section 21.3, Affected Environment (CEQ, 1997). The following guidelines are used to determine if minority populations are present in a study area:

- The minority population of the affected area exceeds 50 percent, or
- The population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographical analysis.

The CEQ guidelines do not specifically state the percentage considered meaningful in the case of low-income populations. For this analysis, the assumptions set forth in the CEQ guidelines for identifying and evaluating impacts on minority populations also are used to identify and evaluate impacts on low-income populations, including a determination that a low-income population is present if the project area if 50 percent or more of the population is living below the poverty level.

The alternatives considered in this EIS do not include project-specific construction activities. In most portions of the study area, the availability of CVP and SWP water supplies directly or indirectly affects most of the population within a county. Therefore, the entire population of each counties within the study area is considered to determine whether minority or low-income areas could be affected by implementation of the alternatives. In the study area, populations below the poverty level do not include 50 percent or more of the population. The highest proportion of populations below the poverty level occurs in Fresno and Tulare counties in which approximately 23 percent of the populations are below the poverty level. However, minority populations contribute more than 50 percent of the total county populations in 24 of the 35 counties. The following counties have 50 percent or more of the total population as minority populations.

- Central Valley Region: Colusa, Sacramento, Solano, Sutter, Yolo, Fresno, Kern, Kings, Madera, Merced, San Joaquin, Stanislaus, and Tulare counties

- Central Coast Region; Santa Barbara.
- Southern California Region: Los Angeles, Orange, Riverside, San Bernardino, San Diego, and Ventura.

Although, the majority of the populations in the Trinity River Region counties are not minority populations, these counties do include the Hoopa Valley Indian Reservation, Yurok Indian Reservation, and Resighini Rancheria. Therefore, the Trinity River Region counties are also included in the environmental justice analysis.

The CEQ guidance provides the following three factors to be considered for determination if disproportionately high and adverse impacts may accrue to minority or low-income populations.

The following criteria were used to evaluate the impacts to minority and low-income populations resulting from the operational changes following the implementation of each of the alternatives as compared to the No Action Alternative and the Second Basis of Comparison:

- Whether there is or would be an impact that results in a disproportionately high and adverse human health and environmental impact, including social and economic effects on environmental justice populations.
- Whether the environmental effects are significant and are, or may be, having an adverse impact on environmental justice populations that appreciably exceeds or is likely to appreciably exceed those on the general population or other appropriate comparison group.
- Whether the environmental effects occur or would occur in an environmental justice population affected by cumulative or multiple adverse exposures from environmental hazards.

To determine whether the operational changes resulting from implementation of each of the alternatives as compared to the No Action Alternative and the Second Basis of Comparison will have a “disproportionately high and adverse impact” on minority and low-income populations, various factors were considered, including potential adverse impacts, mitigation, and enhancement measures that will be incorporated into the alternatives; and offsetting benefits.

The environmental justice guidance documents do not specifically define conditions that would result in “high and adverse human health and environmental impact.” For this analysis, the potential changes in air quality, cultural resources, public health, and socioeconomics were considered within the counties that had a minority population of 50 percent or greater of the total population.

The changes were then determined if the impacts would be disproportionally high on the minority populations. Potential adverse impacts were evaluated with regard to air quality, public health, and socioeconomics.

Changes in CVP and SWP operations under the alternatives as compared to the No Action Alternative and Second Basis of Comparison could result in disproportionally high effects on minority or tribal populations related to changes in air quality, public health, and socioeconomics.

21.4.1.1 Changes in Emissions of Criteria Air Pollutants and Precursors, and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants Related to Changes in Groundwater Pumping

Changes in CVP and SWP operations under the alternatives could change the use of individual engines to operate groundwater wells. To evaluate the potential for changes in emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants, results from the CVHM model that indicate changes in groundwater withdrawals due to changes in CVP and SWP operations were analyzed. However, it is not known how many of the groundwater pumps use electricity and how many use diesel engines. The diesel engines have the potential to emit criteria air pollutants and precursors, and toxic air contaminants, as described in Chapter 16, Air Quality and Greenhouse Gas Emissions.

Most of the groundwater wells in the Central Valley use electrical pumps. As reported in a recent environmental assessment, approximately 14 to 15 percent of the pumps used diesel fuel in 2003 (Reclamation 2013a). It is assumed for this EIS, that the portion of groundwater pumps that use electricity would remain approximately at 85 percent. Therefore, it is assumed that increases or decreases in groundwater pumping would be indicative of an increase or decrease in the use of diesel engines in the Central Valley as well as in the San Francisco Bay Area, Central Coast, and Southern California regions. Changes in CVP and SWP operations would not result in changes in groundwater pumping in the Trinity River Region; therefore, this analysis does not address Trinity River Region.

21.4.1.2 Changes in Public Health Related to Changes in Potential Exposure to Mercury in Fish Used in Human Consumption

Changes in CVP and SWP operations under the alternatives could change public health factors related to mercury concentrations in fish used for human consumption as compared to the No Action Alternative and Second Basis of Comparison, as described in Chapter 18, Public Health.

21.4.1.3 Changes in Socioeconomics

Changes in CVP and SWP operations under the alternatives could change socioeconomic factors related to employment related to irrigated agriculture and municipal and industrial (M&I) water supplies and tribal salmon harvest in the Trinity River Region as compared to the No Action Alternative and Second Basis of Comparison, as described in Chapter 19, Socioeconomics. However, changes in employment related to irrigated agriculture and M&I water supplies would be similar. Therefore, these changes are not analyzed in this EIS.

21.4.1.4 Effects due to Cross Delta Water Transfers

Historically water transfer programs have been developed on an annual basis. The demand for water transfers is dependent upon the availability of water supplies to meet water demands. Water transfer transactions have increased over time as CVP and SWP water supply availability has decreased, especially during drier water years.

Parties seeking water transfers generally acquire water from sellers who have available surface water who can make the water available through releasing previously stored water, pump groundwater instead of using surface water (groundwater substitution); idle crops; or substitute crops that uses less water in order to reduce normal consumptive use of surface water.

Water transfers using CVP and SWP Delta pumping plants and south of Delta canals generally occur when there is unused capacity in these facilities. These conditions generally occur during drier water year types when the flows from upstream reservoirs plus unregulated flows are adequate to meet the Sacramento Valley water demands and the CVP and SWP export allocations. In non-wet years, the CVP and SWP water allocations would be less than full contract amounts; therefore, capacity may be available in the CVP and SWP conveyance facilities to move water from other sources.

Projecting future environmental justice conditions related to water transfer activities is difficult because specific water transfer actions required to make the water available, convey the water, and/or use the water would change each year due to changing hydrological conditions, CVP and SWP water availability, specific local agency operations, and local cropping patterns. Reclamation recently prepared a long-term regional water transfer environmental document which evaluated potential changes in conditions related to water transfer actions (Reclamation 2014c). Results from this analysis were used to inform the impact assessment of potential effects of water transfers under the alternatives as compared to the No Action Alternative and the Second Basis of Comparison.

21.4.2 Conditions in Year 2030 without Implementation of Alternatives 1 through 5

This EIS includes two bases of comparison, as described in Chapter 3, Description of Alternatives: the No Action Alternative and the Second Basis of Comparison. Both of these bases are evaluated at 2030 conditions.

Changes that would occur over the next 15 years without implementation of the alternatives are not analyzed in this EIS. However, the changes to environmental justice factors that are assumed to occur by 2030 under the No Action Alternative and the Second Basis of Comparison are summarized in this section. Many of the changed conditions would occur in the same manner under both the No Action Alternative and the Second Basis of Comparison.

21.4.2.1 Common Changes in Conditions under the No Action Alternative and Second Basis of Comparison

Conditions in 2030 would be different than existing conditions due to:

- Climate change and sea level rise
- General plan development throughout California, including increased water demands in portions of Sacramento Valley
- Implementation of reasonable and foreseeable water resources management projects to provide water supplies

It is anticipated that climate change would result in more short-duration high-rainfall events and less snowpack in the winter and early spring months. The reservoirs would be full more frequently by the end of April or May by 2030 than in recent historical conditions. However, as the water is released in the spring, there would be less snowpack to refill the reservoirs. This condition would reduce reservoir storage and available water supplies to downstream uses in the summer. The reduced end of September storage also would reduce the ability to release stored water to downstream regional reservoirs. These conditions would occur for all reservoirs in the California foothills and mountains, including non-CVP and SWP reservoirs.

These changes would result in a decline of the long-term average CVP and SWP water supply deliveries by 2030 as compared to recent historical long-term average deliveries under the No Action Alternative and the Second Basis of Comparison. However, the CVP and SWP water deliveries would be less under the No Action Alternative as compared to the Second Basis of Comparison, as described in Chapter 5, Surface Water Resources and Water Supplies. Due to climate change and related lower snowfall, end of September low reservoir storage would be lower in critical dry years by 2030 as compared to recent historical conditions in Shasta Lake, Lake Oroville, Folsom Lake, New Melones Reservoir, and San Luis Reservoir. Therefore, the potential for reduced reservoir water supplies for wildland firefighting would be greater under the No Action Alternative and Second Basis of Comparison as compared to recent historical conditions.

Under the No Action Alternative and the Second Basis of Comparison, land uses in 2030 would occur in accordance with adopted general plans.

The No Action Alternative and the Second Basis of Comparison assumes completion of water resources management and environmental restoration projects that would have occurred without implementation of Alternatives 1 through 5, including regional and local recycling projects, surface water and groundwater storage projects, conveyance improvement projects, and desalination projects, as described in Chapter 3, Description of Alternatives. The No Action Alternative and the Second Basis of Comparison also assumes implementation of actions included in the 2008 U.S. Fish and Wildlife Service (USFWS) Biological Opinion (BO) and 2009 National Marine Fisheries Service (NMFS) BO that would have been implemented without the BOs by 2030, as described in Chapter 3, Description of Alternatives.

Under the No Action Alternative and Second Basis of Comparison, it is anticipated that mercury concentrations in fish tissue within the Delta will be either similar or greater than recent historical conditions. Phase 1 of the Delta Mercury Program mandated by the Central Valley Regional Water Quality Control Board (RWQCB) is currently being completed to protect people eating one meal per week of larger fish from the Delta, including Largemouth Bass. Phase 1 is focused on studies and pilot projects to develop and evaluate management practices to control methylmercury from mercury sources in the Delta and Yolo Bypass; and to reduce total mercury loading to the San Francisco Bay. Following completion of Phase 1 in 2019, Phase 2 will be implemented through 2030. Phase 2 will focus on methylmercury control programs and reduction programs for total inorganic mercury. Due to the extent of these studies, it is not anticipated that changes in methylmercury or total mercury concentrations in fish tissue will be reduced by 2030. Future mercury reduction and control programs will reduce mercury sources and related fish tissue concentrations; however, that will occur after 2030.

21.4.3 Evaluation of Alternatives

Alternatives 1 through 5 have been compared to the No Action Alternative; and the No Action Alternative and Alternatives 1 through 5 have been compared to the Second Basis of Comparison.

During review of the numerical modeling analyses used in this EIS, an error was determined in the CalSim II model assumptions related to the Stanislaus River operations for the Second Basis of Comparison, Alternative 1, and Alternative 4 model runs. Appendix 5C includes a comparison of the CalSim II model run results presented in this chapter and CalSim II model run results with the error corrected. Appendix 5C also includes a discussion of changes in the comparison of groundwater conditions for the following alternative analyses.

- No Action Alternative compared to the Second Basis of Comparison
- Alternative 1 compared to the No Action Alternative
- Alternative 3 compared to the Second Basis of Comparison
- Alternative 5 compared to the Second Basis of Comparison.

21.4.3.1 No Action Alternative

The No Action Alternative is compared to the Second Basis of Comparison.

21.4.3.1.1 Central Valley Region

Changes in Emissions of Criteria Air Pollutants and Precursors, and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants Related to Changes in Groundwater Pumping

Groundwater pumping in the San Joaquin Valley portion of the Central Valley Region would increase by 8 percent under the No Action Alternative as compared to the Second Basis of Comparison. It is not known if the additional groundwater pumping would rely upon electricity or diesel to drive the pump engines. Under the worst case analysis, it is assumed that the increased use of diesel engines would be proportional to the increased use of groundwater. Therefore, under the No Action Alternative, there would be a potential increase in emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants as compared to the Second Basis of Comparison.

Changes in Public Health Factors Related to Mercury in Fish used for Human Consumption

Mercury concentrations in Largemouth Bass would be similar (within 5 percent change) in most locations in the Delta, except for Rock Slough, San Joaquin River near Antioch, and Montezuma Slough in Suisun Marsh. In these areas, the mercury concentrations would increase by 7 percent over long-term conditions under the No Action Alternative as compared to the Second Basis of Comparison. Under dry and critical dry years, mercury concentrations would increase by 7 to 8 percent at Rock Slough, intakes of the Banks and Jones pumping plants, and Victoria Canal. All values exceed the threshold of 0.24 mg/kg ww for mercury.

Effects Related to Cross Delta Water Transfers

Potential effects to environmental justice factors could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c). Potential effects to environmental justice were identified as loss of employment in the seller’s service area if crop idling was used to provide transfer water. The analysis indicated that the proportion of crop idled acreage would be small as compared to the overall regional irrigated acreage, and that this change would not result in in disproportionately high or adverse effects. In addition, beneficial effects could occur in the purchaser’s service area if more acreage was cultivated with the water transfer program than without the water transfer program.

Under the No Action Alternative, the timing of cross Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Under the Second Basis of Comparison, water could be transferred throughout the year without an annual volumetric limit. Overall, the potential for cross Delta water transfers would be less under the No Action Alternative than under the Second Basis of Comparison.

21.4.3.1.2 San Francisco Bay Area, Central Coast, and Southern California Regions

Changes in Emissions of Criteria Air Pollutants and Precursors, and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants Related to Changes in Groundwater Pumping

It is anticipated that CVP and SWP water supplies would be decreased by 10 percent and 18 percent, respectively, in the San Francisco Bay Area, Central

Coast, and Southern California regions under No Action Alternative as compared to the Second Basis of Comparison. The decrease in surface water supplies could result in additional use of groundwater pumps and emissions of air pollutants and contaminants if the use of diesel engines is also increased.

21.4.3.2 Alternative 1

As described in Chapter 3, Description of Alternatives, Alternative 1 is identical to the Second Basis of Comparison. As described in Chapter 4, Approach to Environmental Analysis, Alternative 1 is compared to the No Action Alternative and the Second Basis of Comparison. However, because CVP and SWP operations under Alternative 1 are identical to conditions under the Second Basis of Comparison; Alternative 1 is only compared to the No Action Alternative.

21.4.3.2.1 Alternative 1 Compared to the No Action Alternative

Central Valley Region

Changes in Emissions of Criteria Air Pollutants and Precursors, and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants Related to Changes in Groundwater Pumping

Groundwater pumping in the San Joaquin Valley portion of the Central Valley Region would decrease by 8 percent under Alternative 1 as compared to the No Action Alternative. It is not known if the reduction in groundwater pumping would result in a reduction of the use of electricity or diesel to drive the pump engines. For this analysis, it is assumed that the decreased use of diesel engines would be proportional to the decreased use of groundwater. Therefore, under Alternative 1, there would be a potential decrease in emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants as compared to the No Action Alternative.

Changes in Public Health Factors Related to Mercury in Fish used for Human Consumption

Mercury concentrations in Largemouth Bass would be similar in most locations in the Delta, except for Rock Slough, San Joaquin River near Antioch, and Montezuma Slough in Suisun Marsh. In these areas, the mercury concentrations would decrease by 6 percent over the long-term conditions under Alternative 1 as compared to the No Action Alternative. Under dry and critical dry years, mercury concentrations would decrease by 6 to 8 percent at Rock Slough, intakes of the Banks and Jones pumping plants, and Victoria Canal. All values exceed the threshold of 0.24 mg/kg ww for mercury.

Effects Related to Cross Delta Water Transfers

Potential effects to environmental justice conditions could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions would occur during implementation of cross Delta water transfers under Alternative 1 and the No Action Alternative, and that impacts on environmental justice factors would not be substantial due to implementation requirements of the transfer programs.

Under Alternative 1, water could be transferred throughout the year without an annual volumetric limit. Under the No Action Alternative, the timing of cross Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Overall, the potential for cross Delta water transfers would be increased under Alternative 1 as compared to the No Action Alternative.

San Francisco Bay Area, Central Coast, and Southern California Regions

Changes in Emissions of Criteria Air Pollutants and Precursors, and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants Related to Changes in Groundwater Pumping

It is anticipated that CVP and SWP water supplies would be increased by 11 percent and 21 percent, respectively, in the San Francisco Bay Area, Central Coast, and Southern California regions under Alternative 1 as compared to the No Action Alternative. The increase in surface water supplies could result in the reduction in use of groundwater pumps and emissions of air pollutants and contaminants if the use of diesel engines is also decreased.

21.4.3.2.2 Alternative 1 Compared to the Second Basis of Comparison

Alternative 1 is identical to the Second Basis of Comparison.

21.4.3.3 Alternative 2

The CVP and SWP operations under Alternative 2 are identical to the CVP and SWP operations under the No Action Alternative, as described in Chapter 3, Description of Alternatives; therefore Alternative 2 is only compared to the Second Basis of Comparison.

21.4.3.3.1 Alternative 2 Compared to the Second Basis of Comparison

The CVP and SWP operations under Alternative 2 are identical to the CVP and SWP operations under the No Action Alternative. Therefore, changes to environmental justice factors under Alternatives 2 as compared to the Second Basis of Comparison would be the same as the impacts described in Section 18.4.3.1, No Action Alternative.

21.4.3.4 Alternative 3

As described in Chapter 3, Description of Alternatives, CVP and SWP operations under Alternative 3 are similar to the Second Basis of Comparison with modified Old and Middle River flow criteria and New Melones Reservoir operations. As described in Chapter 4, Approach to Environmental Analysis, Alternative 3 is compared to the No Action Alternative and the Second Basis of Comparison.

21.4.3.4.1 Alternative 3 Compared to the No Action Alternative

Central Valley Region

Changes in Emissions of Criteria Air Pollutants and Precursors, and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants Related to Changes in Groundwater Pumping

Groundwater pumping in the San Joaquin Valley portion of the Central Valley Region would decrease by 6 percent under Alternative 3 as compared to the No Action Alternative. It is not known if the reduction in groundwater pumping would result in a reduction of the use of electricity or diesel to drive the pump engines. For this analysis, it is assumed that the decreased use of diesel engines would be proportional to the decreased use of groundwater. Therefore, under Alternative 3, there would be a potential decrease in emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants as compared to the No Action Alternative.

Changes in Public Health Factors Related to Mercury in Fish used for Human Consumption

Mercury concentrations in Largemouth Bass would be similar (within 5 percent change) in most locations in the Delta, except for San Joaquin River near Antioch and Montezuma Slough in Suisun Marsh. In these areas, the mercury concentrations would decrease by 6 percent over the long-term conditions under Alternative 3 as compared to the No Action Alternative. Mercury concentrations under the dry and critical dry years would be similar throughout the Delta. All values exceed the threshold of 0.24 mg/kg ww for mercury.

Effects Related to Cross Delta Water Transfers

Potential effects to environmental justice factors could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions would occur during implementation of cross Delta water transfers under Alternative 3 and the No Action Alternative, and that impacts on environmental justice factors would not be substantial due to implementation requirements of the transfer programs.

Under Alternative 3, water could be transferred throughout the year without an annual volumetric limit. Under the No Action Alternative, the timing of cross Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Overall, the potential for cross Delta water transfers would be increased under Alternative 3 as compared to the No Action Alternative.

San Francisco Bay Area, Central Coast, and Southern California Regions

Changes in Emissions of Criteria Air Pollutants and Precursors, and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants Related to Changes in Groundwater Pumping

It is anticipated that CVP and SWP water supplies would be increased by 9 percent and 17 percent, respectively, in the San Francisco Bay Area, Central Coast, and Southern California regions under Alternative 3 as compared to the No Action Alternative. The increase in surface water supplies could result in the reduction in use of groundwater pumps and emissions of air pollutants and contaminants if the use of diesel engines is also decreased.

21.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison

Central Valley Region

Changes in Emissions of Criteria Air Pollutants and Precursors, and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants Related to Changes in Groundwater Pumping

Groundwater pumping in the San Joaquin Valley portion of the Central Valley Region would be similar (within a 5 percent change) under Alternative 3 as compared to the Second Basis of Comparison. Therefore, the emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants would be similar under Alternative 3 as compared to the Second Basis of Comparison.

Changes in Public Health Factors Related to Mercury in Fish Used for Human Consumption

Mercury concentrations in Largemouth Bass would be similar throughout the Delta under Alternative 3 as compared to the Second Basis of Comparison, as summarized in Chapter 6, Surface Water Quality. All values exceed the threshold of 0.24 mg/kg ww for mercury.

Effects Related to Cross Delta Water Transfers

Potential effects to environmental justice factors could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions would occur during implementation of cross Delta water transfers under Alternative 3 and the Second Basis of Comparison, and that impacts on environmental justice factors would not be substantial in the seller's service area due to implementation requirements of the transfer programs.

Under Alternative 3 and the Second Basis of Comparison, water could be transferred throughout the year without an annual volumetric limit. Overall, the potential for cross Delta water transfers would be similar under Alternative 3 and the Second Basis of Comparison.

San Francisco Bay Area, Central Coast, and Southern California Regions

Changes in Emissions of Criteria Air Pollutants and Precursors, and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants Related to Changes in Groundwater Pumping

It is anticipated that CVP and SWP water supplies and emissions from diesel engines used for groundwater pumping would be similar in the San Francisco Bay Area, Central Coast, and Southern California regions under Alternative 3 as compared to the Second Basis of Comparison.

21.4.3.5 Alternative 4

The environmental justice conditions under Alternative 4 would be identical to the conditions under the Second Basis of Comparison; therefore, Alternative 4 is only compared to the No Action Alternative.

21.4.3.5.1 Alternative 4 Compared to the No Action Alternative

The CVP and SWP operations under Alternative 4 are identical to the CVP and SWP operations under the Second Basis of Comparison and Alternative 1. Therefore, changes in environmental justice conditions under Alternative 4 as compared to the No Action Alternative would be the same as the impacts described in Section 12.4.3.2.1, Alternative 1 Compared to the No Action Alternative.

21.4.3.6 Alternative 5

As described in Chapter 3, Description of Alternatives, CVP and SWP operations under Alternative 5 are similar to the No Action Alternative with modified Old and Middle River flow criteria and New Melones Reservoir operations. As described in Chapter 4, Approach to Environmental Analysis, Alternative 5 is compared to the No Action Alternative and the Second Basis of Comparison.

21.4.3.6.1 Alternative 5 Compared to the No Action Alternative

Central Valley Region

Changes in Emissions of Criteria Air Pollutants and Precursors, and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants Related to Changes in Groundwater Pumping

Groundwater pumping in the San Joaquin Valley portion of the Central Valley Region would be similar under Alternative 5 as compared to the No Action Alternative. Therefore, the emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants would be similar under Alternative 5 as compared to the No Action Alternative.

Changes in Public Health Factors Related to Mercury in Fish used for Human Consumption

Mercury concentrations in Largemouth Bass would be similar throughout the Delta under Alternative 5 as compared to the No Action Alternative, as summarized in Chapter 6, Surface Water Quality. All values exceed the threshold of 0.24 mg/kg ww for mercury.

Effects Related to Cross Delta Water Transfers

Potential effects to environmental justice factors could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions would occur during implementation of cross Delta water transfers under Alternative 5 and the No Action Alternative, and that impacts on environmental justice factors would not be substantial in the seller's service area due to implementation requirements of the transfer programs.

Under Alternative 5 and the No Action Alternative, the timing of cross Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Overall, the potential for cross Delta water transfers would be similar under Alternative 5 and the No Action Alternative.

San Francisco Bay Area, Central Coast, and Southern California Regions

Changes in Emissions of Criteria Air Pollutants and Precursors, and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants Related to Changes in Groundwater Pumping

It is anticipated that CVP and SWP water supplies and emissions from diesel engines used for groundwater pumping would be similar in the San Francisco Bay Area, Central Coast, and Southern California regions under Alternative 5 as compared to the No Action Alternative.

21.4.3.6.2 Alternative 5 Compared to the Second Basis of Comparison

Central Valley Region

Changes in Emissions of Criteria Air Pollutants and Precursors, and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants Related to Changes in Groundwater Pumping

Groundwater pumping in the San Joaquin Valley portion of the Central Valley Region would increase by 8 percent under Alternative 5 as compared to the Second Basis of Comparison. It is not known if the additional groundwater pumping would rely upon electricity or diesel to drive the pump engines. Under the worst case analysis, it is assumed that the increased use of diesel engines would be proportional to the increased use of groundwater. Therefore, under Alternative 5, there would be a potential increase in emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants as compared to the Second Basis of Comparison.

Changes in Public Health Factors Related to Mercury in Fish used for Human Consumption

Mercury concentrations in Largemouth Bass would be similar in most locations in the Delta, except for Rock Slough, San Joaquin River near Antioch, and Montezuma Slough in Suisun Marsh. In these areas, the mercury concentrations would increase by 7 to 8 percent over long-term conditions under Alternative 5 as compared to the Second Basis of Comparison. During dry and critical dry years, mercury concentrations also would increase by 7 percent at intakes to Banks Pumping Plant and Jones Pumping Plant; and 13 percent at Rock Slough. All values exceed the threshold of 0.24 mg/kg ww for mercury.

Effects Related to Cross Delta Water Transfers

Potential effects to environmental justice factors could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions would occur during implementation of cross Delta water transfers under Alternative 5 and the Second Basis of Comparison, and that impacts on environmental justice factors would not be substantial in the seller's service area due to implementation requirements of the transfer programs.

Under Alternative 5, the timing of cross Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Under the Second Basis of Comparison, water could be transferred throughout the year without an annual volumetric limit. Overall, the potential for cross Delta water transfers would be reduced under Alternative 5 as compared to the Second Basis of Comparison.

San Francisco Bay Area, Central Coast, and Southern California Regions

Changes in Emissions of Criteria Air Pollutants and Precursors, and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants Related to Changes in Groundwater Pumping

It is anticipated that CVP and SWP water supplies would be decreased by 10 percent and 18 percent, respectively, in the San Francisco Bay Area, Central Coast, and Southern California regions under Alternative 5 as compared to the Second Basis of Comparison. The decrease in surface water supplies could result in increased use of groundwater pumps and emissions of air pollutants and contaminants if the use of diesel engines is also increased.

21.4.3.7 Summary of Environmental Consequences

The results of the environmental consequences of implementation of Alternatives 1 through 5 as compared to the No Action Alternative and the Second Basis of Comparison are presented in Tables 21.38 and 21.39.

Table 21.38 Comparison of Alternatives 1 through 5 to No Action Alternative

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	Decrease potential for emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants by 8 percent in the Central Valley, 11 to 21 percent in the San Francisco Bay Area Region, and by 21 percent in the Central Coast and Southern California regions. Similar mercury concentrations in Largemouth Bass in the most of the Delta; and a 6 percent decrease near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough over the long-term conditions.	None needed
Alternative 2	No effects on environmental justice factors.	None needed
Alternative 3	Decrease potential for emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants by 6 percent in the Central Valley, 9 to 17 percent in the San Francisco Bay Area Region, and by 17 percent in the Central Coast and Southern California regions. Similar mercury concentrations in Largemouth Bass in the most of the Delta; and a 6 percent decrease near San Joaquin River at Antioch and Montezuma Slough over the long-term conditions.	None needed
Alternative 4	Same effects as described for Alternative 1 compared to the No Action Alternative.	None needed
Alternative 5	Similar potential for emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants in the Central Valley, San Francisco Bay Area, Central Coast, and Southern California regions. Similar mercury concentrations in Largemouth Bass throughout the Delta.	None needed

Note: Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools, incremental differences of 5 percent or less between alternatives and the Second Basis of Comparison are considered to be "similar."

Table 21.39 Comparison of Alternatives 1 through 5 to Second Basis of Comparison

Alternative	Potential Change	Consideration for Mitigation Measures
No Action Alternative	Increase potential for emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants by 8 percent in the Central Valley, 10 to 18 percent in the San Francisco Bay Area Region, and by 18 percent in the Central Coast and Southern California regions. Similar mercury concentrations in Largemouth Bass in the most of the Delta; and a 7 percent increase near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough over the long-term conditions.	Not considered for this comparison.
Alternative 1	No effects on environmental justice factors.	Not considered for this comparison.

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 2	Same effects as described for No Action Alternative as compared to the Second Basis of Comparison.	Not considered for this comparison.
Alternative 3	Similar potential for emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants in the Central Valley, San Francisco Bay Area, Central Coast, and Southern California regions. Similar mercury concentrations in Largemouth Bass throughout the Delta.	Not considered for this comparison.
Alternative 4	No effects on environmental justice factors.	Not considered for this comparison.
Alternative 5	Increase potential for emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants by 8 percent in the Central Valley, 10 to 18 percent in the San Francisco Bay Area Region, and by 18 percent in the Central Coast and Southern California regions. Similar mercury concentrations in Largemouth Bass in the most of the Delta; and a 7 percent increase near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough over the long-term conditions.	Not considered for this comparison.

Note: Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools, incremental differences of 5 percent or less between alternatives and the Second Basis of Comparison are considered to be “similar.”

21.4.3.8 Potential Mitigation Measures

Mitigation measures are presented in this section to avoid, minimize, rectify, reduce, eliminate, or compensate for adverse environmental effects of Alternatives 1 through 5 as compared to the No Action Alternative. Mitigation measures were not included to address adverse impacts under the alternatives as compared to the Second Basis of Comparison because this analysis was included in this EIS for information purposes only.

Changes in CVP and SWP operations under Alternatives 1 through 5 as compared to the No Action Alternative would not result in changes in air quality or public health that are related to environmental justice factors. Therefore, there would be no disproportionately high or adverse environmental justice effects; and no mitigation measures are required.

21.4.3.9 Cumulative Effects Analysis

As described in Chapter 3, the cumulative effects analysis considers projects, programs, and policies that are not speculative; and are based upon known or reasonably foreseeable long-range plans, regulations, operating agreements, or other information that establishes them as reasonably foreseeable.

The cumulative effects analysis Alternatives 1 through 5 for Environmental Justice are summarized in Table 21.40.

Table 21.4 Summary of Cumulative Effects on Environmental Justice of Alternatives 1 through 5 as Compared to the No Action Alternative

Scenarios	Actions	Cumulative Effects of Actions
Past & Present, and Future Actions included in the No Action Alternative and in all Alternatives in Year 2030	Consistent with Affected Environment conditions plus: Actions in the 2008 USFWS BO and 2009 NMFS BO that Would Have Occurred without Implementation of the Biological Opinions, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives), including climate change and sea level rise Actions not included in the 2008 USFWS BO and 2009 NMFS BO that Would Have Occurred without Implementation of the Biological Opinions, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives): • Implementation of Federal and state policies and programs, including Clean Water Act (e.g., Total Maximum Daily Loads); Safe Drinking Water Act; Clean Air Act; and flood management programs • General plans for 2030. • Trinity River Restoration Program. • Central Valley Project Improvement Act programs • Folsom Dam Water Control Manual Update • FERC Relicensing for the Middle Fork of the American River Project • Lower Mokelumne River Spawning Habitat Improvement Project • Dutch Slough Tidal Marsh Restoration • Suisun Marsh Habitat Management, Preservation, and Restoration Plan Implementation • Tidal Wetland Restoration: Yolo Ranch, Northern Liberty Island Fish Restoration Project, Prospect Island Restoration Project, and Calhoun Cut/Lindsey Slough Tidal Habitat Restoration Project • San Joaquin River Restoration Program • Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects with completed environmental documents)	<u>These effects would be the same in all alternatives.</u> Climate change and sea level rise, development under the general plans, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce the availability of surface water, including CVP and SWP water supplies. This could result in increased groundwater withdrawals; and a portion of those groundwater pumps would rely upon diesel engines. Therefore, there would be an increased potential for emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors that could cause a disproportionately high and adverse impact on minority and low-income populations. Mercury concentrations in fish tissue within the Delta will be either similar or greater than recent historical conditions because Phases 1 and 2 of the Delta Mercury Program would be completed by 2030, as mandated by the Central Valley RWQCB, including methylmercury control programs and reduction programs for total inorganic mercury. Due to the extent of these programs, it is anticipated that the programs would be initiated; however, future reductions in mercury sources and related reductions of mercury and methylmercury concentrations in fish tissue would actually occur after 2030.

Scenarios	Actions	Cumulative Effects of Actions
Future Actions considered as Cumulative Effects Actions in with all Alternatives in Year 2030	Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives): • Bay-Delta Water Quality Control Plan Update • FERC Relicensing Projects • Bay Delta Conservation Plan (including the California WaterFix alternative) • Shasta Lake Water Resources, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations • El Dorado Water and Power Authority Supplemental Water Rights Project • Sacramento River Water Reliability Project • Semitropic Water Storage District Delta Wetlands • North Bay Aqueduct Alternative Intake • San Luis Reservoir Low Point Improvement Project • Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects that did not have completed environmental documents during preparation of the EIS)	<u>These effects would be the same in all alternatives.</u> Future reasonably foreseeable storage and water supply projects would improve surface water reliability. These actions would reduce the potential for increased groundwater withdrawals; and reduce the potential for emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors that could cause a disproportionately high and adverse impact on minority and low-income populations.
No Action Alternative with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO	Climate change and sea level rise, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce the availability of surface water, including CVP and SWP water supplies. This could result in increased groundwater withdrawals; and a portion of those groundwater pumps would rely upon diesel engines. Therefore, there would be an increased potential for emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors that could cause a disproportionately high and adverse impact on minority and low-income populations. Mercury concentrations in fish tissue within the Delta will be

Scenarios	Actions	Cumulative Effects of Actions
		either similar or greater than recent historical conditions because Phases 1 and 2 of the Delta Mercury Program would be completed by 2030, as mandated by the Central Valley RWQCB, including methylmercury control programs and reduction programs for total inorganic mercury. Due to the extent of these programs, it is anticipated that the programs would be initiated; however, future reductions in mercury sources and related reductions of mercury and methylmercury concentrations in fish tissue would actually occur after 2030.
Alternative 1 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternative 1 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with these added actions.
Alternative 2 with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions No implementation of structural improvements or other actions that require further study to develop a more detailed action description.	Implementation of Alternative 2 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with these added actions.
Alternative 3 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant) Slight increase in positive Old and Middle River flows in the winter and spring months	Implementation of Alternative 3 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with these added actions.
Alternative 4 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternative 4 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with these added actions.
Alternative 5 with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO Positive Old and Middle River flows and increased Delta outflow in spring months	Implementation of Alternative 5 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with these added actions.

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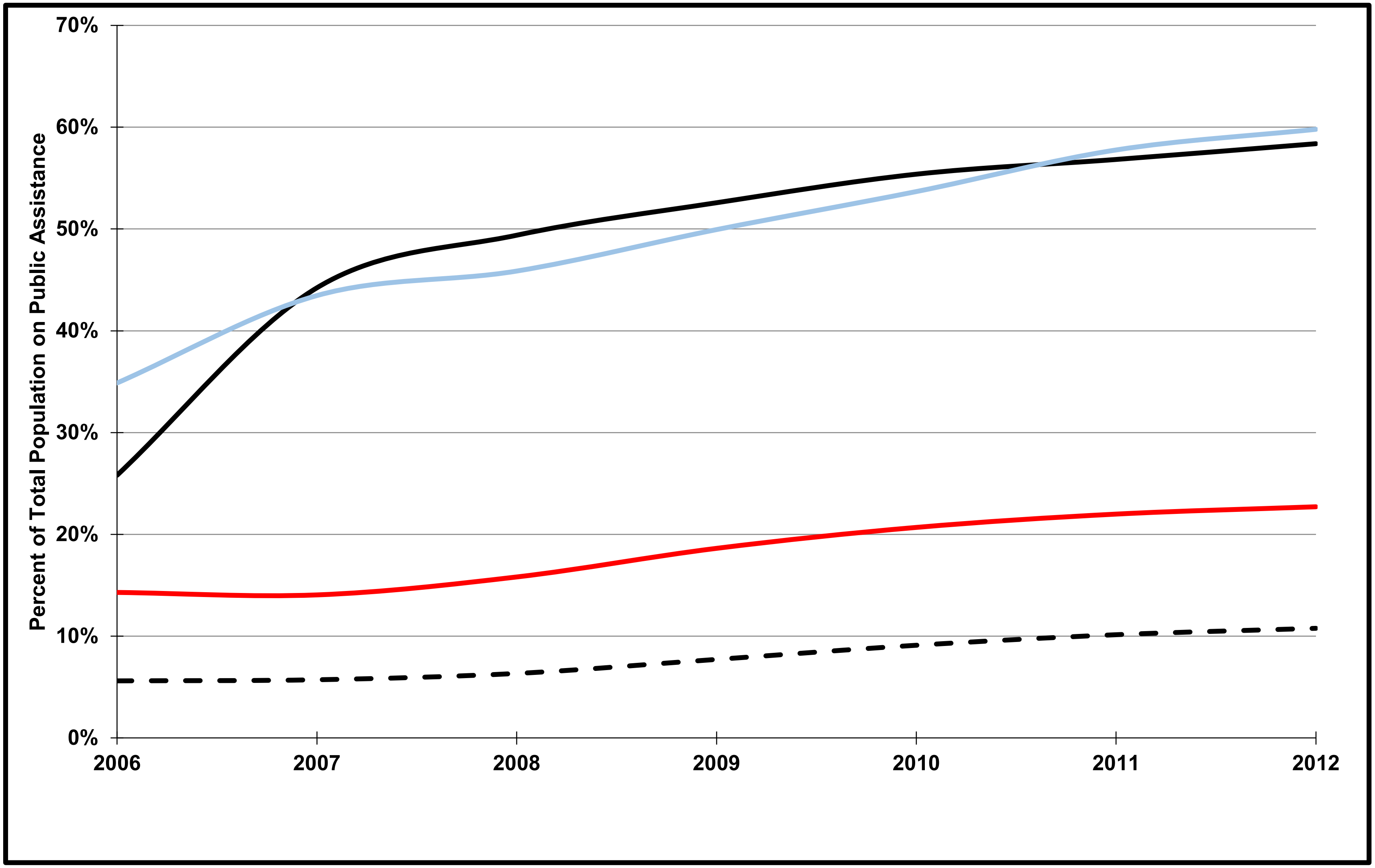

Figure 21.1 Population on CalFresh Program and CalWORKs Program in Huron and Mendota in 2006 through 2012

Source: CDSS 2008a –2008y, 2009a – 2009n, 2012a -2012a, 2013a – 2013i; Fresno County 2013

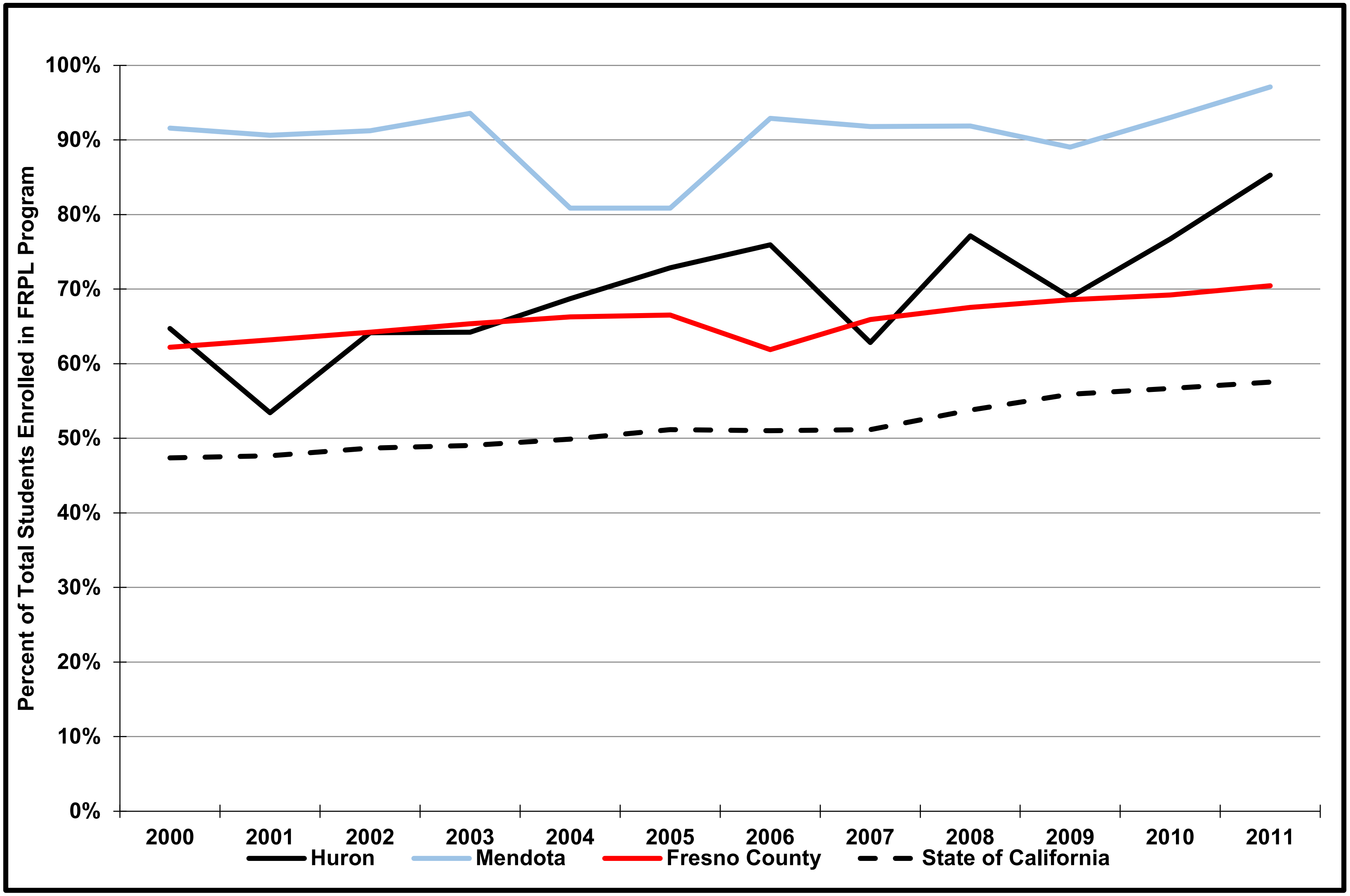

Figure 21.2 Enrollment in Free or Reduced Price Meals Program in Huron and Mendota in 2000 through 2011

Source: CDE 2013

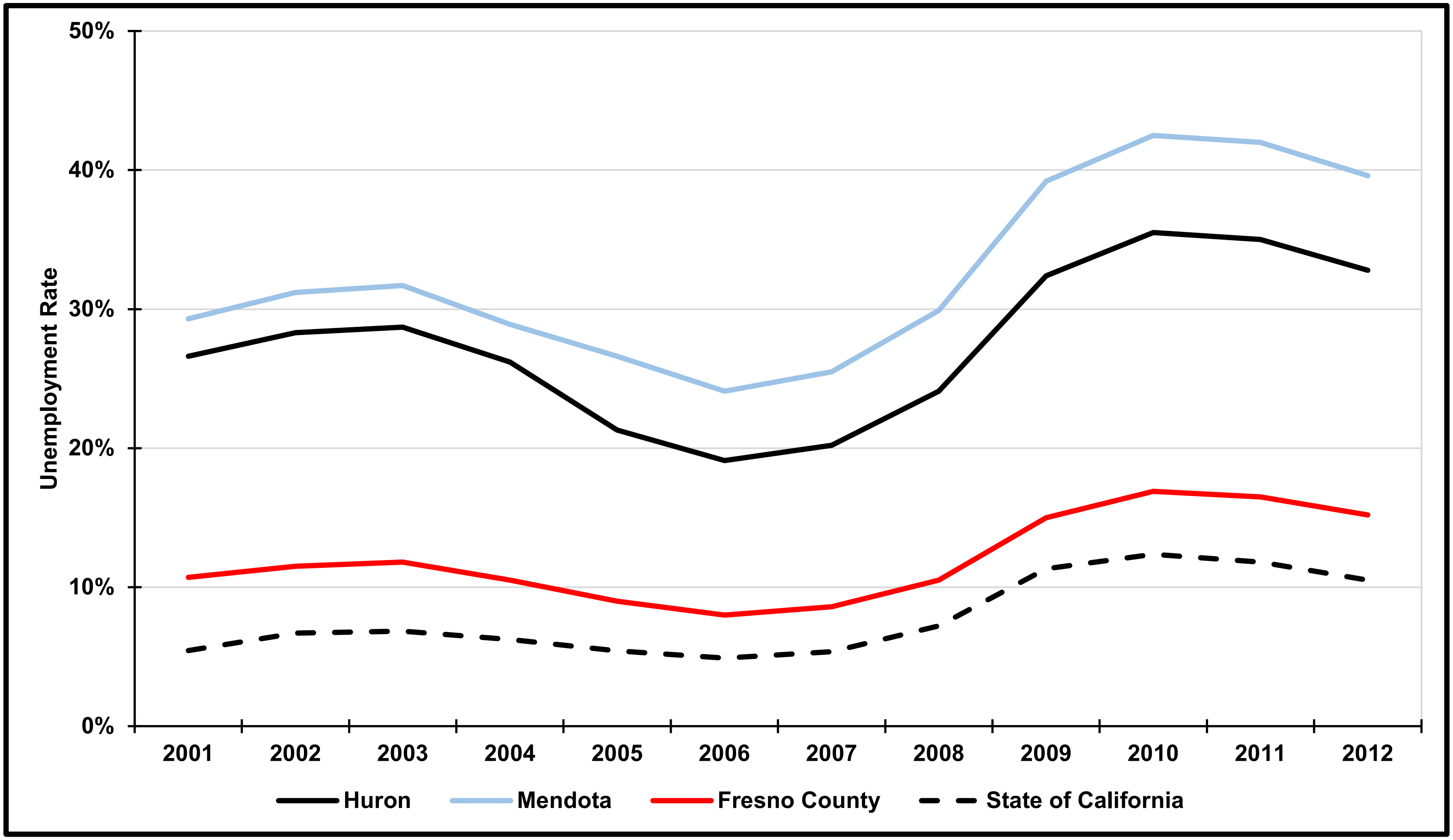

Figure 21.3 Unemployment in Huron and Mendota in 2001 through 2012

Source: BLS 2014; CEDD 2014

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Chapter 22

Other NEPA Requirements

22.1 Introduction

In addition to the factors described in Chapters 5 through 21, the National Environmental Policy Act (NEPA) requires consideration of the relationship of short-term uses and long-term productivity, consideration of irreversible and irretrievable commitments of resources, and growth-inducing impacts as compared to the No Action Alternative (40 Code of Federal Regulations [CFR] 1508.8). These considerations are described in the following sections of this chapter.

22.2 Relationship between Short-term Uses and Long-term Productivity

NEPA requires that an Environmental Impact Statement (EIS) prepared by Federal agencies disclose "…the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity…" (40 CFR 1502.16). As discussed in Chapter 1, Introduction, this EIS evaluates long-term potential direct, indirect, and cumulative impacts on the environment that could result from implementation of alternatives for the continued long-term operation of the Central Valley Project (CVP) and State Water Project (SWP) and implementation of ecosystem restoration. This EIS does not evaluate short-term impacts related to implementing project-specific actions, such as impacts during construction and/or start-up periods for actions that are not fully defined at this time and that may be implemented by Reclamation or other agencies as part of the alternatives. It is recognized that numerous projects would be planned, designed, and constructed under the No Action Alternative and the Second Basis of Comparison, including tidal wetlands and floodplain restoration, as described in Chapter 3, Description of Alternatives. It also recognized that facilities to implement fish passage at CVP reservoirs would be implemented under the No Action Alternative and Alternative 5; and facilities to implement a trap and haul program for steelhead from the San Joaquin River under Alternative 4. Project-specific construction impacts would be addressed in project-specific environmental documents prepared at the time the projects are proposed for approval. At this time, however, the need for, and the nature, magnitude, and extent of specific impacts are not known.

Potential long-term effects (beneficial and adverse) of implementation of Alternatives 1 through 5 as compared to the No Action Alternative with respect to each environmental resource are summarized in Table 22.1.

There would be no long-term effects related to geology and soils resources, agricultural resources, land use, cultural resources, and Indian Trust Assets because the conditions under Alternatives 1 through 5 would be similar to conditions under the No Action Alternative and to the Second Basis of Comparison.

A complete listing of the effects of implementation of Alternatives 1 through 5 as compared to the No Action Alternative and to the Second Basis of Comparison are included Chapter 3, Description of Alternatives.

Table 22.1 Long-term Effects of Implementation of the No Action Alternative and Alternatives 1 through 5

Environmental Resources	Comparison of Alternatives 1 through 5 and the No Action Alternative
Surface Water	
Trinity Lake	Water surface elevations similar in Alternatives 1 through 5 and the No Action Alternative. Storage under Alternatives 1, 3, and 4 is higher than under Alternatives 2 and 5 and the No Action Alternative.
Trinity River at Lewiston Dam	Flows similar or higher in November-December under Alternatives 1, 3, and 4 than under Alternatives 2 and 5 and the No Action Alternative. Similar flows in other months.
Shasta Lake	Water surface elevations similar in Alternatives 1 through 5 and the No Action Alternative. Storage under Alternatives 1, 3, and 4 is higher than under Alternatives 2 and 5 and the No Action Alternative.
Sacramento River at Keswick Dam	Flows similar or higher in December-August under Alternatives 1, 3, and 4 than under Alternatives 2 and 5 and the No Action Alternative. Flows higher in September-November under Alternatives 2 and 5 and the No Action Alternative than under Alternatives 1, 3, and 4.
Sacramento River at Freeport	Flows similar or higher under Alternatives 1 and 4 than under Alternative 3; and flows higher under Alternative 3 than under Alternatives 2 and 5 and the No Action Alternative in May-June. Flows higher in July-December under Alternatives 2 and 5 and the No Action Alternative than under Alternative 3; and flows higher under Alternative 3 than under Alternatives 1 and 4.
Clear Creek near Igo	Flows are similar under Alternatives 1 through 5 and the No Action Alternative in June-April. Flows under Alternatives 2 and 5 and the No Action Alternative are higher in May than under Alternatives 1, 3, and 4.
Lake Oroville	Water surface elevations similar in Alternatives 1 through 5 and the No Action Alternative. Storage under Alternatives 1, 3, and 4 is higher than under Alternatives 2 and 5 and the No Action Alternative.
Feather River downstream of Thermalito Complex	Flows under Alternatives 1, 3, and 4 similar or higher than under Alternatives 2 and 5 and the No Action Alternative.

Environmental Resources	Comparison of Alternatives 1 through 5 and the No Action Alternative
Folsom Lake	Water surface elevations similar in Alternatives 1 through 5 and the No Action Alternative. Storage under Alternatives 1, 3, and 4 is higher in October-January than under Alternatives 2 and 5 and the No Action Alternative. Storage under Alternatives 2 and 5 and the No Action Alternative are higher in August-September than under Alternatives 1, 3, and 4. Storage similar under February-July in Alternatives 1 through 5 and the No Action Alternative.
American River at Nimbus Dam	Flows under Alternatives 1, 3, and 4 similar or higher than under Alternatives 2 and 5 and the No Action Alternative.
New Melones Reservoir	Water surface elevations similar in Alternatives 1 through 5 and the No Action Alternative. Storage under Alternative 3 is higher than under Alternatives 1 and 4; and storage under Alternatives 1 and 4 are higher than under Alternatives 2 and 5 and the No Action Alternative.
Stanislaus River at Goodwin Dam	Flows higher under Alternatives 1 and 4 than under Alternative 3; and flows under Alternative 3 are higher than under Alternative 5 and the No Action Alternative. Flows under Alternative 5 higher than under the No Action Alternative in April-May.
San Joaquin River at Vernalis	Flows higher in October under the Alternatives 2 and 5 and the No Action Alternative than under Alternatives 1, 3, and 4. Flows higher in April under Alternative 5 than under all other alternatives. Flows higher in May under Alternatives 1 and 4 than under Alternatives 3 and 5 and the No Action Alternative. Flows similar during other months.
San Luis Reservoir	Water surface elevations similar in Alternatives 1 through 5 and the No Action Alternative. Storage under Alternatives 1 and 4 higher than under Alternative 3; and storage under Alternatives 2 and 5 and the No Action Alternative. Storage under Alternatives 2 and the No Action Alternative higher than under Alternative 5 in dry and critical dry years.
Flows into Yolo Bypass	Flows entering the Yolo Bypass at Fremont Weir higher under Alternatives 1, 3, and 4 than under Alternatives 2 and 5 and the No Action Alternative.
Delta Outflow	Delta outflow higher under Alternatives 2 and 5 and the No Action Alternative than under Alternatives 1, 3, and 4.
Reverse Flows in Old and Middle Rivers	Old and Middle River flows in April-May more positive under Alternative 5 than under Alternative 2 and the No Action Alternative. Old and Middle River flows in July more positive under Alternatives 1 and 4 than under Alternative 3; and under Alternative 3 than under Alternatives 2 and 5 and the No Action Alternative. Old and Middle River flows in other months higher under Alternatives 2 and 5 and the No Action Alternative than Alternative 3; and higher under Alternative 3 than under Alternatives 1 and 4.
Water Supplies	
Non-CVP and Non-SWP Deliveries	Water deliveries under Alternatives 1 through 5 and the No Action Alternative.
CVP Water Deliveries	Water deliveries higher under Alternatives 1 and 4 than under Alternative 3; and higher under Alternative 3 than under Alternatives 2 and 5 and the No Action Alternative.

Environmental Resources	Comparison of Alternatives 1 through 5 and the No Action Alternative
SWP Water Deliveries	Water deliveries higher under Alternatives 1 and 4 than under Alternative 3; and higher under Alternative 3 than under Alternatives 2 and 5 and the No Action Alternative.
Surface Water Quality	
Salinity in Northern Delta (near Emmaton)	Salinity in September-January under Alternatives 1, 3, and 4 than under Alternatives 2 and 5 and the No Action Alternative. Salinity in February-August under Alternatives 2 and 5 and the No Action Alternative higher than under Alternatives 1, 3, and 4.
Salinity in Western Delta (near Port Chicago)	Salinity in September-January under Alternatives 1, 3, and 4 than under Alternatives 2 and 5 and the No Action Alternative. Salinity in February-August under Alternatives 2 and 5 and the No Action Alternative higher than under Alternatives 1, 3, and 4.
Salinity in Western Central Delta (near Antioch)	Salinity in September-January under Alternatives 1, 3, and 4 than under Alternatives 2 and 5 and the No Action Alternative. Salinity in February-August under Alternatives 2 and 5 and the No Action Alternative higher than under Alternatives 1, 3, and 4.
Salinity in Western Central Delta (near Contra Costa Water District Intakes)	Salinity in September-January under Alternatives 1, 3, and 4 than under Alternatives 2 and 5 and the No Action Alternative. Salinity in February-August under Alternatives 2 and 5 and the No Action Alternative higher than under Alternatives 1, 3, and 4.
Salinity in Southern Delta (near CVP and SWP intakes)	Salinity under Alternatives 1 and 4 higher than under Alternative 3; and salinity under Alternative 3 higher than under Alternatives 2 and 5 and the No Action Alternative.
Mercury in Delta Fish	Mercury concentrations in fish tissue of large fish in the Delta used for human consumption would exceed guidelines established by the State of California under Alternatives 1 through 5 and the No Action Alternative. In the interior Delta along the San Joaquin River and at the CVP Contra Costa Canal Pumping Plant, mercury concentrations in the tissue of large fish used for human consumption would be the higher under Alternative 5 than under Alternative 3. Mercury under Alternative 3 would be higher than under Alternative 2 and the No Action Alternative. Mercury under Alternative 2 and the No Action Alternative would be higher than under Alternatives 1 and 4. Near Suisun Marsh and Cache Slough, mercury concentrations would be higher under Alternative 2 and the No Action Alternative than under Alternatives 1 and 4. Mercury under Alternatives 1 and 4 would be higher than under Alternative 5; and concentrations under Alternative 5 would be higher than under Alternative 3. Along Old River near Clifton Court, mercury concentrations in the tissue of large fish used for human consumption would be higher under Alternative 2 and the No Action Alternative than under Alternative 5. Mercury under Alternative 5 would be higher than under Alternative 3. Mercury under Alternative 3 would be higher than under Alternatives 1 and 4. Near the CVP Jones Pumping Plant intake, mercury concentrations in the tissue of large fish used for human consumption would be higher under Alternative 2 and the No Action Alternative than under Alternative 3. Mercury under Alternative 3 would be higher than under Alternatives 1 and 4. Mercury under Alternatives 1 and 4 would be higher than under Alternative 5.
Selenium in Delta and Delta Fish	Selenium concentrations similar under Alternatives 1 through 5 and the No Action Alternative.

Environmental Resources	Comparison of Alternatives 1 through 5 and the No Action Alternative
Groundwater Resources	
Trinity River Region	Similar groundwater conditions under Alternatives 1 through 5 and the No Action Alternative.
Central Valley Region: Sacramento Valley	Similar groundwater conditions under Alternatives 1 through 5 and the No Action Alternative.
Central Valley Region: San Joaquin Valley	Groundwater pumping would be higher under Alternative 5 than under Alternative 2 and the No Action Alternative. Pumping would be higher under Alternative 2 and the No Action Alternative than under Alternative 3. Pumping would be higher under Alternative 3 than under Alternatives 1 and 4. Increased groundwater pumping would result in lower groundwater elevations and increased subsidence potential.
San Francisco Bay Area, Central Coast, and Southern California Region	Groundwater pumping would be higher under Alternative 5 than under Alternative 2 and the No Action Alternative. Pumping would be higher under Alternative 2 and the No Action Alternative than under Alternative 3. Pumping would be higher under Alternative 3 than under Alternatives 1 and 4. Increased groundwater pumping would result in lower groundwater elevations and increased subsidence potential.
CVP and SWP Energy Resources	
Energy Generated and Used by CVP and SWP Water Users	CVP net energy generation would be higher under Alternative 2 and the No Action Alternative than under Alternatives 1 and 4. Net energy generation would be higher under Alternatives 1 and 4 than under Alternative 3. Net energy generation would be higher under Alternative 3 than under Alternative 5. SWP net energy generation would be higher under Alternative 2 and the No Action Alternative than under Alternative 5. Net energy generation would be higher under Alternative 5 than under Alternative 3. Net energy generation would be higher under Alternative 3 than under Alternatives 1 and 4. Energy use by CVP and SWP water users for alternative water supplies would be higher under Alternative 5 than under Alternative 2 and the No Action Alternative. Energy use would be higher under Alternative 2 and the No Action Alternative than under Alternative 3. Energy use would be higher under Alternative 3 than under Alternatives 1 and 4.
Aquatic Resources	
Trinity River: Coho Salmon	Habitat conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Trinity River: Spring-run Chinook Salmon	Habitat conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Trinity River: Fall-run Chinook Salmon	Habitat conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Trinity River: Steelhead	Habitat conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Trinity River: Green Sturgeon	Habitat conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Trinity Lake and Lewiston Reservoir: Reservoir Fish	Habitat conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Trinity River: Pacific Lamprey	Habitat conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Trinity River: Eulachon	Habitat conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.

Environmental Resources	Comparison of Alternatives 1 through 5 and the No Action Alternative
Sacramento River System: Winter-run Chinook Salmon	Habitat conditions would be better under Alternative 5 and the No Action Alternative than under Alternative 2. Conditions under Alternative 2 would be better than under Alternatives 3 and 4. Conditions under Alternative 3 and 4 would be better than under Alternative 1.
Sacramento River System: Spring-run Chinook Salmon	Habitat conditions would be better under Alternative 5 and the No Action Alternative than under Alternative 2. Conditions under Alternative 2 would be better than under Alternatives 3 and 4. Conditions under Alternative 3 and 4 would be better than under Alternative 1.
Sacramento River System: Fall-run Chinook Salmon	Habitat conditions under Alternatives 1, 3, 4, and 5 and the No Action Alternative would be better than under Alternative 2.
Sacramento River System: Late Fall-run Chinook Salmon	Habitat conditions under Alternatives 1, 3, 4, and 5 and the No Action Alternative would be better than under Alternative 2.
Sacramento River System: Steelhead	Habitat conditions would be better under Alternative 5 and the No Action Alternative than under Alternative 2. Conditions under Alternative 2 would be better than under Alternatives 3 and 4. Conditions under Alternative 3 and 4 would be better than under Alternative 1.
Sacramento River System: Green Sturgeon and White Sturgeon	Habitat conditions would be better under Alternative 3 than under Alternatives 1 and 4. Conditions under Alternative 4 would be better than under Alternatives 2 and 5 and the No Action Alternative.
Delta: Delta Smelt	Habitat conditions would better under Alternatives 2 and 5 and the No Action Alternative than under Alternatives 1, 3, and 4.
Delta: Longfin Smelt	Habitat conditions would better under Alternatives 2 and 5 and the No Action Alternative than under Alternatives 1, 3, and 4.
Delta: Sacramento Splittail	Habitat conditions would better under Alternatives 2 and 5 and the No Action Alternative than under Alternatives 1, 3, and 4.
Sacramento River System: Reservoir Fish	Habitat conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Sacramento River System: Pacific Lamprey	Habitat conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Sacramento River System: Striped Bass, American Shad, and Hardhead	Habitat conditions for Hardhead and American Shad would be similar under Alternatives 1 through 5 and the No Action Alternative. Habitat conditions for Striped Bass would better under Alternatives 1, 2, and 5 and the No Action Alternative than under Alternatives 3 and 4 due to increased harvest limits.
Stanislaus River: Fall-run Chinook Salmon	Habitat conditions better under Alternatives 3 and 4 than under Alternatives 1, 2, and 5 and the No Action Alternative.
Stanislaus River: Steelhead	Habitat conditions better under Alternative 5 and the No Action Alternative than under Alternatives 3 and 4. Conditions under Alternatives 3 and 4 are better than under Alternatives 1 and 2.
Stanislaus River: White Sturgeon	Habitat conditions better under Alternatives 2 and 5 and the No Action Alternative than under Alternatives 1, 3, and 4.
New Melones Reservoir; Reservoir Fish	Habitat conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Stanislaus River: Other Fish	Habitat conditions for Hardhead and American Shad would be similar under Alternatives 1 through 5 and the No Action Alternative. Habitat conditions for Striped Bass would better under Alternatives 1, 2, and 5 and the No Action Alternative than under Alternatives 3 and 4 due to increased harvest limits.

Environmental Resources	Comparison of Alternatives 1 through 5 and the No Action Alternative
Pacific Ocean: Killer Whale	Habitat conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Terrestrial Resources	
Terrestrial Resources along Shoreline of CVP and SWP Reservoirs	Habitat conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Terrestrial Resources along Rivers Downstream of CVP and SWP Reservoirs	Habitat conditions along Trinity, Sacramento, American, and Feather rivers would be similar under Alternatives 1 through 5 and the No Action Alternative. Habitat conditions along the Stanislaus River would be better under Alternatives 2 and 5 and the No Action Alternative than under Alternatives 1, 3, and 4.
Terrestrial Resources in Yolo Bypass	Habitat conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Terrestrial Resources in Western Delta	Freshwater habitat in the western Delta would be better under Alternatives 2 and 5 and the No Action Alternative than under Alternatives 1, 3, and 4.
Geology and Soils Resources	
Geology and Soils Resources	Geology and soils conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Agricultural Resources	
Agricultural Production and Employment	Agricultural production and employment conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Land Use	
Municipal and Industrial Land Use	Municipal and industrial land use conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Visual Resources	
Visual Resources of Land Irrigated with CVP and SWP Water	Visual resource conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Visual Resources at Reservoirs that Store CVP and SWP Water	Visual resource conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Recreation Resources	
Recreation Resources at Reservoirs that Store CVP and SWP Water	Recreational resource conditions at the reservoirs would be similar under Alternatives 1 through 5 and the No Action Alternative.
Recreation Resources in Rivers downstream of CVP and SWP Reservoirs	Recreational resource conditions at the along the rivers would be similar under Alternatives 1 through 5 and the No Action Alternative. Recreational resource conditions related to Striped Bass fishing and sport ocean salmon fishing would be better under Alternatives 1, 2, and 5 and the No Action Alternative than under Alternatives 3 and 4 due to increased harvest limitations.

Environmental Resources	Comparison of Alternatives 1 through 5 and the No Action Alternative
Air Quality and Greenhouse Gas Emissions	
Emissions of Criteria Air Pollutants and Precursors and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants from Diesel Engines at Groundwater Wells	In the San Joaquin Valley and the San Francisco Bay Area, Central Coast, and Southern California regions, potential emissions from diesel engines used for groundwater pumping would be higher under Alternative 5 than under Alternative 2 and the No Action Alternative. Emissions would be higher under Alternative 2 and the No Action Alternative than under Alternative 3. Emissions would be higher under Alternative 3 than under Alternatives 1 and 4.
Increased Greenhouse Gas Emissions (GHG) due to Changes in Energy Resources Related to CVP and SWP Water Use	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could increase due to energy use related to alternative water supplies. Energy use by CVP and SWP water users for alternative water supplies would be higher under Alternative 5 than under Alternative 2 and the No Action Alternative. Energy use would be higher under Alternative 2 and the No Action Alternative than under Alternative 3. Energy use would be higher under Alternative 3 than under Alternatives 1 and 4.
Cultural Resources	
Potential for Disturbance of Cultural Resources	Cultural resource conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Public Health	
Water Supply Availability for Wildland Firefighting	Water supply conditions for fighting wildland firefighting would be similar under Alternatives 1 through 5 and the No Action Alternative.
Potential Exposure to Mercury in Fish in Delta	Mercury concentrations in fish tissue of large fish in the Delta used for human consumption would exceed guidelines established by the State of California under Alternatives 1 through 5 and the No Action Alternative. In the interior Delta along the San Joaquin River and at the CVP Contra Costa Canal Pumping Plant, mercury concentrations in the tissue of large fish used for human consumption would be the higher under Alternative 5 than under Alternative 3. Mercury under Alternative 3 would be higher than under Alternative 2 and the No Action Alternative. Mercury under Alternative 2 and the No Action Alternative would be higher than under Alternatives 1 and 4. Near Suisun Marsh and Cache Slough, mercury concentrations would be higher under Alternative 2 and the No Action Alternative than under Alternatives 1 and 4. Mercury under Alternatives 1 and 4 would be higher than under Alternative 5; and concentrations under Alternative 5 would be higher than under Alternative 3. Along Old River near Clifton Court, mercury concentrations in the tissue of large fish used for human consumption would be higher under Alternative 2 and the No Action Alternative than under Alternative 5. Mercury under Alternative 5 would be higher than under Alternative 3. Mercury under Alternative 3 would be higher than under Alternatives 1 and 4. Near the CVP Jones Pumping Plant intake, mercury concentrations in the tissue of large fish used for human consumption would be higher under Alternative 2 and the No Action Alternative than under Alternative 3. Mercury under Alternative 3 would be higher than under Alternatives 1 and 4. Mercury under Alternatives 1 and 4 would be higher than under Alternative 5.
Socioeconomics	
Agricultural and Municipal and Industrial Employment	Agricultural, municipal, and industrial employment would be similar under Alternatives 1 through 5 and the No Action Alternative.

Environmental Resources	Comparison of Alternatives 1 through 5 and the No Action Alternative
Municipal and Industrial Water Supply Operating Expenses	Municipal and industrial water supply operating expenses would be similar under Alternatives 1 through 5 and the No Action Alternative.
Recreational Economics CVP and SWP Reservoirs	Recreational economic conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Recreational Economics Related to Striped Bass Fishing in Delta	Recreational economic conditions related to Striped Bass fishing would be better under Alternatives 1, 2, and 5 and the No Action Alternative than under Alternatives 3 and 4 due to changes in harvest limitations.
Commercial and Sport Ocean Salmon Fishing	Recreational economic conditions related to commercial and sport ocean salmon fishing would be better under Alternatives 1, 2, and 5 and the No Action Alternative than under Alternatives 3 and 4 due to changes in harvest limitations.
Indian Trust Assets	
Potential for Disturbance of Indian Trust Assets	Indian Trust Asset conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Environmental Justice	
Emissions of Criteria Air Pollutants and Precursors and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants from Diesel Engines at Groundwater Wells	In the San Joaquin Valley, potential emissions from diesel engines used for groundwater pumping would be higher under Alternative 5 than under Alternative 2 and the No Action Alternative. Emissions would be higher under Alternative 2 and the No Action Alternative than under Alternative 3. Emissions would be higher under Alternative 3 than under Alternatives 1 and 4.
Potential Exposure to Mercury in Fish in Delta	Mercury concentrations in fish tissue of large fish in the Delta used for human consumption would exceed guidelines established by the State of California under Alternatives 1 through 5 and the No Action Alternative. In the interior Delta along the San Joaquin River and at the CVP Contra Costa Canal Pumping Plant, mercury concentrations in the tissue of large fish used for human consumption would be the higher under Alternative 5 than under Alternative 3. Mercury under Alternative 3 would be higher than under Alternative 2 and the No Action Alternative. Mercury under Alternative 2 and the No Action Alternative would be higher than under Alternatives 1 and 4. Near Suisun Marsh and Cache Slough, mercury concentrations would be higher under Alternative 2 and the No Action Alternative than under Alternatives 1 and 4. Mercury under Alternatives 1 and 4 would be higher than under Alternative 5; and concentrations under Alternative 5 would be higher than under Alternative 3. Along Old River near Clifton Court, mercury concentrations in the tissue of large fish used for human consumption would be higher under Alternative 2 and the No Action Alternative than under Alternative 5. Mercury under Alternative 5 would be higher than under Alternative 3. Mercury under Alternative 3 would be higher than under Alternatives 1 and 4. Near the CVP Jones Pumping Plant intake, mercury concentrations in the tissue of large fish used for human consumption would be higher under Alternative 2 and the No Action Alternative than under Alternative 3. Mercury under Alternative 3 would be higher than under Alternatives 1 and 4. Mercury under Alternatives 1 and 4 would be higher than under Alternative 5.

22.3 Irreversible and Irretrievable Commitments of Resources

NEPA requires that an EIS prepared by Federal agencies disclose "…any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented…" (40 CFR 1502.16). An irreversible and irretrievable commitment of resources includes use of natural or depletable resources, including consumption of construction materials and nonrenewable energy sources, and permanent conversion of land uses or habitat.

As described in Chapter 3, Description of Alternatives, there are several ongoing projects that are assumed to be implemented by 2030, such as Grasslands Bypass Project which is currently under construction. It is assumed that these projects would be included in the No Action Alternative, all other alternatives, and Second Basis of Comparison. The 2030 conditions assume the projected long-term conditions for each ongoing project as described in their respective environmental documents. This analysis does not address the construction activities of each ongoing project because those impacts were addressed in separate environmental documents for each project.

The alternatives include several future actions that would require construction, such as implementation of tidal wetlands and floodplains, fish passage facilities, or temperature control devices at CVP dams. Specific details for location and construction of these future projects are not identified at this time and are not addressed in this EIS. Future environmental documents would be prepared to analyze potential environmental consequences related to specific construction and operations. This EIS analyzes implementation of the alternatives with the assumption that these projects would be implemented by 2030; however, this EIS does not address irreversible and irretrievable commitment of resources associated with consumption of construction materials and permanent conversion of land uses or habitat.

Changes in nonrenewable energy resources would occur through implementation of the No Action Alternative and Alternatives 1 through 5. Under the alternatives, energy would be generated by CVP and SWP operations and used to convey water in CVP and SWP facilities. As discussed in Chapter 8, Energy, changes in CVP and SWP energy generation and use would result in the ability to provide additional energy for use by others or the need to purchase additional energy from others to operate the CVP and SWP facilities. Under both long-term average conditions and dry/critical dry water years, Alternative 5 would result in the least demand for electrical generation by others which would generally be produced using fossil fuels. The No Action Alternative and Alternative 2 would require more electrical generation by non-CVP and SWP facilities than Alternative 5; and less electrical generation than under Alternatives 1, 3, and 4. Alternative 1 would require the most electrical generation as compared to other alternatives.

22.4 Growth-Inducing Impacts

NEPA requires that an EIS prepared by Federal agencies evaluate indirect growth-inducing effects (40 CFR 1508.8). A project could result in growth-inducing impacts through several measures, including the removal of obstacles to population growth, or actions that encourage and facilitate other activities beyond those proposed by the project. The availability of adequate water supplies, employment opportunities, and improved cultural amenities are examples of actions that could be growth-inducing impacts. Growth inducement may or may not be detrimental, beneficial, or significant. However, if the induced growth impacted the environment, or the ability of agencies to provide public services to an extent not envisioned due to the project actions, the impacts would be considered to be adverse.

As described in Chapter 13, Land Use, and Chapter 19, Socioeconomics, land use and growth projections are not anticipated to change under Alternatives 1 through 5 as compared to the No Action Alternative and the Second Basis of Comparison. Municipal and industrial water users that use CVP and SWP water have prepared Urban Water Management Plans (UWMPs) that project water demand and future water supplies to meet the demands by 2030, including water conservation measures. Projects that had undergone environmental review, were under design, or under construction were considered to exist in 2030 water supply assumptions in the No Action Alternative, Alternatives 1 through 5, and the Second Basis of Comparison. Future projects described in the UWMPs that are under evaluation are considered as options to increase fixed-yield supplies, including additional groundwater pumping, water transfers, recycling water treatment, and desalination water treatment. Existing and future water supplies considered for municipalities by 2030 are presented in Appendix 5B, Future Municipal Water Supplies for CVP and SWP Water Users. For smaller water users that are not addressed in a UWMP, information was obtained from water master plans and integrated regional water management plans. The analysis presented in Chapter 19, indicated that use of the existing and planned future projects would be adequate to meet the water demands in 2030 with or without the CVP and SWP water supply availability under the alternatives considered in this EIS.

Alternatives 1, 3, and 4 would result in higher CVP and SWP water deliveries than the No Action Alternative and Alternatives 2 and 5. However, the additional water supplies under Alternatives 1, 3, and 4 would result in less groundwater pumping and less water transfers which could result in less potential for groundwater overdraft and soil subsidence, and less potential impacts in the service area of the seller for the transfer water. None of the alternatives considered in this EIS would increase the total water supplies to meet 2030 water demands; and therefore, none of the alternatives considered in this EIS are considered to be growth inducing.

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Chapter 23

Consultation and Coordination

23.1 Introduction

This chapter summarizes completed, ongoing, and anticipated public outreach and agency involvement efforts related to preparation of the Environmental Impact Statement (EIS) for the coordinated long-term operation of the Central Valley Project (CVP) and State Water Project (SWP).

23.2 Consultation with the Public and Interested Parties

Consultation activities were initiated in 2012 with the scoping process and continued through the preparation of the Final EIS. In this section, the term “interested parties” includes representatives from agencies, utilities, agencies, organizations, and other entities.

23.2.1 Scoping Process

As described in Chapters 1 and 3, the scoping process was initiated on March 28, 2012, with the publication of the Notice of Intent (NOI) in the Federal Register and continued through June 28, 2012. Initially the public scoping process was to be completed on May 29, 2012. During the public scoping process, other agencies and interested persons requested an extension of the public scoping process to allow additional opportunities to provide scoping comments. In response to these requests, U.S. Department of the Interior, Bureau of Reclamation (Reclamation) published a notice on May 25, 2012, to extend the public scoping period through June 28, 2012.

Scoping meetings were held to inform the public and interested stakeholders about the project, and to solicit comments and input on the EIS. The scoping meetings were held in the following locations and resulted in the following level of public participation:

- Madera, California on April 25, 2012 (6 participants)
- Diamond Bar, California on April 26, 2012 (3 participants)
- Sacramento, California on May 2, 2012 (15 participants)
- Marysville, California on May 3, 2012 (2 participants)
- Los Banos, California on May 22, 2012 (230 participants)

Reclamation posted the scoping notices in the Federal Register, on its website, and in newspapers that served areas where the scoping meetings were held. Reclamation also published press releases to news organizations and others that have requested notifications for all press releases.

Each participant in the scoping meetings was invited to sign an attendance sheet and provided with an agenda, fact sheet, comment card, and speaker card. The agenda, fact sheet, and comment card were available in both English and Spanish.

Each scoping meeting began with a presentation by Reclamation. The presentation described the purpose of the meeting and the public scoping process, an overview of the reasons that Reclamation was preparing the EIS, description of the process and schedule that Reclamation will use to complete the EIS, and methods to provide comments at the scoping meeting and subsequently until the end of the public scoping period. The participants were encouraged to submit written comments by mail, email, or fax until the close of the public scoping comment period. During the presentation, Reclamation responded to questions as they arose from the meeting participants. Following the presentation, Reclamation heard testimony from those who presented oral comments. Oral comments were recorded by a transcriber. Reclamation offered to provide Spanish translation of the presentation and oral comments at each scoping meeting; however, the translation service was only requested and provided at the scoping meeting in Los Banos, California.

The scoping comments included suggestions related to:

- Purpose and need for the action.
- Geographical extent of the Project Area.
- Definition and assumptions of the No Action Alternative.
- Definition and assumptions of the action alternatives.
- Important considerations either for description of the affected environment or for the methods of analyses for the following resources:
  - Water resources.
  - Biological resources.
  - Land use and socioeconomics.
  - Air quality.
  - Recreation and visual resources.

Scoping comments were used in the development of a reasonable range of alternatives and identification of key issues that would require analysis in the Environmental Consequences sections of this EIS, as described in Chapters 3.

Scoping comments also were used in development of the level of detail and methods of analyses for water resources, biological resources, land use, socioeconomics, recreation, air quality, and visual resources. These resources are discussed in Chapters 5 through 10, 12 through 17, and 19 through 21.

Reclamation also posted on its website an initial range of alternatives discussed at the meeting on October 19, 2012 of invited stakeholders. As described in Chapter 3, Description of Alternatives, comments received during that process were used to refine the description of the alternatives.

Project status meetings were held with cooperating agencies and other stakeholders during preparation of the Draft EIS, including meetings in Sacramento, California on January 16, May 29, and November 5, 2014; February 20, 2015; and June 24, 2015.

The scoping report is included in Appendix 23A, Scoping Report.

23.2.2 Other Activities

Reclamation established a website which includes the background material related to the purpose and need for the action, materials used in the scoping process, scoping comments, and information related to meetings with invited stakeholders and interest groups to discuss assumptions to be considered in the development of the No Action Alternative and action alternatives. As described in Chapter 3, comments received on the information posted on Reclamation's website during that process were used to refine the description of the alternatives.

23.2.3 Stakeholder and Public Involvement during Preparation of the Final EIS

The Draft EIS was published for public review in July 2015. The Notice of Availability was published by Reclamation in the Federal Register on July 31, 2015 (Federal Register, Vol 80, No. 147, 45681). A copy of the Notice of Availability is included in Appendix 23B, Public Review of Draft Environmental Impact Statement.

Newspaper advertisements providing the dates and locations of the public meetings for the Draft EIS were published in the following newspapers on the specified dates.

- Sacramento Bee, Sacramento, California – August 26, 2015
- Oakland Tribune, Oakland, California – August 26, 2015
- San Jose Mercury, San Jose, California – August 26, 2015
- Contra Costa Times, Walnut Creek, California – August 26, 2015
- Record Searchlight, Redding, California – August 27, 2015
- Los Banos Enterprise, Los Banos, California – August 28, 2015
- Fresno Bee, Fresno, California – September 1, 2015
- Los Angeles Times, California – September 3, 2015

The distribution list for the Draft EIS is included in Chapter 24, Environmental Impact Statement Distribution List. Reclamation posted notification of the availability of the Draft EIS and the location and timing of public meetings on its website and through press releases.

Four public meetings were held during the public review period for the Draft EIS in the following locations, with the following level of public participation:

- Sacramento, California on September 9, 2015 (9 participants)
- Red Bluff, California on September 10, 2015 (9 participants)
- Los Banos, California on Tuesday, September 15, 2015 (9 participants)
- Irvine, California on September 17, 2015 (2 participants)

The public meetings included an open house preceding a presentation by Reclamation. The open house portion of the meetings included several project information stations staffed by project team members available to respond to attendee's questions. The open house stations included:

- Welcome Station with display boards that described the public meeting format
- Purpose and Need of the Project
- Surface Water and Groundwater Resources
- Aquatic, Wildlife, and Botanical Resources
- Socioeconomics
- Comments with a court reporter to record verbal comments

Fact sheets were provided at each of the open house stations.

Following the open house portion of the public meeting, Reclamation staff led a brief presentation. The open house portion of the public meeting was resumed after the presentation.

Copies of the display boards, fact sheets, and the presentation are included in Appendix 23B, Public Review of Draft Environmental Impact Statement.

Only attendees at the meeting in Red Bluff chose to provide verbal comments to the court reporter. The transcript of those comments also is included in Appendix 23B. Responses to those comments are included in Appendix 1E.

Approximately 860 written and verbal comments were received on the Draft EIS. All of the comments received on the Draft EIS were considered in preparation of the Final EIS. Written responses to all substantial comments received are included in Appendices 1A through 1E of the Final EIS.

23.3 Consultation with U.S. Fish and Wildlife Service and National Marine Fisheries Service

As described in Chapter 1, federal agencies also have an obligation pursuant to the Endangered Species Act (ESA) to "…ensure that any discretionary action authorized, funded, or carried out by such an agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification…" of such species' designated "critical habitat," "…unless such agency has been granted an exemption for such action…" by the Endangered Species Committee which the ESA creates (16 United States Code (U.S.C.) section 1536 (a)(2). A discretionary agency action jeopardizes the continued existence of a listed species if it “reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species” (50 Code of Federal Regulations [CFR] section 402.02). Such action results in the destruction or adverse modification of designated critical habitat if there is “… a direct or indirect alteration that appreciably diminishes the value of critical habitat for both the survival and recovery of a listed species” (50 CFR section 402.02).

In carrying out its obligations, Reclamation must consult with the appropriate regulatory agency or agencies (e.g., U.S. Fish and Wildlife Service [USFWS] and National Marine Fisheries Service [NMFS]). At the conclusion of this consultation process, those agencies render written statements (known as biological opinions) setting forth their opinion as to how an action being proposed by Reclamation would affect a listed species and its designated critical habitat. If these agencies conclude that an action will jeopardize the continued existence of a listed species or result in the destruction or adverse modification of their designated critical habitat, then they must suggest a reasonable and prudent alternative to the action being proposed by Reclamation.

Pursuant to ESA Section 7(a)(1), Reclamation also considers which it could take under its existing authorities to benefit listed species. However, Section 7(a)(1) does not give Reclamation additional authority to undertake any particular action, regardless of its potential benefit for threatened and endangered species.

The Fish and Wildlife Coordination Act requires that Reclamation consult with fish and wildlife agencies (federal and state) on all water development projects that could affect biological resources. As part of this project, Reclamation has been in continuous consultation with USFWS and NMFS. This continuous consultation also satisfies any applicable requirements of the Fish and Wildlife Coordination Act.

23.4 Consultation with Cooperating Agencies and Other Entities

In accordance with requirements of the National Environmental Policy Act (NEPA), Reclamation invited eligible governmental agencies to participate as a cooperating agency. The federal cooperating agencies include the USFWS, NMFS, U.S. Environmental Protection Agency (USEPA), U.S. Army Corps of Engineers (USACE), and Bureau of Indian Affairs (BIA).

Reclamation also provided non-federal agencies with the opportunity to participate in the NEPA process if they qualified under NEPA (as described above) as a cooperating agency. In August of 2012, Reclamation mailed invitations to 747 non-federal entities to be cooperating agencies for this EIS, including:

- California Department of Water Resources

- State Water Resources Control Board
- California Department of Fish and Wildlife
- Agencies that have contracts with the CVP or SWP for water delivery, water service repayment, exchange or settlement, or use of CVP or SWP facilities for conveyance
- State and Federal Contractors Water Agency
- Cities and counties within the CVP and SWP service areas
- Federally-recognized tribes within the CVP and SWP service area or areas affected by CVP or SWP operations

Non-federal entities that meet the specified criteria for cooperating agencies are required to enter into a Memorandum of Understanding (MOU) with Reclamation to memorialize their participation as a cooperating agency.

Reclamation has signed cooperating agency MOUs with the following entities:

- Anderson-Cottonwood Irrigation District
- California Department of Water Resources
- California Valley Miwok Tribe
- City of Hesperia
- Contra Costa Water District
- Friant Water Authority
- Glenn-Colusa Irrigation District
- Metropolitan Water District of Southern California
- Oakdale Irrigation District
- Reclamation District 108
- San Diego County Water Authority
- San Juan Water District
- San Luis & Delta-Mendota Water Authority
- Stockton East Water District
- Sutter Mutual Water District
- Tehama Colusa Canal Authority
- Zone 7 Water Agency

These agencies have participated in preliminary review of written materials that were used to prepare this Draft EIS.

Reclamation also received a request from an interested party to include the Federal Emergency Management Agency (FEMA) as a cooperating agency. However, Reclamation concluded that FEMA does not have special expertise related to environmental issue that would not be addressed by other cooperating federal agencies.

Reclamation also received a request from the State Water Contractors, a non-profit association of 27 public agencies from northern, central, and southern California that purchase water under contract from the SWP (SWC 2015).

However, Reclamation concluded that the State Water Contractors was not a public agency; and therefore, could not be cooperating agency. However, this group and several other non-profit groups (including the Natural Resources Defense Council and The Bay Institute) have participated in preliminary review of written materials that were used to prepare this Draft EIS.

23.5 Consultation with Other Federal, State, and Local Agencies

This EIS was prepared in accordance with policies and regulations adopted by federal and state agencies. Brief discussions of relevant policies and regulations for each resource are included in Appendix 4A, Federal and State Policies and Regulations. Reclamation considered the requirements of these policies and regulations during preparation of the EIS and consultation with the related agencies, including the major regulations summarized below.

23.5.1 Federal Water Pollution Control Act Amendments of 1972 (Clean Water Act)

The Federal Water Pollution Control Act Amendments of 1972, also known as the Clean Water Act (CWA), established the institutional structure for the U.S. Environmental Protection Agency (USEPA) to regulate discharges of pollutants into the waters of the United States, establish water quality standards, conduct planning studies, and provide funding for specific grant projects. The Clean Water Act was further amended through the Clean Water Act of 1977 and the Water Quality Act of 1987. The California State Water Resources Control Board (SWRCB) has been designated by the USEPA along with the nine Regional Water Quality Control Boards (RWQCBs) to develop and enforce water quality objectives and implementation plans in California. The provisions of the Clean Water Act which affect water resources in the project area are described below.

- Section 401 of the Clean Water Act requires water discharges into navigable waters of the United States to apply for a Federal license or permit and to certify that the discharge will be in compliance with specified provisions of the Clean Water Act. Federal permits that are issued related to disturbance of waters of the United States (such as streams and wetlands) also require a Water Quality Certification in accordance with Clean Water Act section 401.

- Section 402 established the National Pollutant Discharge Elimination System (NPDES) permit program to regulate point source and non-point source discharges of pollutants into waters of the United States. An NPDES permit sets specific discharge limits for point and non-point sources discharging pollutants into waters of the United States and establishes monitoring and reporting requirements. The NPDES permits are issued for long-term discharges, including discharges from treatment plants, and temporary discharges, such as discharges during construction activities (e.g., General Permit for Storm Water Discharges Associated with Construction Activities).

- Section 404 requires the U.S. Army Corps of Engineers (USACE) to issue permits for discharge of dredge or fill material into navigable waters, their tributaries, and associated wetlands. Activities regulated by 404 permits include, but are not limited to, dredging, bridge construction, flood control actions, and some fishing operations.
- Section 303 requires preparation of basins plans. The SWRCB has approved water quality control plans (basin plans) for each watershed basin in the State. The basin plans designate the beneficial uses of waters within each watershed basin, and water quality objectives designed to protect those uses pursuant to Section 303 of the Clean Water Act. The beneficial uses together with the water quality objectives that are contained in the basin plans constitute State water quality standards.
- Under the CWA section 303(d), the SWRCB and USEPA identifies and ranks water bodies for which existing pollution controls are insufficient to attain or maintain water quality standards based upon information prepared by all states, territories, and authorized Indian tribes. Each state must establish priority rankings and develop Total Maximum Daily Loads (TMDLs) for all impaired waters. TMDLs calculate the greatest pollutant load that a waterbody can receive and still meet water quality standards and designated beneficial uses.

23.5.2 Rivers and Harbors Act

The navigable waters of the United States in the Study Area, including the major rivers in Sacramento and San Joaquin rivers watersheds and waterways in these watersheds affected by tidal action, are subject to the requirements of the Rivers and Harbors Act. “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 used, have been used in the past, or may be susceptible to use in interstate or foreign commerce. Sections 9 and 10 of the River and Harbors Act are applicable to the coordinated long-term operation of the CVP and SWP.

Under the reauthorization of the Rivers and Harbor Act of 1937, Reclamation took responsibility for the operation of the CVP.

23.5.2.1 Section 9 of the Rivers and Harbors Act

Section 9 of the Rivers and Harbors Act prohibits construction of any dike or dam across any navigable waters without approvals from the Chief of Engineers and the Secretary of the Army.

23.5.2.2 Section 10 of the Rivers and Harbors Act

Section 10 of the Rivers and Harbors Act of 1899 prohibits alterations of any navigable waters, including construction of structures in, over, or under; excavation of material from; and deposition of material into navigable waters of the United States without permission from the USACE. The approval process generally is completed simultaneously with the approval process under the Clean Water Act Section 404.

23.5.3 Federal Safe Drinking Water Act

The Safe Drinking Water Act (SDWA) protects public health by regulating the nation’s public drinking water supply. The SDWA authorizes USEPA to set national health-based standards for drinking water to protect against both naturally occurring and human-made contaminants that may be found in drinking water and its sources, including rivers, lakes, reservoirs, springs, and groundwater wells.

23.5.4 Wild and Scenic Rivers Act

Congress created the National Wild and Scenic Rivers Act in 1968 (Public Law 90-542; USC 1271 et seq.) to preserve rivers and outstanding natural, cultural, or recreational features in a free-flowing condition. High priority is place on visual resource management of these rivers to preserve or restore their scenic characteristics. Under this act, a Federal agency may not assist the construction of a water resources project that would have a direct and adverse effect on the free-flowing, scenic, and natural values of a wild or scenic river. If the project would affect the free-flowing characteristics of a designated river or unreasonably diminish the scenic, recreational, and fish and wildlife values present in the area, such activities should be undertaken in a manner that would minimize adverse impacts and should be developed in consultation with the National Park Service.

Within the study area, the following portions of the rivers have been designated as Wild and Scenic Rivers.

- The Klamath River from the confluence with the Trinity River to the Pacific Ocean was designated to be part of the National Wild and Scenic Rivers System on January 19, 1981.
- The Middle Fork Feather River (from Beckwourth downstream of Lake Davis to Lake Oroville) was designated to be part of the National Wild and Scenic Rivers System on October 2, 1968.
- The American River between Nimbus Dam and the confluence with the Sacramento River was designated to be part of the National Wild and Scenic Rivers System on January 19, 1981.

23.5.5 Fish and Wildlife Coordination Act (16 USC Section 651 et seq.)

The Fish and Wildlife Coordination Act, as amended in 1964, was enacted to protect fish and wildlife when federal actions result in the control or modification of a natural stream or body of water. The statute requires federal agencies to take into consideration the effect that water-related projects would have on fish and wildlife resources. Consultation and coordination with USFWS and State fish and game agencies are required to address ways to prevent loss of and damage to fish and wildlife resources and to further develop and improve these resources.

23.5.6 Marine Mammal Protection Act (16 USC 1361-1421h)

The Marine Mammal Protection Act (MMPA) was enacted in 1972. All marine mammals are protected under the MMPA. The MMPA prohibits, with certain exceptions, the "take" of marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products into the United States. It defines "take" to mean "to hunt harass, capture, or kill" any marine mammal or attempt to do so. Exceptions to the moratorium can be made through permitting actions for take incidental to commercial fishing and other nonfishing activities; for scientific research; and for public display at licensed institutions such as aquaria and science centers.

23.5.7 Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) implements a series of international treaties that provide migratory bird protection. The MBTA authorizes the Secretary of the Interior to regulate the taking of migratory birds, and the act provides that it shall be unlawful, except as permitted by regulations, "to pursue, take, or kill any migratory bird, or any part, nest or egg of any such bird" (16 USC section 703). This prohibition includes both direct and indirect acts, although harassment and habitat modification are not included unless they result in direct loss of birds, nests, or eggs. The current list of species protected by the MBTA was published in the March 10, 2010 *Federal Register* (*Federal Register*, Volume 75, page 9282 [75 FR 9282]).

23.5.8 Executive Order 13186: Responsibilities of Federal Agencies to Protect Migratory Birds

Executive Order 13186 (January 10, 2001) directs federal agencies that have, or are likely to have, a measurable negative effect on migratory bird populations to develop and implement a Memorandum of Understanding with USFWS to promote the conservation of migratory bird populations. The Memorandum of Understanding should include implementation actions and reporting procedures that would be followed through each agency's formal planning process, such as resource management plans and fisheries management plans.

23.5.9 Executive Order 11990: Protection of Wetlands

Executive Order 11990 (May 24, 1977) 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.

23.5.10 Federal Clean Air Act

National air quality policies are regulated through the Federal Clean Air Act (FCAA) of 1970 and its 1977 and 1990 amendments. Basic elements of the FCAA include national ambient air quality standards for criteria air pollutants, hazardous air pollutants standards, state attainment plans, motor vehicle emissions standards, stationary source emissions standards and permits, acid rain control measures, stratospheric ozone protection, and enforcement provisions.

23.5.11 National Historic Preservation Act of 1966

Section 106 of the NHPA and its implementing regulations (36 Code of Federal Regulations (CFR) Part 800) require Federal agencies to consider the effects of their undertakings on cultural resources that are, or that may be, eligible for listing in the National Register of Historic Places (NRHP) and to afford the Advisory Council on Historic Preservation an opportunity to comment. NRHP-eligible resources are considered to be “significant.” The criteria used to evaluate eligibility for listing on the NRHP are further discussed in the next subsection.

The Section 106 process that is typically associated with NEPA compliance requires consultation of the federal lead agency with other federal, state, and local agencies, the Advisory Council on Historic Preservation, the State Historic Preservation Officer (SHPO), Indian tribes, and interested members of the public, such as historical societies. Throughout the Section 106 process, the federal lead agency and consulting parties work together to identify adverse impacts on sites of cultural significance or historic properties, and seek ways to avoid, minimize, or mitigate the adverse effects. A Memorandum of Agreement or Programmatic Agreement is issued by the participating parties that includes the measures agreed upon to avoid or reduce (i.e., mitigate) adverse effects. For large or complex undertakings, a Programmatic Agreement may also be negotiated to develop a phased approach to historic properties management or alternative Section 106 processes through consultations. Thus, impacts to cultural resources that are identified in a NEPA document are addressed through Section 106.

Section 110 of the NHPA sets out the broad responsibilities of Federal agencies for identifying and protecting historic properties under their jurisdiction, and for avoiding unnecessary damage to them. It is intended to ensure that an historic preservation program is fully integrated into the ongoing program of each Federal agency. Section 110 allows the costs of preservation activities as eligible project costs in all undertakings conducted or assisted by a Federal agency. Federal agencies are directed to withhold grants, licenses, approvals, or other assistance to applicants who intentionally damage or adversely affect historic properties in an effort to avoid the Section 106 process.

23.5.12 American Indian Religious Freedom Act

The American Indian Religious Freedom Act of 1978 protects the rights of Native Americans to freedom of expression of traditional religions (24 U.S. Code section 1996). This act established “the policy of the United States to protect and preserve for American Indians their inherent right of freedom to believe, express, and exercise the traditional religions…including but not limited to access to sites, use and possession of sacred objects, and the freedom to worship through ceremonials and traditional rites.”

23.5.13 Indian Sacred Sites on Federal Land

Executive Order 13007 provides that in managing Federal lands, each Federal agency with statutory or administrative responsibility for management of Federal lands shall, to the extent practicable and as permitted by law, 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.

23.6 Consultation with Tribal Governments

Consistent with President Clinton's April 29, 1994 Memorandum and President Obama's November 5, 2009 Memorandum, Reclamation contacted federally-recognized tribal governments to participate in preparation of this EIS. Reclamation met with the California Valley Miwok Tribe in 2012 and the Miwok Maidu United Auburn Indian Community of the Auburn Rancheria in 2013.

Reclamation will continue to consult with each tribe on a government-to-government basis before taking any action that could affect a tribal government. Under the Federal Trust responsibility, Reclamation will provide full disclosure of the beneficial and adverse impacts of a project to the tribal government in a manner that provides adequate time for review and response. Reclamation will review comments received and consult with the tribal government prior to decisions related to a project.

Tribes and Indian Trust Assets were considered during preparation of this EIS, in accordance with environmental justice considerations identified in Executive Order 12898 (February 11, 1994), as summarized in Chapter 20, Indian Trust Assets, and Chapter 21, Environmental Justice.

23.7 References

SWC (State Water Contractors). 2015. "State Water Contractors – About Us." Site accessed June 23, 2015. http://www.swc.org/about-us

Chapter 24

Environmental Impact Statement Distribution List

This chapter provides locations where the Draft and Final Environmental Impact Statement (EIS) are available for review and a list of governmental entities, organizations, and interested parties that received copies of this EIS.

24.1 Document Availability

The public distribution of this Draft and Final EIS emphasizes the use of electronic media to ensure cost-effective, broad availability to the public and interested parties. The Draft and Final EIS are available on the Internet at Reclamation's website.

Printed copies of the Draft and Final EIS are available for review at the following locations.

U.S. Department of the Interior, Bureau of Reclamation Library
2800 Cottage Way
Sacramento, CA 95825

U.S. Department of the Interior, Bureau of Reclamation, Bay-Delta Office
801 I Street, Suite 140
Sacramento, CA 95814

Electronic copies of the Draft and Final EIS are available on compact disc for viewing at the following libraries.

Alameda County Library
1247 Marin Avenue
Albany CA 94706

Alameda County Library
200 Civic Plaza
Dublin CA 94568

Alameda County Library
6300 Civic Terrace Avenue
Newark CA 94560

Butte County Library
1108 Sherman Avenue
Chico CA 95926

Colusa County Free Library
738 Market Street
Colusa CA 95932

Contra Costa County Library
501 W. 18th Street
Antioch CA 94509

Contra Costa County Library
104 Oak Street
Brentwood CA 94513

Contra Costa County Library
1050 Neroly Road
Oakley CA 94561

Contra Costa County Library
80 Power Avenue
Pittsburg CA 94565

Contra Costa County Library
1750 Oak Park Boulevard
Pleasant Hill CA 94523

El Dorado County Library
345 Fair Lane
Placerville CA 95667

Fresno County Library
2420 Mariposa Street
Fresno CA 93721

Glenn County Library
201 North Lassen Street
Willows CA 95988

Kern County Library
701 Truxton Avenue
Bakersfield CA 93301

Kings County - Hanford Branch Library
401 N Douty Street
Hanford CA 93230

Los Angeles County Central Library
630 West 5th Street
Los Angeles CA 90071

Madera County Library
121 North G Street
Madera CA 95637

Merced County Library
2100 O Street
Merced CA 95340

Napa County Library
580 Coombs Street
Napa CA 94559

Orange County Library
11200 Stanford Avenue
Garden Grove CA 92840

Placer County Library
350 Nevada Street
Auburn CA 95603

Plumas County Library
445 Jackson Street
Quincy CA 95970

Riverside County Library
5840 Mission Boulevard
Riverside CA 92509

Sacramento County Library
170 Primasing Avenue
Courtland CA 95615

Sacramento County Library
8900 Elk Grove Boulevard
Elk Grove CA 95624

Sacramento County Library
412 Union Street
Isleton CA 95641

Sacramento Central Library
828 I Street
Sacramento CA 95814

Santa Barbara County Library
40 E Anapamu Street
Santa Barbara CA 93101

San Benito County Library
470 5th Street
Hollister CA 95023

San Bernardino County Library - Norman Feldheym Central Library
555 W 6th Street
San Bernardino CA 92410

San Diego County Public Library
330 Park Boulevard
San Diego CA 92101

San Joaquin County - Escalon Branch Library
1540 2nd Street
Escalon CA 95320

San Joaquin County - Lathrop Branch Library
450 Spartan Way
Lathrop CA 95330

San Joaquin County - Manteca Public Library
320 W Center Street
Manteca CA 95336

San Joaquin County - Margaret K Troke Branch Library
502 W Benjamin Holt Drive
Stockton CA 95207

San Joaquin County - Cesar Chavez Central Library
605 N El Dorado Street
Stockton CA 95202

San Joaquin County - Tracy Branch Library
20 E Eaton Avenue
Tracy CA 95376

San Luis Obispo County Library
995 Palm Street
San Luis Obispo CA 93403

Santa Clara County - Cupertino Library
10800 Torre Avenue
Cupertino CA 95014

Santa Clara County - Milpitas Library
160 N Main Street
Milpitas CA 95035

Shasta County - Redding Public Library
1100 Parkview Avenue
Redding CA 96001

Solano County - Fairfield Civic Center Library
1150 Kentucky Street
Fairfield CA 94533

Solano County Fairfield Cordelia Library
5050 Business Center Drive
Fairfield CA 94534

Solano County - John F Kennedy Library
505 Santa Clara Street
Vallejo CA 94590

Solano County - Springstowne Library
1003 Oakwood Avenue
Vallejo CA 94591

Solano County - Vacaville Public Library
1 Town Square Place
Vacaville CA 95688

Solano County - Vacaville Public Library
1020 Ulatis Drive
Vacaville CA 95687

Solano County - Rio Vista Library
44 S 2nd Street
Rio Vista CA 94571

Solano County - Suisun City Library
601 Pintail Drive
Suisun City CA 94585

Stanislaus County Library
1500 I Street
Modesto CA 95354

Sutter County Library
750 Forbes Avenue
Yuba City CA 95991

Tehama County Library
645 Madison Street
Red Bluff CA 96080

Trinity County Library
351 N Main Street
Weaverville CA 96093

Tulare County Library
200 W Oak Avenue
Visalia CA 93291

Ventura County - Ojai Library
111 E Ojai Avenue
Ojai CA 93023

Ventura County - E P Foster Library
651 E Main Street
Ventura CA 93001

Ventura County - Oak Park Library
899 Kanan Road
Oak Park CA 91377

Yolo County - Clarksburg Branch Library
52915 Netherlands Road
Clarksburg CA 95612

Yolo County - Mary L Stephens Davis Branch Library
315 E 14th Street
Davis CA 95616

Yolo County - Winters Branch Library
708 Railroad Avenue
Winters CA 95694

Yolo County Library
250 1st Street
Woodland CA 95695

Yolo County Branch Library
37750 Sacramento Street
Yolo CA 95697

24.2 Agencies and Organizations Receiving Copies of the Draft Environmental Impact Statement

All persons, agencies, and organizations listed in this chapter have been informed of the availability of and locations to obtain the Draft and Final EIS. Parties listed below have received an electronic copy on a compact disc of the Draft and Final EIS.

24.2.1 Federal Agencies

- Bureau of Indian Affairs
- National Marine Fisheries Service
- U.S. Army Corps of Engineers
- U.S. Environmental Protection Agency
- U.S. Fish and Wildlife Service
- Western Area Power Administration

24.2.2 Tribal Interests

- California Valley Miwok Tribe
- United Auburn Indian Community

24.2.3 State Agencies

- California Department of Fish & Wildlife
- California Department of Water Resources
- Delta Stewardship Council

24.2.4 Regional and Local Entities

- Alameda County Zone 7

- Anderson-Cottonwood Irrigation District
- Central Delta Water Agency
- Contra Costa Water District
- East Bay Municipal Utility District
- El Dorado County Water Agency
- El Dorado Irrigation District
- El Dorado Water and Power Authority
- Folsom, City of
- Friant Water Authority
- Glenn-Colusa Irrigation District
- Hesperia, City of
- Lower Tule River Irrigation District
- Oakdale Irrigation District
- Placer County Water Agency
- Reclamation District 108
- Roseville, City of
- Sacramento, City of
- San Diego County Water Authority
- San Juan Water District
- San Luis & Delta Mendota Water Authority
- Santa Clara Valley Water District
- South Delta Water Agency
- South San Joaquin Irrigation District
- Stanislaus, County of
- Stockton East Water District
- Sutter Mutual Water Company
- Tehama-Colusa Canal Authority
- Westlands Water District

24.2.5 Other Interested Parties

- AquAlliance
- The Bay Institute
- California Farm Bureau Federation
- Coalition for a Sustainable Delta
- California Water Impact Network
- California Sportfishing Protection Alliance
- The Center for Environmental Science Accuracy and Reliability
- Environmental Water Caucus
- Friends of the River
- Golden Gate Salmon Association
- Kern County Water Agency
- Northern California Water Agency
- Natural Resources Defense Council
- North Coast Rivers Alliance

- Pacific Coast Federation of Fisherman's Associations
- Restore the Delta
- South Valley Water Association
- State and Federal Contractors Water Authority
- State Water Contractors
- Water 4 Fish

Chapter 25

List of Preparers

The following individuals contributed to the preparation of this Environmental Impact Statement.

Bureau of Reclamation

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Ben Nelson	Natural Resources Specialist	5
Bonnie Van Pelt	Natural Resources Specialist	9
Carolyn Bragg	Natural Resources Specialist	8
David O'Connor	Water Resource Modeler	9
David van Rijn	Chief, Science Division	22
Donna Garcia	Project Manager	–
Erwin Van Nieuwenhuyse	Supervisory Fish Biologist	15
Greg Krzys	Natural Resources Specialist	20
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Kirk Nelson	Civil Engineer (Hydraulic)	11
Kristin White	Hydraulic Engineer	11
Laureen Perry	Regional Archaeologist	25
Michael Mosley	Physical Scientist	7
Michael Tansey	Climate Change Coordinator	40
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Rebecca Victorine	Natural Resource Specialist	18
Ronald Silva	Chief, Engineering and O&M Division	30
Russell Grimes	Chief, Environmental Compliance and Habitat Conservation Branch	24
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Traci Michel	Water Management Goal Supervisor	22

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Kearns and West

Name	Project Role	Education
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QEDA

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Appendix 1A

Comments from Federal Agencies and Responses

This section contains copies of comment letters from federal agencies on the Draft Environmental Impact Statement (EIS) for the Coordinated Long-term Operation of the Central Valley Project (CVP) and State Water Project (SWP). Each comment in the comment letters was assigned a number, in sequential order. The numbers were combined with the agency name (example: NMFS 1). The comments with the associated responses are arranged alphabetically by agency name, and appear in the chapter in that order.

Copies of the comments are provided in Section 1A.1. Responses to each of the comments follow the comment letters, and are numbered in accordance with the numbers assigned in the letters. None of the comments from the Federal agencies included attachments.

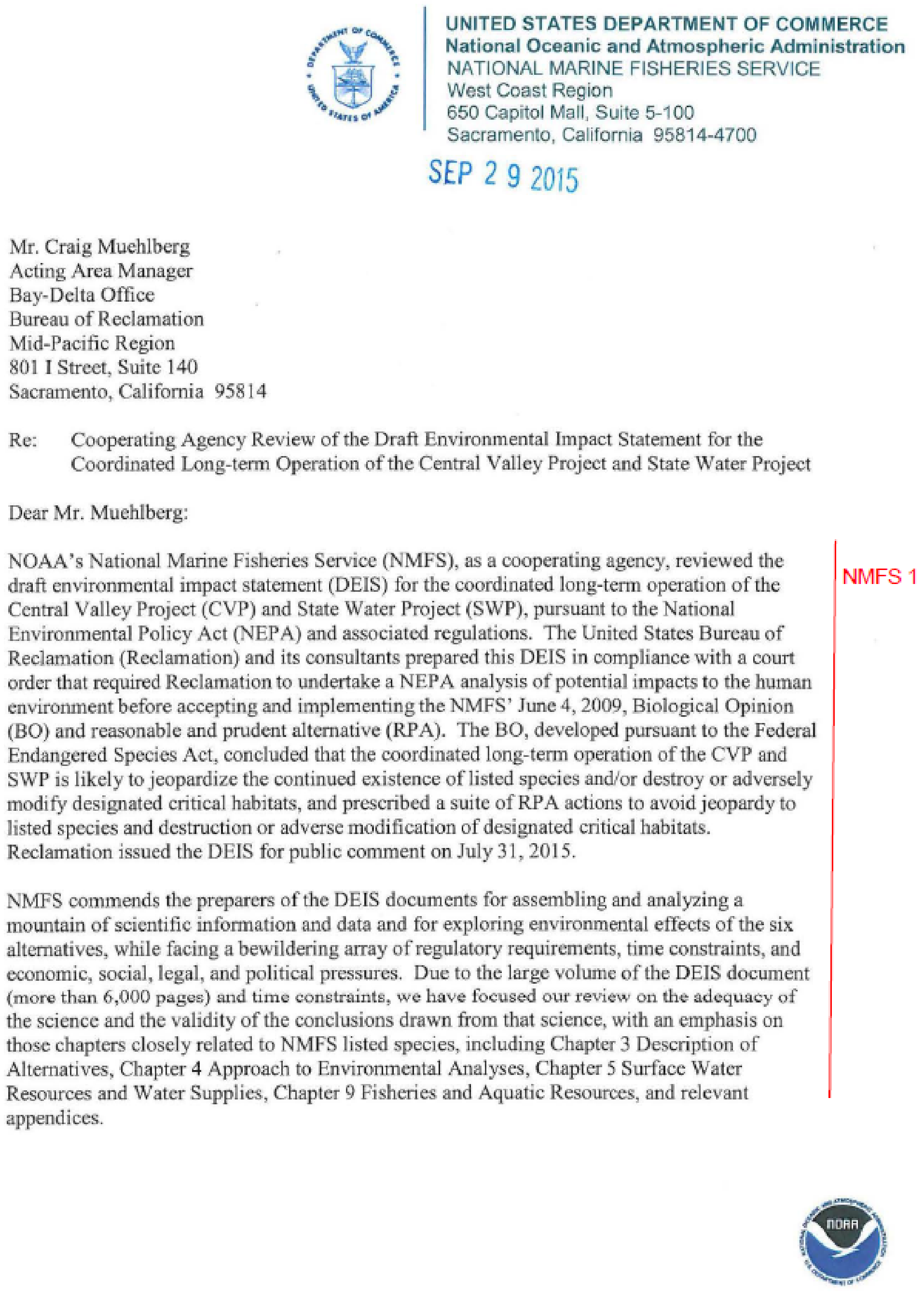
1A.1 Comments and Responses

The federal agencies listed in Table 1A.1 provided comments on the Draft EIS.

Table 1A.1 Federal Agencies Providing Comments on the Draft Environmental Impact Statement

Acronym	Commenter
NMFS	National Marine Fisheries Service, National Oceanic and Atmospheric Administration
EPA	U.S. Environmental Protection Agency
Western	Western Area Power Administration, Department of Energy

1A.1.1 National Marine Fisheries Service



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700

SEP 29 2015

Mr. Craig Muehlberg
Acting Area Manager
Bay-Delta Office
Bureau of Reclamation
Mid-Pacific Region
801 I Street, Suite 140
Sacramento, California 95814

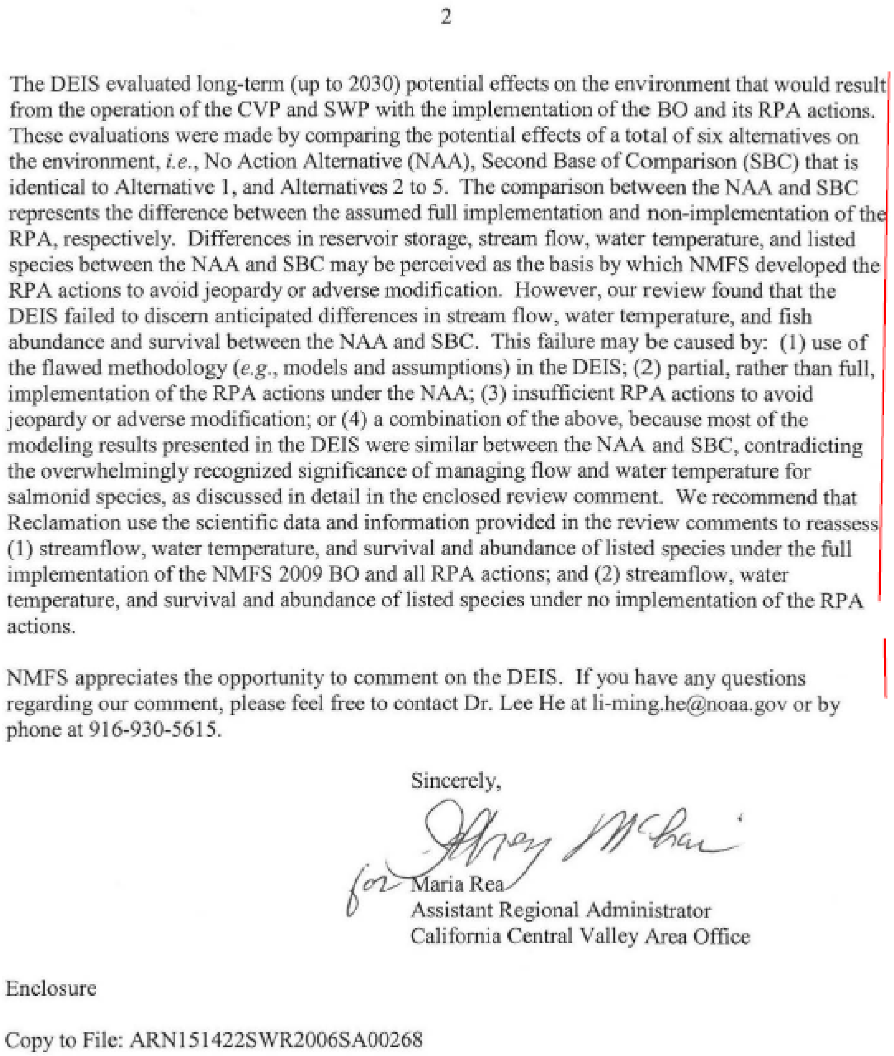
Re: Cooperating Agency Review of the Draft Environmental Impact Statement for the Coordinated Long-term Operation of the Central Valley Project and State Water Project

Dear Mr. Muehlberg:

NMFS 1

NOAA's National Marine Fisheries Service (NMFS), as a cooperating agency, reviewed the draft environmental impact statement (DEIS) for the coordinated long-term operation of the Central Valley Project (CVP) and State Water Project (SWP), pursuant to the National Environmental Policy Act (NEPA) and associated regulations. The United States Bureau of Reclamation (Reclamation) and its consultants prepared this DEIS in compliance with a court order that required Reclamation to undertake a NEPA analysis of potential impacts to the human environment before accepting and implementing the NMFS' June 4, 2009, Biological Opinion (BO) and reasonable and prudent alternative (RPA). The BO, developed pursuant to the Federal Endangered Species Act, concluded that the coordinated long-term operation of the CVP and SWP is likely to jeopardize the continued existence of listed species and/or destroy or adversely modify designated critical habitats, and prescribed a suite of RPA actions to avoid jeopardy to listed species and destruction or adverse modification of designated critical habitats. Reclamation issued the DEIS for public comment on July 31, 2015.

NMFS commends the preparers of the DEIS documents for assembling and analyzing a mountain of scientific information and data and for exploring environmental effects of the six alternatives, while facing a bewildering array of regulatory requirements, time constraints, and economic, social, legal, and political pressures. Due to the large volume of the DEIS document (more than 6,000 pages) and time constraints, we have focused our review on the adequacy of the science and the validity of the conclusions drawn from that science, with an emphasis on those chapters closely related to NMFS listed species, including Chapter 3 Description of Alternatives, Chapter 4 Approach to Environmental Analyses, Chapter 5 Surface Water Resources and Water Supplies, Chapter 9 Fisheries and Aquatic Resources, and relevant appendices.



NMFS 2

The DEIS evaluated long-term (up to 2030) potential effects on the environment that would result from the operation of the CVP and SWP with the implementation of the BO and its RPA actions. These evaluations were made by comparing the potential effects of a total of six alternatives on the environment, *i.e.*, No Action Alternative (NAA), Second Base of Comparison (SBC) that is identical to Alternative 1, and Alternatives 2 to 5. The comparison between the NAA and SBC represents the difference between the assumed full implementation and non-implementation of the RPA, respectively. Differences in reservoir storage, stream flow, water temperature, and listed species between the NAA and SBC may be perceived as the basis by which NMFS developed the RPA actions to avoid jeopardy or adverse modification. However, our review found that the DEIS failed to discern anticipated differences in stream flow, water temperature, and fish abundance and survival between the NAA and SBC. This failure may be caused by: (1) use of the flawed methodology (*e.g.*, models and assumptions) in the DEIS; (2) partial, rather than full, implementation of the RPA actions under the NAA; (3) insufficient RPA actions to avoid jeopardy or adverse modification; or (4) a combination of the above, because most of the modeling results presented in the DEIS were similar between the NAA and SBC, contradicting the overwhelmingly recognized significance of managing flow and water temperature for salmonid species, as discussed in detail in the enclosed review comment. We recommend that Reclamation use the scientific data and information provided in the review comments to reassess (1) streamflow, water temperature, and survival and abundance of listed species under the full implementation of the NMFS 2009 BO and all RPA actions; and (2) streamflow, water temperature, and survival and abundance of listed species under no implementation of the RPA actions.

NMFS 3

NMFS appreciates the opportunity to comment on the DEIS. If you have any questions regarding our comment, please feel free to contact Dr. Lee He at li-ming.he@noaa.gov or by phone at 916-930-5615.

Sincerely,

for Maria Rea
Assistant Regional Administrator
California Central Valley Area Office

Enclosure

Copy to File: ARN151422SWR2006SA00268

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Review of the Draft Environmental Impact Statement for the Coordinated Long-term Operation of the Central Valley Project and State Water Project

NOAA Fisheries West Coast Region
California Central Valley Area Office

September 29, 2015

Table of Contents

1 Introduction

NOAA's National Marine Fisheries Service (NMFS) reviewed the draft environmental impact statement (DEIS) for the coordinated long-term operation of the Central Valley Project (CVP) and State Water Project (SWP), pursuant to the National Environmental Policy Act (NEPA) and associated regulations. The United States Bureau of Reclamation (Reclamation) and its consultants prepared this DEIS in compliance with a court order that required Reclamation to undertake a NEPA analysis of potential impacts to the human environment before accepting and implementing the 2009 NMFS Biological Opinion (BO). The BO, developed pursuant to the Federal Endangered Species Act (ESA), concluded that the coordinated long-term operation of the CVP and SWP is likely to jeopardize the continued existence of listed species and/or destroy or adversely modify designated critical habitats, and prescribed a suite of reasonable and prudent alternative (RPA) actions to avoid jeopardy to listed species and destruction or adverse modification of designated critical habitats. NMFS 4

The DEIS evaluated long-term (up to 2030) potential effects on the environment that would result from the operation of the CVP and SWP with the implementation of the BO and its RPA actions. These evaluations were made by comparing the potential effects of a total of six alternatives on the environment, *i.e.*, No Action Alternative (NAA), Second Base of Comparison (SBC) that is identical to Alternative 1, and Alternatives 2 to 5. The comparison between the NAA and SBC represents the difference between the assumed full implementation and non-implementation of the RPA. Differences in reservoir storage, stream flow, water temperature, and listed species between the NAA and SBC may be perceived as the basis by which NMFS developed the RPA actions to avoid jeopardy or adverse modification. However, our review found that the DEIS failed to discern anticipated differences in stream flow, water temperature, and fish abundance and survival between the NAA and SBC. This failure may be caused by: (1) use of the flawed methodology (*e.g.*, models and assumptions) in the DEIS; (2) partial, rather than full, implementation of the RPA actions under the NAA; (3) insufficient RPA actions to avoid jeopardy or adverse modification; or (4) a combination of the above, because most of the modeling results presented in the DEIS were similar between the NAA and SBC, contradicting the overwhelmingly recognized significance of managing flow and water temperature for salmonid species, as discussed below in detail. NMFS 5

NMFS commends the preparers of the DEIS documents for assembling and analyzing a mountain of scientific information and data and for exploring environmental effects of the six alternatives, while facing a bewildering array of regulatory requirements, time constraints, and economic, social, legal, and political pressures. Due to the large volume of the DEIS document (more than 6,000 pages) and time constraints, we have focused our review on the adequacy of the science and the validity of the conclusions drawn from that science, with an emphasis on those chapters closely related to NMFS listed species, including Chapter 3 Description of Alternatives, Chapter 4 Approach to Environmental Analyses, Chapter 5 Surface Water Resources and Water Supplies, Chapter 9 Fisheries and Aquatic Resources, and relevant appendices. NMFS 6

2 General Comments

This DEIS contains 70 files and more than 6,000 pages. Chapter 9 (Fisheries and Aquatic Resources) alone has 470 pages plus more than 1,000 pages of appendices. This long and poorly organized DEIS is difficult to read and follow. We recommend the following to make the EIS more readable and easier to follow.

NMFS 7

2.1 Include a Table of Contents for Each Chapter and Appendix

At the beginning of each chapter and appendix, there should be a table of contents that would provide guidance for readers to move through a long chapter or appendix and select which sections to read.

2.2 Include a Meaningful Summary for Each Chapter and Appendix

Each chapter should begin with a sharply focused summary of the main points, results, conclusions, and uncertainties. We recommend using tables or graphs or both in these summaries when appropriate.

2.3 Overview of the Tiered Modeling Approach

It will be more appropriate to provide an overview of the tiered modeling approach in Chapter 4, including all the models used in the DEIS on climate change and related hydrology, water resource optimization, hydrodynamics and water quality (including water temperature), and survival and abundance of fish. The overview should include, but is not limited to, model version, domain, temporal and spatial scale and resolution, uncertainty analysis, calibration, limitations, and aggregation or disaggregation of input data for each model used in the DEIS. The partial overview in the DEIS is currently buried in Appendix 5A.A.

NMFS 8

3 Models Used in the DEIS

The DEIS used a series of models with an attempt to predict the effects of project operations on reservoir storage, flow, water temperature, water exports, and survival and abundance of listed fish species. The tiered modeling approach applied the results of climate change models as inputs to a hydrologic model, outputs of which were used as inputs to a water resource optimization planning model (CalSim II). The results of CalSim II were used as inputs to hydrodynamic and water temperature models, which generated outputs for biological models. Many of the models used in the DEIS have limitations in that they are planning tools or are best applied in a comparative sense; this can limit the extent of interpretation of modeling results. Furthermore, the models have a broad range of temporal resolutions from 15 minutes to 1 day to 30 days. The linkage of models with different temporal resolutions could result in propagation of large errors that would influence decisions derived from the modeling results (National Research Council 2010). NMFS previously commented on the application of the CalSim II based modeling approach to effects analysis (National Marine Fisheries Service 2014). Some of those comments are reiterated in this review.

NMFS 9

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3.1 Climate Change and Hydrologic Models

The Variable Infiltration Capacity (VIC) hydrologic model was used to generate watershed runoff and streamflow (daily, monthly, or annual) for the major rivers and streams in the Central Valley for the time period of 2011 to 2040. The minimum set of variables that VIC requires the user to supply include: daily total precipitation (rain and/or snow), daily maximum and minimum air temperature, and daily average wind speed. It is unclear on how these input data were derived. Please provide information on how daily precipitation, daily air temperature, and daily wind speed were derived from climate models for the time period of 2011-2040. NMFS 10

It is unclear if an uncertainty analysis for the VIC model was conducted. If so, please provide information and data about the uncertainty analysis for the model. If not, the modeling error from the VIC model is unknown, which should be acknowledged. There should be discussion of the uncertainty the model introduces and the implications of incorporating that uncertainty into the tiered modeling approach. NMFS 11

These VIC-simulated runoff data were then used to adjust the 82-year (1921-2003) "unimpaired flow data." Once the flow data had been adjusted, water year types and other hydrologic indices that govern water operations or compliance were also revised to be consistent with the climate change-incorporated hydrologic regime. The adjusted inflows, key valley floor accretions, water year types, and hydrologic indices were used as input to CalSim II. However, the DEIS did not provide sufficient information about the climate change based "adjustment" for the "unimpaired flow data." How did you use the VIC-simulated flow data from 2011 to 2040 to adjust the flow data from 1921 to 2003? In addition, please provide a summary of the differences between the unadjusted and adjusted unimpaired flow data for the 82 years from 1921 to 2003. NMFS 12

The DEIS presented climate change related changes in figures. Please provide summarized key statistical results in tables for differences between the historical condition and the future climate change incorporated condition for the following data: (1) Inflow time series records for major streams in the Central Valley, (2) Sacramento and San Joaquin valley water year types, and (3) runoff forecasts used for reservoir operations and allocation decisions. NMFS 13

3.2 Water Resources Optimization Model: CalSim II

CalSim II uses linear programming to solve sets of equations that simulate water movement through the CVP-SWP system in accordance with various objective functions and operational constraints. It is a data-driven system simulation planning tool and is not a physical process-based hydrologic model. Use of an optimization algorithm allows a suitable decision to be identified from among all possible and feasible decisions. Most successful applications of optimization that attempt to simulate the behavior of a system have calibrated their objective functions (*i.e.*, set the weights that prioritize the preference for meeting individual constraints) so that the model results correspond to what actually happens or would happen under a particular scenario. NMFS 14

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3.2.1 Calibration and Validation

NMFS 15

The DEIS states: "Because it [CalSim II] is not a physically based model, CalSim II is not calibrated…" (page Appendix 5A.A-13).

It is a standard practice to ensure the appropriate use of models through the processes of calibration and testing (National Research Council 2010). Regardless of how possible it is to match the model closely with observed behavior, statistics on the accuracy of the calibration run should be supplied to users to enable them to gauge the likely errors involved with using the model output (Close *et al.* 2003). The calibration and validation phase is especially critical since the outcome establishes how well the model represents the system for the purpose of a study. Thus, this is the "bottom line" of the model application effort, as it determines whether or not the model results can be relied upon and used effectively for decision-making (Duda *et al.* 2012). NMFS recognizes that calibrating a complex, linear programming based model such as CalSim II is challenging, but we also note that others have embarked upon similar efforts, as demonstrated by Draper *et al.* (2003) and Cai and Wang (2006). We reiterate our previous requests that resources be allocated to a calibration/validation effort, allowing for a better alignment between model results and empirical data. Although use of the entire simulation period (82 years) for testing and calibration may not be practical or necessary, a subset of the data for a portion of the simulation period, which had similar operational and other constraints in the system, could be used for calibration to assess the uncertainty of CalSim II simulations.

NMFS 16

In the absence of a calibration and validation, CalSim II results should be discussed in the proper context, and, when necessary, evaluated to determine whether trends or anomalies are driven by the limitations of the model.

3.2.2 Monthly Output Data

NMFS 17

The DEIS states: "Therefore, reporting sub-monthly results from CalSim II or from any other subsequent model that uses monthly CalSim results as an input is not considered an appropriate use of model results" (page 5A.A-14).

This leads to another major concern about the limitations of the monthly CalSim II modeling results and other modeling results from subsequent models to which the CalSim II results were used as inputs. Monthly data are not useful for analyzing the effects of short-term flow and water temperature variability on anadromous fish species because the impact of water temperature, which is critical to survival, growth, and reproduction of anadromous fish species, can result from exposure time of hours. This could be one of the reasons why the DEIS concluded that there were minimal differences in survival and abundance of winter-run Chinook salmon (winter-run) between the NAA and SBC.

3.2.3 Rules in CalSim II

NMFS 18

The DEIS states: "The model has no capability to adjust these rules based on a sequence of hydrologic events such as a prolonged drought, or based on statistical performance criteria such as meeting a storage target in an assumed percentage of years" (page 5A.A-13).

To our understanding, the rules developed for CalSim II can be changed or updated. Please clarify if CalSim II model developers or users are able to modify those existing rules or add new rules to incorporate new constraints or events into CalSim II.

NMFS 18 continued

3.2.4 Mixed Minimum Flow Assumptions Used in CalSim II

It is confusing that the DEIS provided multiple regulatory requirements for minimum instream flows under the same alternative in Clear Creek, Sacramento River, and Stanislaus River (see Table 5A.B.20). For example, under "Minimum flow below Whiskeytown Dam," the "No Action Alternative Assumption" column listed the following assumptions: "Downstream water rights, 1963 Reclamation Proposal to USFWS and NPS, predetermined CVPIA 3406(b)(2) flows, and NMFS BO (June 2009) Action I.1.1." Which one was actually used in CalSim II in this DEIS? Please clarify for Clear Creek and other rivers.

NMFS 19

3.3 Delta Hydrodynamics and Water Quality Model: DSM2

It is unclear in the DEIS on the simulation time period of DSM2. Was it simulated for the entire CalSim II simulation period of 82 years from 1921 to 2003? Or was only a portion of the 82 years used for the simulation in DSM2? If the latter, what portion of the 82 years was used, why was that selected, and how does it compare to the full 82 years in terms of distribution of water year types and sequences of extreme years? This should be clearly described in the model overview section.

NMFS 20

3.3.1 Meteorological Data Used in DSM2

What meteorological data were used in DSM2 if the simulation period was 82 years? How did you derive some of the meteorological variables that were not readily available but required in DSM2?

NMFS 21

3.4 Water Temperature Model: HEC-5Q

The HEC-5Q model was used to generate 6-hour water temperature data in Clear Creek and the Sacramento, American, and Stanislaus rivers. The HEC-5Q model was developed between the late 1970s and early1990s (Willey *et al.* 1996) through the Hydrologic Engineering Center (HEC) of the U.S. Army Corps of Engineers (USACE). However, HEC-5Q is no longer available from and is not supported by the USACE. The Sacramento River Water Quality Model (SRWQM) is a HEC-5Q based water temperature model to simulate Sacramento River water temperatures. Has the SRWQM been updated or recalibrated since its implementation to the Sacramento River in 2005? If so, please provide a summary of updates and recalibration.

NMFS 22

For water temperature modeling, HEC-5Q used the concept of equilibrium temperature to calculate the net heat transfer. The equilibrium temperature method is best suited for large time step (*i.e.*, monthly) models because these most closely approximate steady-state conditions (Deas and Lowney 2001). In 2008, the then-CALFED Science Advisory Panel recommended that the latest technology in flow and temperature modeling with smaller time-steps (*e.g.*, one-hour) be

NMFS 23

adopted to better assess biological effects (Deas *et al.* 2008). More recently, there were concerns about the 1-D representation for reservoir dynamics and calibration and uncertainty of the legacy HEC-5Q model (Anderson *et al.* 2013). NMFS 23 continued

HEC-5Q requires daily input data such as flow, water temperature, and meteorological data (*e.g.*, solar radiation, air temperature, dew point, wind speed, atmospheric pressure, wind direction, and cloud cover). Please provide a summary of how these daily input data to HEC-5Q were derived for the 82 years (1921-2003) as water temperature and many of the meteorological variables rarely had records back to 1921. The uncertainty of input data may substantially affect the uncertainty of water temperature output. NMFS 24

Assuming that the monthly flow data from CalSim II were used as input to HEC-5Q, which requires daily data, please explain how the monthly flow data from CalSim II were disaggregated to daily flow data as input to HEC-5Q. NMFS 25

3.5 Salmon Mortality Model

The salmon mortality model, which was developed in the mid-1990s, used daily water temperature data to simulate egg mortality based on egg survival-temperature relationships specified in the model. In the DEIS analyses, daily water temperatures were derived from HEC-5Q and the final output from the mortality model was the annual percent mortality. NMFS 26

Has the salmon mortality model been calibrated? If so, please provide a summary of the calibration process and results.

It is unclear what relationships between egg mortality (or survival) and water temperature were used in the salmon mortality model. Please provide those relationships in a table. Do the relationships used in the model represent the best science available? NMFS 27

3.6 Annual Juvenile Production and Mortality Model: SALMOD

The SALMOD model was used to generate annual juvenile production and mortality for fall-run, late fall-run, spring-run, and winter-run Chinook salmon within the Sacramento River from below Keswick Dam to the Red Bluff Diversion Dam. Was SALMOD, as applied to the Sacramento River in the DEIS, calibrated? If so, please provide a summary of the calibration process and results. NMFS 28

3.7 Winter-run Chinook Salmon Annual Abundance Model: OBAN

The Oncorhynchus Bayesian Analysis (OBAN) is a regression model based on the relationship between the historical winter-run annual abundance (adults or juveniles) and explanatory variables. The explanatory variables include streamflow (monthly), water temperature, Yolo Bypass flow, water export, striped bass abundance, wind stress curl index, and harvest. OBAN uses the Akaike Information Criterion (AIC) to evaluate the best possible set of exploratory variables to predict winter-run abundance. The model has been established using the observed NMFS 29

1

data for escapement from 1967 to 2008 and for juvenile production from 1995 to 1999 and 2002 to 2007 (Hendrix 2013). However, it is unclear for what years the predicted winter-run abundance was generated in the DEIS analyses. Please clarify.

NMFS 29 continued

3.8 Winter-run Chinook Salmon Annual Egg Survival and Escapement Model: IOS

The interactive object-oriented salmon simulation (IOS) model simulates the entire life cycle of winter-run Chinook salmon through successive generations. The model requires daily input data for flow, water temperature, and water export to produce the output – winter-run escapement and egg survival. Was this model, as applied to the winter-run in the DEIS, calibrated? If so, please provide a summary of the calibration process and results.

NMFS 30

3.9 Delta Juvenile Survival Model: DPM

The Delta Passage Model (DPM) was used to simulate survival through the Delta of winter-run, fall-run, and late fall-run Chinook salmon. The DPM used limited study results based on late fall-run smolts to represent the relationships between daily flows or exports and juvenile survival rates in the Delta. Was there any uncertainty analysis for the model as applied to the winter-run in the DEIS? If so, please provide a summary of the analysis and results.

NMFS 31

3.10 Evaluation of Comparative Differences when Model Accuracy Is Unknown

The accuracy or uncertainty of a model is closely related to comparative results, from which a conclusion of whether or not there is a meaningful difference between two alternatives is drawn. Assuming there were two alternatives - one had an output flow of 100 cfs and the other had 110 cfs, the relative difference was 10 percent. If the model used had a 5 percent error, it may reasonably conclude that the 10 percent difference reflects a meaningful difference and may be statistically significant (Figure A below). However, if the model used had a 40 percent error, it may reasonably conclude that the 10 percent difference may not indicate a meaningful difference and may not be statistically significant (Figure B below).

NMFS 32

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NMFS 32 continued

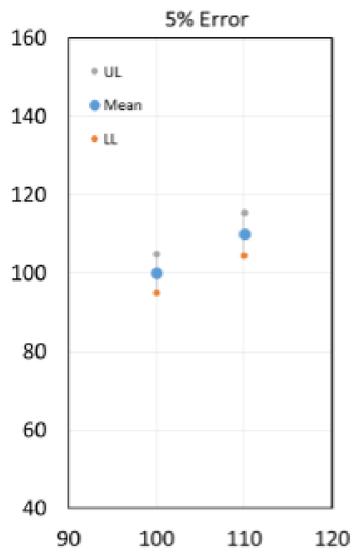

Figure A. Comparing two alternatives using model output with the model error of 5 percent

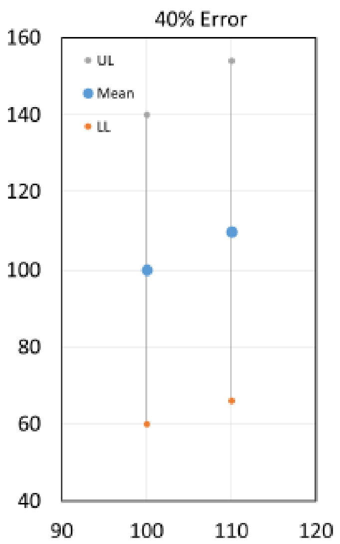

Figure B. Comparing two alternatives using model output with the model error of 40 percent

Since the uncertainty of many models used in the DEIS is unknown, it is reasonable to consider the common realization for evaluating model performance (Table 1). The values in the table attempt to provide some general guidance, in terms of the percent mean errors or differences between simulated and observed values, so that users can gage what level of agreement or accuracy (*i.e.* excellent, good, fair, or poor) may be expected from the model application. The values shown in Table 1 have been derived primarily from Hydrological Simulation Program – Fortran (HSPF) experience and past efforts on model performance criteria; however, they do reflect common tolerances accepted by many modeling professionals (Duda *et al.* 2012).

Table 1. General tolerance ranges (*i.e.*, percent mean errors) for assessing hydrologic and water quality model performance

Variable	Percent Difference Between Simulated and Observed Values			
	Excellent	Good	Fair	Poor
Hydrology/Flow	< 10	10 - 15	16 - 25	> 25
Sediment	< 20	20 - 30	31 - 45	> 45
Water Temperature	< 7	8 - 12	13 - 18	> 18
Water Quality/Nutrients	< 15	15 - 25	26 - 35	> 35
Pesticides/Toxics	< 20	20 - 30	31 - 40	> 40

We recommend that these recognized model uncertainties be considered in setting thresholds for the relative difference in comparing two alternatives. It should be acknowledged that the output errors for biological models would be expected to be higher than those for physical variables, as biological variables such as escapement or juvenile production are more variable and unpredictable than physical variables. For these reasons, it may need to be improved for the comparative difference of 5 percent for physical variables and 1 percent for biological variables, as stated in the DEIS.

NMFS 32 continued

3.11 Error Propagation in the Tiered Modeling Approach

As described in the DEIS, CalSim II modeling results were used as input to DSM2 to find hydrodynamic conditions in the Delta. CalSim II results were also used in water temperature models. Modeled flows and water temperatures were then used as inputs to biological models to assess the effects of alternatives on listed species. In this cascade modeling approach, uncertainties, which never cancel out, will be compounded and propagate, resulting in greater uncertainties. Pijanowski *et al*. (2011) examined how land-use errors from a land change model propagate through to climate (rainfall, temperature, etc.) as simulated by a regional atmospheric model. Results indicate that small errors from the land change model could grow as a "coupling drift" if both were used to forecast into the future; these couplings could create larger combined errors of land–climate interactions. There was no assessment of the propagation of uncertainties from the tiered modeling approach. Error propagation in the modeling approach should be discussed in the EIS.

NMFS 33

4 Alternatives in the DEIS

4.1 Not All RPA Actions Were Included in CalSim II for the NAA

The DEIS states that the NAA assumed the full implementation of all RPA actions as described in NMFS 2009 BO. However, many RPA actions were not included in CalSim II for the NAA, resulting in substantial deviations from what should occur under the true NAA. For example, the DEIS states: "For Action I.2.1, which calls for a percentage of years that meet certain specified end-of-September and end-of-April storage and temperature criteria resulting from the operation of Lake Shasta, no specific CalSim II modeling code is implemented to simulate the performance measures identified" (page 5A-9). RPA Action I.1.2, which called for channel maintenance flows in Clear Creek, was not included in CalSim II under the NAA. We think that many water temperature related RPA actions in Clear Creek, Sacramento River, American River, and Stanislaus River, which called for additional coldwater releases from reservoirs to meet specific water temperature requirements, were not included in the NAA because water temperature requirements cannot be represented directly in CalSim II. Therefore, the relative comparisons between the NAA and other alternatives may underestimate the true differences between them. This may be one of the causes that resulted in no difference in most modeling results between the NAA and SBC, as detailed in sections 5, 6, and 7.

NMFS 34

4.2 Proposed San Joaquin River Juvenile Trap and Haul Program

NMFS 35

Alternatives 3 and 4 included a proposed trap and haul program for juvenile salmonids entering the Delta from the San Joaquin River. The trap and haul method is intended to assist the migration of juvenile Chinook salmon and steelhead, and hopefully to increase survival rates during their migration through the Delta. However, this method will have unintended consequences for fish populations, which may include altered adult behaviors such as reduced homing, increased straying, and fallback downstream, thereby reducing their survivorship and altering adaptations in the wild. For example, when compared to fish that migrated naturally, transported juveniles had lower survivorship as adults and were less likely to find their way home (Keefer *et al.* 2008). Transported fish are more likely to stray from their home tributary. Alteration of adult homing behavior can have important fitness consequences, and may additionally affect non-target populations when adults enter and breed in non-natal streams. If these lost fish breed with another wild population, the resulting gene flow can reduce that population's evolutionary fitness (Keefer *et al.* 2008). Straying may reduce fitness of wild endemic populations in the short term and is particularly problematic for relatively small wild populations (*e.g.*, steelhead populations in the San Joaquin River basin) currently at moderate to high risk of extinction (Lindley *et al.* 2007). While transportation of juveniles may have short-term juvenile survival benefits, the delayed effects that manifest in adult stages illustrate the need to fully evaluate the success of a trap and haul program throughout the life cycle of salmon and steelhead. In addition to biological concerns regarding a trap and haul program, Reclamation should ensure that a trap and haul program is technologically feasible. For example, what frequency of trapping and hauling, and from which tributaries, would Reclamation need to implement on an annual basis, and how would Reclamation evaluate the success (or lack thereof) of a trap and haul program? Note that NMFS submitted this comment to Reclamation through its July 22, 2015, letter.

4.3 Proposed Salmon Harvest Restrictions

NMFS 36

Alternative 4 included by-catch limits of winter-run. As a result of a jeopardy conclusion and associated RPA, NMFS developed and implemented a fisheries management framework for reducing the impact of ocean salmon fishery on winter-run for the Pacific Coast Salmon Fishery Management Plan (National Marine Fisheries Service 2012). The framework consists of two components. The first component specifies that the previous standards for winter-run regarding minimum size limits and seasonal windows south of Point Arena for both the commercial and recreational fisheries will continue to remain in effect at all times regardless of abundance estimates or impact rate limit. The second component is based on the population status of winter-run where, during periods of relatively low abundance, the proposed structure of fishing management measures each year for winter-run south of Point Arena must be equal to or less than the maximum allowable impact rate (MAIR) specified annually. The fishery control rule and tiered approach for managing winter-run impacts in the ocean salmon fishery include: (1) if the geometric mean of the most recent 3 years of spawning return estimates is less than 500, the MAIR is zero percent; and (2) if the geometric mean of the most recent 3 years of spawning return estimates is between 500 and 4,000, the MAIR is between 10 percent and 20 percent, increasing linearly. NMFS is concerned that Alternative 4 proposes a minimum bycatch limit that may preclude the fishery control rule, and therefore ocean harvest management and its

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associated ESA section 7 consultation, including the RPA, from being implemented during years of low winter-run abundance. Note that NMFS submitted this comment to Reclamation through its July 22, 2015, letter. NMFS 36 continued

5 Hydrologic Analyses in the DEIS

Due to time constraints, our review is focused on differences in streamflow, reservoir storage, water export, and OMR flow between the NAA and SBC. Our comments may be applicable to other alternative comparisons in the DEIS. NMFS 37

5.1 Reservoir Storage

Shasta Reservoir is used as an example for examining reservoir storage. As presented in the DEIS "Table 5.13 Changes in Shasta Lake Storage under the NAA as Compared to the SBC," Shasta Reservoir storage was higher under the SBC than that under the NAA. However, most of the percent changes were less than 10 percent, except for August and September in critically dry years. The percent change was about 14 percent for these two months in critically dry years. For critically dry years such as 2014 and 2015, implementing RPA Action Suite I.2 and other management measures would increase the end-of-September reservoir storage under the NAA, but CalSim II did not include those RPA actions or management measures under those critically dry circumstances. NMFS 38

The DEIS did not analyze the Whiskeytown Reservoir storage. We recommend that this analysis be included in the EIS. NMFS 39

5.2 Streamflow

NMFS 40

Clear Creek and the Sacramento River are used as examples to examine streamflow. Our comments may be applicable to other streams such as American River, Stanislaus River, and others in the Central Valley.

Monthly Clear Creek flows from the CalSim II simulations under the NAA were identical to those under the SBC except in May. In May, the NAA flows were higher by 28-41 percent compared to the SBC flows (Table 5.19). It is unclear what caused the difference in May or similarity in other months. It could result from assumptions used in CalSim II, which is also unclear as discussed in section 3.2.4. If the higher streamflow in May were caused by pulse flows implemented through RPA Action I.1.1, it would also have been reflected in the streamflow in June when pulse flows were also implemented. In addition, the implementation of RPA Action I.1.5 should have increased streamflows under the NAA as compared to the SBC in September and October. However, they were identical from the CalSim II simulated flows. All of these inconsistencies may indicate the limitations of CalSim II to capture the real-time decisions or components that cannot be incorporated into the model, which could result in misinformation for simulated water temperatures, particularly in September and October for spawning and egg incubation of spring-run Chinook salmon in Clear Creek, while comparing egg mortality between the NAA and SBC. Based on the CalSim II simulated streamflow in September and October, water temperature and egg mortality would be similar between the NAA

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NMFS 40 continued

and SBC. Indeed, the simulated water temperatures were identical as discussed in section 6.2, leading to identical egg mortality between the NAA and SBC in Clear Creek. This is contradictory to what would happen in Clear Creek. We expect that the actual egg mortality would be lower under the NAA (when RPA Actions I.1.1 and I.1.5 are implemented) as compared to the SBC (when no RPA actions are implemented).

NMFS 41

The CalSim II simulated flows for the Sacramento River at Keswick Dam showed meaningful differences only in September for wet or above normal years and in November for all water years except critically dry years. In these cases, the flows under the NAA were higher than those under the SBC, with differences ranging from 21 percent to 33 percent in November and from 48 percent to 78 percent in September. For all other cases, the flows under the NAA were either similar to or lower than those under the SBC. These results seemed contradictory to the expected outcome between implementation and non-implementation of the RPA actions. For example, if RPA Action Suite I.2 were implemented, flows in the Sacramento River would be expected to be higher than those without implementation of the Action Suite, particularly during the months of July to October in drier years.

5.3 Water Exports at the Federal and State Pumping Facilities

NMFS 42

While considering water exports on an annual basis instead of a monthly basis, the average percent difference between the NAA and SBC was 19 percent with a range of 15 percent to 22 percent among water year types. Water exports under the SBC, as compared to the NAA, was increased by about 30 percent in January and February and about 50 percent in April and May. The CalSim II simulated water exports under the SBC were 7.1 million acre feet (MAF) for wet water years and 6.6 MAF for above normal water years. These high-level water exports rarely occurred in the past. Are these high water exports expected to occur in the future?

5.4 Old and Middle Rivers Flow

NMFS 43

The simulated Old and Middle Rivers flows (OMR flows) (absolute values) under the SBC, as compared to the NAA, were increased by about 45 percent in January and February, and by more than 100 percent in April and May. The difference in the simulated OMR flows between the NAA and SBC was about 6,000 cfs in April and May, changing from positive 1,000 cfs under the NAA to negative 5,000 cfs under the SBC. These substantial differences apparently resulted from much higher water exports under the SBC than the NAA and would be indicative of potentially high entrainment of juvenile fish by the water export facilities under the SBC.

6 Water Temperature Analyses in the DEIS

6.1 Water Temperature Objectives

NMFS 44

Water temperature objectives used in the DEIS (Table 9.3) are inconsistent for the same life stages of salmonids. For example, for spring-run Chinook salmon holding, it was 60 °F in the Trinity River, but 56 °F in Clear Creek; for Chinook salmon and steelhead spawning and egg incubation, it was 56 °F in the Trinity River, but 63 °F in Clear Creek; for steelhead juvenile rearing, there were 56 °F, 63 °F, and 65 °F presented in the DEIS Table 9.3. Some of the water

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temperature objectives used in the DEIS (Table 9.3) are also inconsistent with the EPA recommended water temperature criteria for salmonids. The EPA (2013) recommends 56 °F (13 °C) for adult holding, spawning, egg incubation, and fry emergence; 61 °F (16 °C) for juvenile rearing in the upper reaches of a river and 64 °F (18 °C) in the lower reaches (U.S. Environmental Protection Agency 2003). The EPA criteria for salmonids are considered the best available science (National Marine Fisheries Service 2010) and should be used in the EIS.

NMFS 44 continued

6.2 Simulated Water Temperature in Clear Creek

It is not surprising that the HEC-5Q simulated water temperature in Clear Creek was identical between the NAA and SBC except for May because it was based on the CalSim II simulated flow. However, even in May, the difference was only 0.6 °F on average, accounting for 1.2 percent difference. This small difference could be caused most likely by the modeling error of the water temperature models used in the DEIS.

NMFS 45

The simulated water temperature in Clear Creek rarely exceeded 56 °F - the water temperature criterion for spawning and egg incubation. On the contrary, the measured daily average water temperatures in Clear Creek exceeded 56 °F for 29 days in July, 30 days in August, and 21 days in September from 1997 to 2013 (17 years). This discrepancy between the simulated and measured water temperatures indicates, again, the ill-representation of the modeling processes used in the DEIS.

NMFS 46

6.3 Simulated Water Temperature in the Sacramento River

The DEIS concluded that "Overall, the temperature differences between the No Action Alternative and Second Basis of Comparison would be relatively minor (less than 0.5°F) and likely would have little effect on winter-run Chinook Salmon in the Sacramento River" (page 9-159); and "Temperature conditions under the No Action Alternative could be more likely to affect winter-run Chinook Salmon spawning than under the Second Basis of Comparison because of the increased frequency of exceedance of the 56°F threshold from April through August" (page 9-160). This is contradictory to the expected outcome from implementation of the RPA actions. If the RPA Action Suite I.2, including Action I.2.4, were implemented under the NAA, water temperatures between Balls Ferry and Bend Bridge would be lower under the NAA than those under the SBC and would not be in excess of 56 °F from mid-May through September under the NAA.

NMFS 47

7 Listed Species Analyses in the DEIS

We used winter-run Chinook salmon as an example to examine the species analyses in the DEIS. Our comments may be applicable to other listed salmonid species analyzed in the DEIS.

NMFS 48

7.1 Winter-run Chinook Salmon Escapement

Based on the OBAN model results, the DEIS concluded that "Escapement was generally higher under the No Action Alternative as compared to the Second Basis alternative (Appendix 9I). The median abundance under the No Action Alternative was higher in 19 of the 22 years of

NMFS 49

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simulation (1971 to 2002), and there was typically greater than a 25 percent chance that the No Action Alternative values would be greater than under the Second Basis of Comparison (page 9-162). On the contrary, the IOS model, with simulation of 82 years, showed similar escapement results between the NAA and SBC. The median winter-run adult escapement was 3,935 under the NAA and 4,042 under the SBC. Please explain why these two models had very different results.

7.2 Winter-run Chinook Salmon Egg Mortality

NMFS 50

The Egg Mortality Model results (Appendix 9C, Table B-4) indicated that the average winter-run egg mortality under the NAA (5.0 percent) was similar to that under the SBC (4.3 percent). The egg mortality was less than 1 percent except for critically dry years. In critically dry years, the egg mortality rate under the NAA was 31.4 percent comparable to 26.0 percent under the SBC. On the contrary, the IOS model indicated much lower overall egg mortality. The IOS median egg mortality was 1.0 percent under the NAA and 1.3 percent under the SBC (page 9-162). These simulated egg mortality results seem too low to be real.

NMFS 51

The DEIS concluded, based on SALMOD, that the temperature-related egg mortality was 20 percent higher under the NAA than that under the SBC (page 9-161). Please explain why the NAA resulted in egg mortality rates higher than the SBC. The EIS should also discuss how to interpret these contradictory modeling results in making decisions.

7.3 Winter-run Chinook Salmon Juvenile Mortality in the Sacramento River

NMFS 52

Based on the SALMOD results, both temperature- and flow (habitat)-related fry mortality was approximately 19 to 21 percent higher under the NAA as compared to the SBC. The temperature-related juvenile mortality was approximately 17 percent higher under the NAA than that under the SBC (page 9-161). Please explain why the NAA resulted in juvenile mortality higher than the SBC.

7.4 Winter-run Chinook Salmon Juvenile Production

NMFS 53

Based on the SALMOD results, the DEIS concluded that "[o]verall, potential juvenile production would [be] the same under the No Action Alternative as compared to the Second Basis of Comparison (Appendix 9D)" (page 9-162). These model results are contradictory to the expected outcome from the NAA (implementation of all RPA actions) as opposed to the SBC (non-implementation of the RPA actions). No OBAN model results for juvenile production were presented in the DEIS.

7.5 Winter-run Chinook Salmon Juvenile Entrainment to the Central and South Delta

NMFS 54

Winter-run juvenile entrainment to the Central Delta through Georgiana Slough was similar under the NAA and SBC during January, February, and March when winter-run juveniles are most abundant in the Delta. Winter-run juvenile entrainment to South Delta through Turner Cut, Columbia Cut, the Middle River, and the Old River was similar under the NAA and SBC (page 9-163). This is contradictory to the conclusion for winter-run juvenile salvage as discussed in section 7.6.

NMFS 54 continued

7.6 Winter-run Chinook Salmon Juvenile Salvage at the Federal and State Fish Collection Facilities

Model results indicated a substantially reduced fraction of winter-run juveniles salvaged under the NAA comparing to the SBC in January and February. This is consistent with simulated water exports and OMR flows as discussed in sections 5.3 and 5.4, respectively, but inconsistent with the simulated juvenile entrainment as discussed in section 7.5.

NMFS 55

7.7 Winter-run Chinook Salmon Juvenile Survival through the Delta

The simulated Delta survival rates for winter-run juveniles, based on the OBAN results, ranged from 0.005 to 0.013 for all the alternatives (Figure 9I.9 Delta Survival under the Alternatives and Second Basis of Comparison). It was about 12 percent higher under the NAA as compared to the SBC. However, the simulated Delta survival rate, based on the DPM results, was 0.349 for the NAA and 0.352 for the SBC. The DPM results are contradictory to the recent study results based on a newly developed life cycle model for Central Valley Chinook salmon (Cunningham *et al.* 2015). Cunningham *et al.* (2015) found that higher water export rates lead to reduced survival for Sacramento River Chinook salmon. They estimated that increasing exports by 30 percent above the 1967-2010 average would result in a 39-59 percent reduction in median survival for spring-run Chinook salmon. While results indicated that winter-run survival would be minimally influenced by a 30 percent increase or reduction in future exports, the zero export scenario was predicted to increase survival by 28-91 percent, most appreciably when combined with a cooler and wetter future climate change scenario and positive future marine conditions. Changes to juvenile routing may provide a reasonable explanation for the estimated survival influence of Delta water exports. Higher exports result in greater water diversion into the interior delta where survival has been observed to be substantially lower than that in the Sacramento River mainstem (Perry and Skalski 2010, Perry *et al.* 2013), potentially resulting from an increased encounter rate with predators or prolonged residence in areas with suboptimal feeding opportunities or dissolved oxygen (DO) concentrations.

NMFS 56

The following statement is confusing: "The differences in survival, although not consistent across the uncertainty in the parameter values, suggest a high probability of no difference between these two bases of comparison" (page 9-162). Please clarify why there would be no difference when the results showed higher survival rates under the NAA than those under the SBC.

NMFS 57

8 Significance of Streamflow and Water Temperature for Salmonids

As discussed in section 7, above, simulated escapement, egg survival, and juvenile production, survival, and entrainment for winter-run under the NAA are either similar to or worse than those under the SBC except for the OBAN model results. The OBAN results indicated higher escapement and higher survival under the NAA than those under the SBC. Considering the fact

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that the NAA represents the full implementation of the NMFS 2009 BO and RPA actions, which were developed for improving the survival, growth, and productivity of listed salmonid species by a suite of measures, including appropriate streamflow and water temperature for the listed salmonids, the simulated results and conclusions derived from those results are contradictory to the overwhelmingly recognized significance of managing flow and water temperature for salmonid species. Provided below is a review of published literature on the importance of streamflow and water temperature for salmonids. The review is not meant to be inclusive, but to reflect the collective science of these two major determinants of energetics and metabolism of stream fishes with consequent strong influences on their survival, growth, and fitness. We recommend that Reclamation consider the scientific data and information provided below to reassess: (1) streamflow and water temperature under the full implementation of the NMFS 2009 BO and RPA, and (2) impacts on listed salmonid species if no RPA is implemented.

NMFS 58 continued

NMFS 59

8.1 Streamflow

Streamflow has been deemed a "master variable." It strongly influences fish and the food web, and it has substantial effects on spawning and rearing habitat quality and availability because of its influence on sediment transport, channel morphology, and streambed substrate characteristics (Poff *et al.* 1997, Trush *et al.* 2000, Bunn and Arthington 2002, Richter 2008, Brown and Bauer 2009, Poff *et al.* 2010, Poff and Zimmerman 2010, Malcolm *et al.* 2012, Richter *et al.* 2012, Webb *et al.* 2013). Zeug *et al.* (2010) found that flow alteration below a dam, compared to habitat loss, was a stronger predictor of extirpation of spring-run Chinook salmon in the Central Valley. The analysis of post-project flow changes suggests that water operations reduced stream flows during a critical period when adult spring-run Chinook salmon were migrating upstream. This substantial change may have contributed to their extirpation because adult spring-run Chinook salmon migration coincides with periods of peak flows or the declining limb of high-flow periods in the pre-project period (Zeug *et al.* 2010).

Numerous studies have revealed that altered flows impact the communities of fish, macroinvertebrate, and riparian vegetation (Nelson and Lieberman 2002, Brown and Bauer 2009, Poff and Zimmerman 2010, Carlisle *et al.* 2011, Kiernan *et al.* 2012, Webb *et al.* 2013). Poff and Zimmerman (2010) reviewed a total of 165 papers that studied flow alteration in terms of magnitude, frequency, duration, timing, and rate of change and their impacts to aquatic biology characterized by taxonomic identity (fish, macroinvertebrate, and riparian vegetation) and type of responses (abundance, diversity, and demographic parameters). They found that 152 papers (92 percent) reported decreased abundance, diversity, or demographic parameters of fish, macroinvertebrate, or riparian vegetation in response to a variety of types of flow alteration (decreased magnitude, duration, or frequency of peak or high flows), whereas 21 papers (13 percent) reported increased values, and these often reflected shifts in ecological organization such as increases in non-native species or non-woody plant cover on dewatered floodplains.

Carlisle *et al.* (2011) assessed flow alteration at 2,888 streamflow monitoring sites throughout the conterminous United States. The magnitudes of mean annual (1980–2007) minimum and maximum streamflows were found to have been altered in 86 percent of assessed streams.

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Biological assessments conducted on a subset of these streams showed that, relative to eight chemical and physical covariates, diminished flow magnitudes were the primary predictor of biological integrity for fish and macroinvertebrate communities, and the likelihood of biological impairment doubled with increasing severity of diminished streamflows. Among streams with diminished flow magnitudes, increasingly common fish and macroinvertebrate taxa possessed traits characteristic of lentic habitats, including a preference for fine-grained substrates and slow-moving currents, as well as the ability to temporarily leave the aquatic environment. Biological impairment was observed in some sites with hydrologic alteration of 0-25 percent (the lowest class of alteration assessed) and in an increasing percentage of sites beyond 25 percent hydrologic alteration.

Richter *et al.* (2012) concluded that daily flow alterations no greater than 10 percent will provide a high level of ecological protection; a high level of protection means that the natural structure and function of the riverine ecosystem will be maintained with minimal changes. Daily flow alterations by 11–20 percent will provide a moderate level of protection; a moderate level of protection means that there may be measurable changes in structure and minimal changes in ecosystem functions. Alterations greater than 20 percent will likely result in moderate to major changes in natural structure and ecosystem functions, with greater risk associated with greater levels of alteration in daily flows (Richter *et al.* 2012).

It has generally been recognized that streamflow influences adult immigration from estuarine environments to main rivers and from main rivers to spawning tributaries (Arthaud *et al.* 2010, Marston *et al.* 2012, Nislow and Armstrong 2012). The latter phase, referred to as the spawning migration, is best treated as part of the spawning process, as it involves the movement to specific spawning locations, often incorporating a search phase that may include both upstream and downstream movements, which are thought to relate to fish selecting a suitable redd location, finding a potential mate, and locating a safe position to spend time until spawning. Nislow and Armstrong (2012) concluded that adult abundance was correlated to daily flows during the spawning migration period. The timing of spawner arrival was found to be a function of flow regime type and, in particular, antecedent hydrological conditions during the pre-spawning period. In wet years, fish entered the stream early in the season and at a consistent rate throughout the spawning period. In dry years, they entered later and often on the back of relatively small increments in flow, increments which in wet years did not stimulate significant arrivals. In years with high mean annual flows, fish migrated further up the stream, resulting in a more even spread of spawning activity. They speculated that low flow conditions at spawning time may, therefore, affect production through a reduction in total adult numbers (Nislow and Armstrong 2012).

Salmonids spawn in areas with specific hydraulic and sedimentary characteristics. Sedimentary conditions are generally considered to be of primary importance, with flow (via its influence on velocity and depth) determining whether conditions over spawning gravels are conducive to spawning. Spawning tends to occur at relatively high flows. Most spawning takes place at flows greater than (2.0–2.4 times) the median flow. Fish spawning in the upper parts of the stream select relatively higher velocities than those in lower parts. Salmonids tend to avoid periods of rapidly varying flows, indicating that rates of flow change need to be considered when developing instream flows for water resources management (Nislow and Armstrong 2012).

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Flows also have a major influence on the growth and survival of juveniles (including fry, parr, and smolt) (Arthaud *et al.* 2010, Nislow and Armstrong 2012, Zeug *et al.* 2014, Michel *et al.* 2015). Michel *et al.* (2015) estimated the outmigration survival of acoustic tagged hatchery-origin late fall-run Chinook salmon smolts for 5 years (2007-2011) using a receiver array spanning the entire outmigration corridor, from the upper Sacramento River, through the estuary, and into the coastal ocean. The first 4 years of releases occurred during below-average streamflows, while the 5th year (2011) occurred during above-average flows. The overall outmigration survival in 2011 was two to five times higher than survival in the other 4 years. The higher survival in the high-discharge year (2011) was due mainly to increased survival in the river region, indicating the importance of streamflow for juvenile survival (Michel *et al.* 2015).

Stream flows in the lower Stanislaus River were a significant driver of the survival, migration, and size of juvenile fall-run Chinook salmon. Greater cumulative flow and flow variability during the out-migration season (from mid-January to late May) promoted higher juvenile survival, higher proportion of pre-smolt migrants, and larger size of smolts (Zeug *et al.* 2014). In a regulated stream in the Salmon River in Idaho, spring stream flows exhibited strong correlations with egg-to-juvenile and egg-to-adult survival rates for spring-run Chinook salmon and were consistently a better predictor of productivity than late summer stream flows. High flows during early rearing were the single best predictor of egg–to-juvenile survival rates (Arthaud *et al.* 2010). Decreased flow magnitude was generally associated with lower growth rates, resulting in 24–50 percent decreases in the size of juvenile salmon and trout under low-flow conditions (Nislow and Armstrong 2012). Smolt migration appears to be highly tuned to characteristics of natural flow regimes. Generally, most smolts outmigrate during the descending limb of the spring hydrograph, and flow is a co-trigger along with temperature and day length initiating migration. Flows must be of sufficient magnitude to aid downstream migration (which to some extent is a passive process), and there is evidence that speed of migration is dependent on flow, with higher flows leading to more rapid downstream migration. Migration speed appears to be a critical determinant of successful migration for smolts. Examples from both Pacific and Atlantic salmonid species have demonstrated that low flows during smolt migration are associated with low smolt survival. This is likely due to several mechanisms. Delays may increase vulnerability to within-river predators. Migratory delays may also cause smolts to lose the physiological and behavioral characteristics that prepare them for life in seawater, as retention of these characteristics has been shown to be time- and temperature-dependent (McCormick *et al.* 1999, Nislow and Armstrong 2012).

Studies have indicated that stream flows impact invertebrate assemblages, which in turn influence the food availability for juvenile salmonids. Yarnell *et al.* (2013) found differences in both benthic macroinvertebrate diversity and density between regulated and unregulated rivers in the Central Valley. Study sites in the unregulated rivers exhibited the highest diversity in hydraulic habitat in space and time and the highest diversity in primary productivity. Conversely, the study sites with the most altered flow regimes exhibited the lowest and least consistent hydraulic diversity and the lowest diversity in primary productivity. These differences between unregulated and altered study sites were observed in both study years, regardless of water year type. For the American River watershed, a positively-correlated relationship occurred

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between the hydraulic diversity and the Ephemeroptera (mayflies)-Plecoptera (stoneflies)-Trichoptera (caddisflies) (EPT) index. The relationship suggests diverse hydraulic niches support diverse benthic macroinvertebrate assemblages (Yarnell *et al.* 2013).

8.2 Water Temperature

Water temperature is an important water quality component because of its enormous significance for all freshwater organisms (McCullough 1999, U.S. Environmental Protection Agency 2003, McCullough *et al.* 2009) and its influence on other aspects of water quality, such as DO solute and pollutant fluxes, toxicity of pollutants, nutrient concentrations, and organic matter and suspended sediment concentrations (Caissie 2006, Webb *et al.* 2008, Olden and Naiman 2010). Water temperature affects the distribution, health, and survival of native salmonids and other aquatic organisms by influencing their physiology and behavior. Water temperature, along with adequate flow, food, oxygen, shelter, and other resources, determines habitat suitability for each species. While community composition is shaped by numerous habitat components, each of which can provide optimal or suboptimal conditions, water temperature is an important aspect of habitat quality. Furthermore, water temperature acts synergistically with other environmental stressors, thereby affecting the ability of individual fish to survive and reproduce, and affecting salmonid population viability.

Salmonid response to water temperatures may be described as lethal, sublethal, and optimal. High water temperatures can pose lethal or sublethal impacts to salmonids at all life stages, including adult migration, pre-spawn holding, spawning, egg incubation, fry emergence, and juvenile rearing and outmigration (McCullough 1999, Poole and Berman 2001, U.S. Environmental Protection Agency 2003, Poole *et al.* 2004, Richter and Kolmes 2005, Jonsson and Jonsson 2009, McCullough *et al.* 2009). Lethal temperatures are those that cause direct mortality. The embryo survival rate for Chinook salmon showed a sharp increase from 2 °C (35.6 °F) to 5 °C (41.0 °F), remained high from 5 °C (41.0 °F) to 13 °C (55.4 °F), and decreased drastically with water temperatures above 13 °C (55.4 °F). The alevin survival rate for Chinook salmon was > 0.9 from 2 °C (35.6 °F) to 14 °C (57.2 °F) and then decreased sharply with water temperatures above 14 °C (57.2 °F) (Velsen 1987, Beacham and Murray 1990). There are temperatures that may not cause mortality to embryos, however, alevins developed in temperatures above 13 °C (55.4 °F) may be subject to higher mortality at the next developmental stage (McCullough 1999).

Sublethal effects affect the distribution, physiology, and behavior of salmonids that may result in higher mortality of the individuals of later life stages. Lethal temperatures may occur in nature and can be locally problematic, but temperatures in the range where sublethal effects occur are widespread and may have the greatest effect on the overall well-being of salmonids (U.S. Environmental Protection Agency 2001). Exposure to water temperatures in the sublethal range results in increased severity of harmful effects, such as decreased juvenile growth that results in smaller fish more vulnerable to predation; increased susceptibility to disease that can lead to mortality, affecting reproduction, inhibiting smoltification; and decreased ability to compete (U.S. Environmental Protection Agency 2003, Richter and Kolmes 2005, Jonsson and Jonsson 2009, McCullough *et al.* 2009). All of these responses, even those not resulting in immediate

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death, can lead to mortality prior to reproduction or reduced fecundity. These impacts would result in reduced productivity of a stock and reduced population size.

Adult fish holding in warm water experience bioenergetics stress and consume their stored energy more rapidly, which may result in reduced spawning success. Prolonged holding in sub-optimal temperatures can result in multiple stresses, such as concurrent thermal stress, disease, and energy depletion. Thermal stress experienced while fish are holding can decrease gamete viability (U.S. Environmental Protection Agency 2001). Warm water can also present thermal barriers to adult and juvenile migration. If enough fish are affected, salmonid population viability may be reduced.

Warm temperatures can alter juvenile growth and development, water quality (*e.g.*, DO), resistance to disease, competitive ability, swimming speed, and predator avoidance (McCullough 1999, Poole and Berman 2001, U.S. Environmental Protection Agency 2001, Richter and Kolmes 2005). Juvenile growth increases with an increase in temperature to an optimum, at which point growth is maximized. This is followed by a rapid decline in growth rate as temperatures increase further. The optimum temperature for growth is dependent on the availability of food. At ration levels lower than the maximum, the optimal temperature for growth is reduced because of the effects of temperature on metabolic rates and the subsequent maintenance metabolic demands for energy inputs (Brett *et al.* 1982). Zeug *et al.* (2014) found a negative relationship between fall-run Chinook salmon smolt size and water temperature in the Stanislaus River. The Stanislaus River is located near the southern range limit of Chinook salmon spawning where water temperatures have frequently exceeded the water temperature criteria for the species.

The DO concentration decreases with increasing water temperature. When fish experience temperature stress, they may also experience some stress from low DO levels. McCullough (1999) concluded that adult migration of Chinook salmon can be impeded when water temperature and DO requirements are not met. Warmer water temperatures often increase the infection rate or virulence of fish pathogens and lessen the ability of a fish to withstand disease. Many important salmonid diseases become virulent above approximately 15.6-16 °C (60.1-60.8 °F) (Richter and Kolmes 2005). Water temperature may also impact food availability, feeding rates, and metabolism (McCullough *et al.* 2009). In addition, water temperature influences the abundance and well-being of organisms by controlling their metabolic processes.

It appears obvious that a single exceedance of a maximum temperature threshold of an extreme magnitude would be sufficient to instantaneously eliminate a species in a particular reach, assuming no coldwater refugia were available and upstream migration was not efficient. However, for less extreme maxima, the cumulative effects of consecutive days of maxima exceeding critical limits may produce negative biological responses, such as cumulative stress leading to death, disease, poor reproductive success, or poor growth. The stressful impacts of water temperatures on salmonids are cumulative and positively correlated to the duration and severity of exposure. The longer a salmonid is exposed to thermal stress, the less chance it has for long-term survival (U.S. Environmental Protection Agency 2001). All these responses, even those not resulting in immediate death, can lead to mortality prior to reproduction or reduced fecundity. There were studies of the influence of cumulative exposure to adverse high

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temperatures in a fluctuating regime in which mortality results from successive thermal cycles. These studies demonstrated that, although a single thermal cycle was not sufficient to produce mortality, accumulated stress from consecutive thermal cycles resulted in mortality. In addition to the seasonal probability of consecutive days of critical maxima, consecutive years with serious cumulative thermal effects over significant portions of a species' range for one or more life stages can lead to dramatic reduction in stock viability (McCullough 1999).

It may be possible for healthy fish populations to endure some of these sublethal, chronic impacts with little appreciable loss in population size. However, for vulnerable fish populations such as the endangered or threatened salmonids of the Central Valley, these sublethal effects can reduce the overall health and size of the population, making the survival and eventual recovery of these listed species more uncertain. It is essential to provide optimal water temperatures to those listed fish species whenever and wherever possible.

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1A.1.1.1 Responses to Comments from National Marine Fisheries Service

NMFS 1: Comment noted.

NMFS 2: The comparison of the No Action Alternative to the Second Basis of Comparison are presented as a combination of both quantitative and qualitative results because the numerical analytical tools cannot simulate all of the 2009 National Marine Fisheries Service (NMFS) Biological Opinion (BO) Reasonable and Prudent Alternative (RPA) actions. In the Final EIS, the presentation of the results of the qualitative analyses and the integrated results of the quantitative and qualitative results have been modified to provide more clarity. Presentation of an alternative analytical approach to consider effects on sturgeon also have been included in the Final EIS.

It should be noted that the results of the impact analyses in the EIS are presented as incremental changes between the alternatives as compared to the No Action Alternative and Second Basis of Comparison for Year 2030 conditions with climate change, sea level rise, and projected population growth. The EIS does not present an analysis of the alternatives as compared to existing conditions. In addition, all of the alternatives, the No Action Alternative, and the Second Basis of Comparison include the implementation of the 2009 NMFS BO RPA actions I.1.3, I.14, I.2.6, I.3.1, I.5, I.6.1, and II.1 and the 2008 USFWS BO RPA Component 4 because these actions were being implemented prior to issuance of the BO and would have been completed without the BOs. Therefore, the analysis in the EIS would not indicate any differences between implementation of the No Action Alternative and the Second Basis of Comparison due to implementation of these actions.

Reclamation has modified the Final EIS in response to comments from NMFS and other commenters; and will use the Final EIS in the development of the Record of Decision.

NMFS 3: Comment noted.

NMFS 4: Comment noted.

NMFS 5: Please see response to Comment NMFS 2.

NMFS 6: Comment noted.

NMFS 7: The summaries of the impact analyses in Chapters 5 through 21 of the Final EIS have been modified to improve clarity; however, the summaries have remained at the end of the chapters. The level of detail in the bookmarks in the chapters has been expanded in the Final EIS.

NMFS 8: The figure from Appendix 5A, Section A, CalSim II and DSM2 Modeling, referred to in the comment has been included in Chapter 4 of the Final EIS. Due to the complexity of the methodologies for the different analytical tools and qualitative analyses, the extent of the analytical coverage with the limitations and uncertainties of each method are presented in Chapters 5 through 21 and in the appendices that provide the modeling methodologies (see Appendices 5A, 6B through 6E, 7A, 8A, 9C through 9O, 12A, and 19A through 19B).

NMFS 9: As discussed in this comment, the analytical tools do have limitations and uncertainties, as discussed in the appendices of the EIS. Some of these limitations are related to the ability to simulate specific conditions or regulatory requirements; and some of the limitations are related to the use of CalSim II with a monthly time step as the basic hydraulic simulation tool. Given the complexity of the system and the number of models used in the analysis, it is not possible to do a statistical error propagation analysis. The acknowledgement of these limitations and uncertainties is the reason that the discussions in the EIS emphasize that the model results in all EIS chapters must be used in a comparative manner to determine the incremental differences between Alternatives 1 through 5 as compared to the No Action Alternative, and between the No Action Alternative and Alternatives 1 through 5 as compared to the Second Basis of Comparison. The model results are not used to project specific physical, biological, or human resource values. By using the models in a comparative manner, the results of the analysis are less affected by the limitations and uncertainties. The quantitative model results are used in conjunction with the qualitative analyses presented in this EIS to consider the comparative results of the entire analyses.

NMFS 10: The VIC model accepts input meteorological data directly from global or national gridded databases or from GCM projections. The discussion of the VIC model has been expanded in Appendix 5A, Section A, CalSim II and DSM2 Modeling, in the Final EIS.

NMFS 11: Section 5A.A.5.4 of Appendix 5A, Section A, discusses the VIC model limitations. A separate uncertainty analysis for the VIC model was not conducted. As described in the response to Comment NMFS 9, the EIS uses the tools in a comparative manner to determine incremental changes between alternatives which reduces the limitations of the models as compared to using the tools for to predict specific values.

NMFS 12: The information requested in this comment is included in the references cited in the EIS. However, the discussion of the VIC model has been expanded in Appendix 5A, Section A, CalSim II and DSM2 Modeling, in the Final EIS.

NMFS 13: The analysis in the EIS is performed assuming climate change conditions at Year 2030. The NEPA analysis does not provide a comparison of conditions under the alternatives, No Action Alternative, and Second Basis of Comparison with existing conditions. Therefore, the analytical tools were not developed to simulate existing conditions.

NMFS 14: A linear-programming solver is used within CalSim to route the flow based on complex regulatory requirements. The weights indicate priorities in the system; such as weights that are used to ensure mass balance and weights to comply with regulatory requirements.

NMFS 15: The CalSim II model is not calibrated and was developed to be used in for comparative analyses, and not to predict values. The model has been peered review in a historical comparison was conducted for CVP and SWP operations in the Historical Operations Study of water years 1975 to 1998 (DWR 2003).

NMFS 16: Section 5A.A.3.5 of Appendix 5A, Section A, CalSim II and DSM2 Modeling, describes the appropriate use of the CalSim II model.

NMFS 17: The CalSim II and DSM2 models cannot simulate daily real-time operations that are based upon real-time observations. The models are appropriate for a NEPA analysis when used in conjunction with qualitative analyses of decisions that are based upon real-time information and other issues that are not included in the numerical models. As discussed in the response to Comment NMFS 2, presentation of the results of the qualitative analyses and the integrated results of the quantitative and qualitative results have been modified in the Final EIS to provide more clarity.

NMFS 18: The paragraph referred to in this comment (see page 5A.A-13 of the Draft EIS) describes that CalSim II model cannot adjust the set of predefined rules that represent the assumed regulations to simulate extreme events, such as a prolonged drought, or to perform statistical performance criteria, such as storage target objectives in an assumed percentage of years. Therefore, the CalSim II model includes logic to represent predefined operational rules, such as policy level decisions, when there is not enough water to meet all needs. Use of the 82-year hydrology in the CalSim II model does provide a range of different hydrologic conditions and sequences. However, due to these limitations, the CalSim II model is considered a planning model and was developed to be used in a comparative manner.

NMFS 19: When more than one regulatory requirement is listed in the assumptions table referred to in this comment, the flows comply with all listed regulations. These regulations may have different requirements at different months. The model operates to the flow requirement that is controlling in each month.

NMFS 20: As shown in Table 5A.B.20, the DSM2 model is run for the 82-year hydrologic period (water years 1922 through 2003).

NMFS 21: DSM2 was not used for any temperature analysis. Therefore no meteorological inputs were necessary. Model inputs used for DSM2 HYDRO and QUAL for Delta hydrodynamics and water quality simulations are provided in Section 5A.A.4.2.3.

NMFS 22: A new calibration was not performed on the HEC-5Q model; however several updates were done as explained in Appendix 6B, Section C.

NMFS 23: Comment noted.

NMFS 24: The information related to model inputs has been modified in Appendix 6B of the Final EIS.

NMFS 25: This information related to disaggregation of monthly flow data has been modified in Appendix 6B of the Final EIS.

NMFS 26: The Salmon Mortality Model has not been calibrated. The development of the Reclamation Salmon Mortality Model was a collaborative and iterative effort by Reclamation, USFWS, and the California Department of Fish and Wildlife (CDFW). This interaction provided quality assurance and data quality assessment for the model. The rationale for use of the model, assumptions, and limitations of the model are described in Appendix L of the 2008 Central Valley Project and State Water Project Operations Criteria and Plan Biological Assessment (2008 BA) which is referenced in the EIS. Appendix L of the 2008 BA is identified as the primary source document for the Reclamation Salmon Mortality Model Analysis in Appendix 9C of the EIS.

NMFS 27: Table L-7 in Appendix L of the 2008 BA provides the salmon mortality criteria and the model mathematics are described on page L-5 of that document and in Hydrologic Consultants, Inc. (1996). In order to utilize the best available scientific data, the model was updated to include data provided by NMFS during preparation of the EIS related to the recent distribution of winter-run Chinook Salmon spawning in the Sacramento River.

Reference is found at Hydrologic Consultants, Inc. 1996. *Water Forum Issue Paper Chinook Salmon Mortality Model: Development, Evaluation, and Application as One Tool to Assess the Relative Effects of Alternative Flow and Diversion Scenarios on the Lower American River.*

NMFS 28: SALMOD has not been calibrated. SALMOD has been applied to several river systems. The SALMOD model and its applications are published in many peer-reviewed journals; and applied to the Sacramento River in multiple efforts. The data and parameters for the Sacramento River were well refined in these applications. The rationale for use of the model, assumptions, and limitations of the model are described in Appendix P of the 2008 BA. Appendix P of the 2008 BA is identified as the primary source document for the SALMOD Analysis in Appendix 9D of the DEIS.

NMFS 29: As indicated on page 9I-10 of Appendix 9I in the EIS, the OBAN model produces forecasts of escapement and delta survival rates for simulation years 1967 to 2002, and incorporates parameter uncertainty in each of these outputs.

NMFS 30: The IOS model was not calibrated to observed escapement. IOS is a simulation model to be used in a comparative manner, and is not meant to be predictive of future or past observations.

NMFS 31: A sensitivity analysis was performed for the DPM model that examines structural and parameter uncertainty. That analysis was reviewed by a multi-agency workgroup including NMFS, USFWS, CDFW and Department of Water Resources (DWR).

NMFS 32: We concur with the statements in the comment regarding challenges associated with evaluating model results given the inherent uncertainty and level of accuracy of the available modeling tools. Because the suite of models used for different analyses in the EIS either use monthly time steps or starts with output from the monthly time step CalSim II model, it was determined that incremental changes between model runs of 5 percent or less were related to the uncertainties in the model processing. Therefore, changes of 5 percent or less in this comparative analysis are considered to be not substantially different, or "similar."

NMFS 33: Please see the response to Comment NMFS 9.

NMFS 34: The EIS acknowledges that certain operations cannot be captured in the modeling exercise; therefore, effects of some RPA actions that cannot be simulated in the CalSim II and other models, including implementation of fish passage and Shasta performance measures in the No Action Alternative, are analyzed in a qualitative manner. Text has been added in Section 9.4 of Chapter 9, Fish and Aquatic Resources, in the Final EIS to clarify the integrated results of quantitative and qualitative analyses.

NMFS 35: In response to this comment, a detailed description of the analysis of the trap and haul program associated with Alternatives 3 and 4 was added to the Final EIS as Appendix 9O. Text also was added to Section 9.4.1 of Chapter 9 to describe the mechanism for analysis of the trap and haul program. Text revisions to page 9-316 of the Draft EIS describe the potential for unintended consequences associated with the trap and haul program. Use of Keefer et al. 2008 was included in the Final EIS.

NMFS 36: Text was added to page 9-342 of the Draft EIS to provide more clarity related to Alternative 4 assumptions and consistency with NMFS's fisheries management framework for reducing the impact of ocean salmon fishery on winter-run Chinook Salmon for the Pacific Coast Salmon Fishery Management Plan.

NMFS 37: Comment noted.

NMFS 38: As described in response to Comment NMFS 34, impact analysis related to RPA actions that are not included in CalSim II model are qualitatively assessed in Chapter 9. Text has been added in Section 9.4 of Chapter 9, Fish and Aquatic Resources, in the Final EIS to clarify the integrated results of quantitative and qualitative analyses. For example, under the No Action Alternative, benefits that would occur due to inclusion of fish passage and temperature management at Shasta Lake are analyzed qualitatively and described in combination with the quantitative results of the CalSim II and water temperature models.

Storage in CVP and SWP reservoirs is affected by multiple actions in the system. For example, maintaining Old and Middle River flows at certain levels during December through June, increased closure of the Delta Cross Channel under the No Action Alternative as compared to conditions under the Second Basis of Comparison that included requirements per State Water Resources Control Board (SWRCB) Decision 1641 (D-1641), export limitations in April and May based on

San Joaquin Flow at Vernalis, and increased Delta outflow in fall months following wet and above normal years. All of these actions affect project operations and result in increased reservoir releases. These effects include a shift in export patterns from spring to summer months that causes more water to be released from the reservoirs than that is being exported to meet the Delta water quality standards during a season where Delta is more saline, an increased need in supply from the Sacramento River in April and May since San Joaquin River supply is limited, and increased reservoir releases in fall months following wet and above normal years. Therefore, this reduction in flexibility to use available water supply in most efficient way for water supply and water quality needs further limits possibility of meeting storage and temperature performance requirements on upper Sacramento River (e.g., 2009 NMFS BO RPA actions 1.2.1, 1.2.2, 1.2.3, and 1.2.4.).

NMFS 39: Whiskeytown Lake storage is simulated in the CalSim II model; however, the results were was not specifically reported in the EIS because there were no specific analyses related to this water body in Chapter 9, Fish and Aquatic Resources. The analysis focus on conditions in Clear Creek.

NMFS 40: The CalSim II implementation of 2009 NMFS BO RPA Action 1.1.1, and other NMFS BO RPA actions, was determined by a multi-agency process (including NMFS) in 2009. This implementation is described in Section 5A.9.1.1 of Appendix 5A, Section A. It was decided to simulate the pulse flow only in May for the EIS analysis.

For the EIS analysis, a revised flow release pattern from Whiskeytown Dam to reduce thermal stress (2009 NMFS RPA Action I.1.5) was not specifically simulated in the CalSim II model. Text has been added to Chapter 9 to clarify that implementation of the flow release pattern could result in benefits to spring-run Chinook Salmon under the No Action Alternative and Alternatives 2 and 5.

NMFS 41: The implementation of the 2009 NMFS BO RPA actions that can be included in the CalSim II model are described in Section 5A.9 of Appendix 5A, Section A, CalSim II and DSM2 Modeling. The 2009 NMFS BO RPA Action 1.2 is not implemented in the CalSim II model and is analyzed qualitatively in the EIS. Text has been added in Section 9.4 of Chapter 9, Fish and Aquatic Resources, in the Final EIS to clarify the integrated results of quantitative and qualitative analyses. The increase in river flows in fall months of wet and above normal years is due to the 2008 USFWS BO RPA Action 4 (Fall X2). It is important to note that actions that require increased river flows cause reduced storage in upstream reservoirs and the cold water pools.

NMFS 42: As shown in Figures 5.47 and 5.48 of the EIS, historical CVP and SWP water exports have exceeded 7 million acre-feet in wetter years.

NMFS 43: The comment is consistent with the information included in Chapter 5, Surface Water Resources and Water Supplies, in the EIS.

NMFS 44: The water temperature thresholds used in this analysis were based on various objectives, guidance, and criteria previously developed for the California water bodies analyzed in the EIS. For the Trinity River, temperature thresholds were based on the temperature objectives developed for the Trinity River Flow Evaluation by USFWS and the Hoopa Tribe (USFWS 1999), which specified temperatures protective of salmonids in the reaches of the Trinity River downstream of Lewiston Dam. For winter-run Chinook Salmon egg incubation in the Sacramento River, the analysis used the optimum upper temperature as described in the 2009 NMFS BO. The temperature thresholds used for steelhead adult migration, spawning, rearing, and smoltification in the Stanislaus River were based on the criteria presented in the 2009 NMFS BO Action III.1.2. All other temperature thresholds used in the analysis were based on the criteria contained in the Bay-Delta Conservation Plan Draft EIR/EIS and associated environmental documentation (DWR et al. 2013). These temperatures were developed collaboratively with the state and Federal agencies in consideration of appropriate temperature criteria for application in California. The EPA Region 10 *Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards* (EPA 2003) presents temperature guidance that in some instances differs slightly from the thresholds used in the analysis in the EIS. The EPA-recommended metric for these temperature criteria is the maximum 7-day average of the daily maxima.

NMFS 45: The differences in May are not due to modeling error, but rather reflect the influence of spring attraction flows for spring-run Chinook Salmon that are included in the CalSim II model. These spring attraction flows are enough to cause a slight increase in the average monthly flow which results in a slight (0.3°F) decrease in the average monthly water temperature in May. This small difference is below the resolution of the model as explained in Section 9.4.1.2.2 of the Final EIS and water temperatures under the No Action Alternative and Second Basis of Comparison are considered “similar” in the analysis.

NMFS 46: The CalSim II model is used to provide input into the temperature models. The CalSim II model is operated to prioritize meeting flow and water quality criteria with assumptions for air temperatures. The assumptions of air temperatures and real-time operations of the CVP and SWP would not necessarily represent the modeled conditions. Therefore, the CalSim II model results must be considered in a comparative manner and not used for specific values in the comparison of alternatives with the No Action Alternative and Second Basis of Comparison.

NMFS 47: The modeling does not include several items in the 2009 NMFS BO, such as fish passage. As described in response to Comment NMFS 34, impact analysis related to RPA actions that are not included in CalSim II model are qualitatively assessed in Chapter 9. Text has been added in Section 9.4 of Chapter 9, Fish and Aquatic Resources, in the Final EIS to clarify the integrated results of quantitative and qualitative analyses.

NMFS 48: See responses to comments NMFS-54 to NMFS-62.

NMFS 49: IOS and OBAN are two distinctly different modeling approaches using different data and different assumptions. Both IOS and OBAN rely on CalSim II based flows and temperatures as inputs, however, IOS simulates the winter-run lifecycle over the 81 year (1922 – 2002) period whereas OBAN simulates from 1967 – 2002 period. Another important difference is that IOS includes a more detailed representation of the Delta reaches (8 reaches), and a reach specific survival is calculated based on the DSM2 simulated flows in each reach. In contrast, OBAN treats Delta as one reach with Delta survival computed based on just the south Delta exports. Further, IOS assumes a small percentage of the population is affected by entrainment in Delta.

NMFS 50: The methodologies for computing egg mortality in Reclamation Egg Mortality Model and IOS model are different, as discussed or referenced in Appendices 9C and 9H, respectively.

NMFS 51: The modeling does not include several items in the 2009 NMFS BO, such as fish passage. As described in response to Comment NMFS 34, impact analysis related to RPA actions that are not included in CalSim II model are qualitatively assessed in Chapter 9. Text has been added in Section 9.4 of Chapter 9, Fish and Aquatic Resources, in the Final EIS to clarify the integrated results of quantitative and qualitative analyses.

NMFS 52: The modeling does not include several items in the 2009 NMFS BO, such as fish passage. As described in response to Comment NMFS 34, impact analysis related to RPA actions that are not included in CalSim II model are qualitatively assessed in Chapter 9. Text has been added in Section 9.4 of Chapter 9, Fish and Aquatic Resources, in the Final EIS to clarify the integrated results of quantitative and qualitative analyses.

NMFS 53: As described in response to Comment NMFS 34, impact analysis related to RPA actions that are not included in CalSim II model are qualitatively assessed in Chapter 9. Text has been added in Section 9.4 of Chapter 9, Fish and Aquatic Resources, in the Final EIS to clarify the integrated results of quantitative and qualitative analyses.

NMFS 54: The EIS analysis used the junction entrainment analysis (see Appendix 9L) to assess the likelihood of juvenile salmon entering the areas within the Delta where they could be at greater risk of exposure to the export facilities. The analysis in the EIS also examined the potential for salvage of juvenile salmon at the export facilities (see Appendix 9M). One approach assesses a likelihood of routing, whereas the other estimates the number of fish salvaged. While both of these tools address a related issue, they are separate models that rely on different inputs and different assumptions. In addition, that factors that influence routing are different from those that influence salvage. Thus, the results for winter-run Chinook Salmon junction entrainment and salvage analyses are different, but not necessarily “inconsistent.”

NMFS 55: Please refer to the response to Comment NMFS 54.

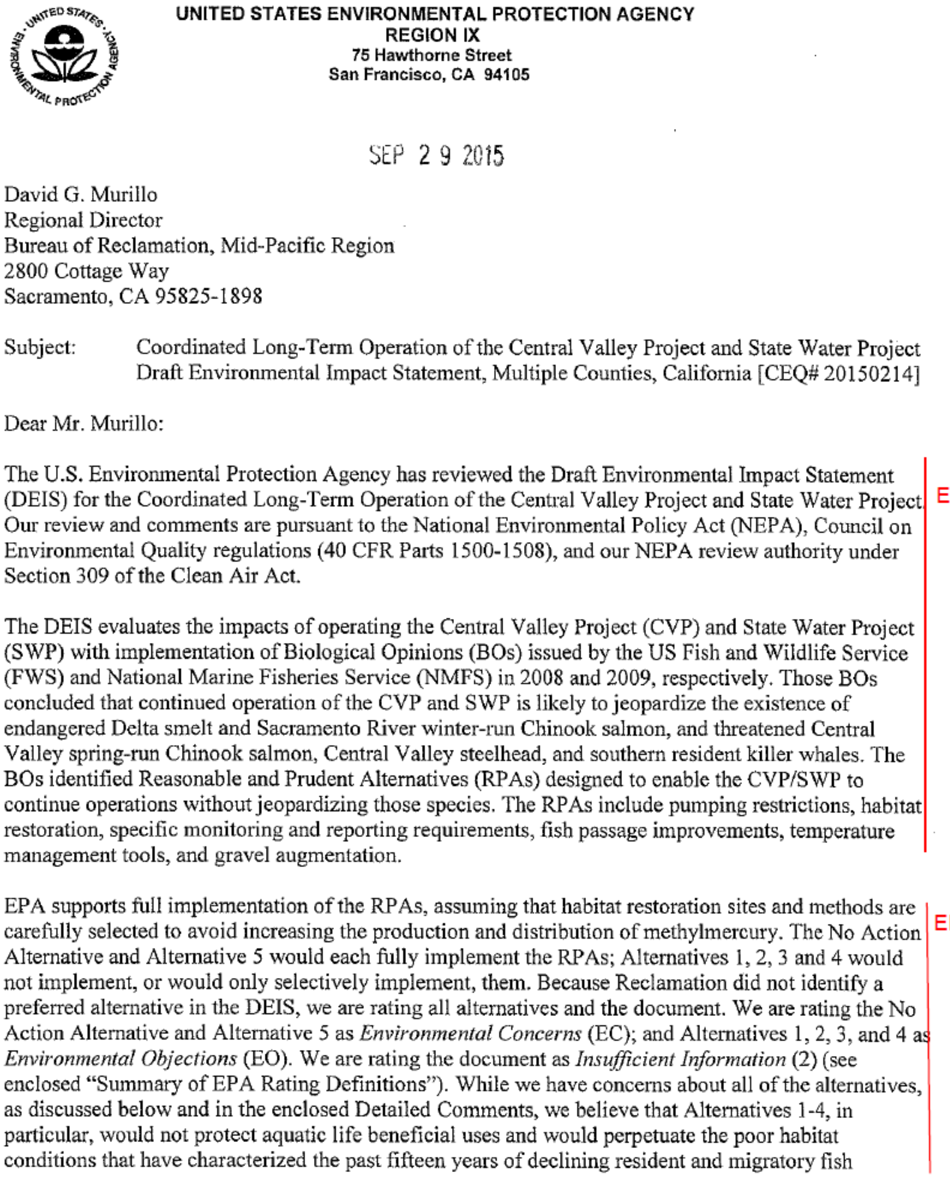
NMFS 56: The DPM results are not necessarily contradictory to those of Cunningham et al. (2015); the DPM provides estimates of salmonid survival through the Delta and the results of Cunningham et al. (2015) represent survival from egg to adult. They are two distinctly different modeling approaches using different data and different assumptions. There is no reason to expect they should be the same or even similar. Cunningham et al. (2015) developed a stage-structured life history model of summer, spring and winter-run Chinook salmon, fitted this model to available data on salmon stock abundance and environmental conditions, and estimated the impact of the environmental conditions on survival of the different stocks of Chinook salmon. This model was then used to forecast how differences in future climate change, marine conditions or productivity, and water exports would affect the survival of the different stocks of Chinook salmon. They concluded from the model fitting exercise that the estimated effect that water exports from the Sacramento – San Joaquin Delta on juvenile Chinook survival through this region was of importance. However, these export-related covariate effects did not appear at the top of the list of most often included covariates, indicating that while they have substantial potential to explain historical patterns in spring and fall-run Chinook survival, there are other environmental covariates which explain a greater proportion of variation in historical abundance. Moreover, the results presented in the EIS are intended to be used in a comparative context to evaluate the relative differences between alternative scenarios.

NMFS 57: Text on page 9-162 has been revised for clarity.

NMFS 58: The modeling does not include several items in the 2009 NMFS BO, such as fish passage. As described in response to Comment NMFS 34, impact analysis related to RPA actions that are not included in CalSim II model are qualitatively assessed in Chapter 9. Text has been added in Section 9.4 of Chapter 9, Fish and Aquatic Resources, in the Final EIS to clarify the integrated results of quantitative and qualitative analyses.

NMFS 59: The reference material was reviewed and considered in the preparation of the Final EIS.

1A.1.2 U.S. Environmental Protection Agency



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

SEP 29 2015

David G. Murillo
Regional Director
Bureau of Reclamation, Mid-Pacific Region
2800 Cottage Way
Sacramento, CA 95825-1898

Subject: Coordinated Long-Term Operation of the Central Valley Project and State Water Project Draft Environmental Impact Statement, Multiple Counties, California [CEQ# 20150214]

Dear Mr. Murillo:

EPA 1

The U.S. Environmental Protection Agency has reviewed the Draft Environmental Impact Statement (DEIS) for the Coordinated Long-Term Operation of the Central Valley Project and State Water Project. Our review and comments are pursuant to the National Environmental Policy Act (NEPA), Council on Environmental Quality regulations (40 CFR Parts 1500-1508), and our NEPA review authority under Section 309 of the Clean Air Act.

The DEIS evaluates the impacts of operating the Central Valley Project (CVP) and State Water Project (SWP) with implementation of Biological Opinions (BOs) issued by the US Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS) in 2008 and 2009, respectively. Those BOs concluded that continued operation of the CVP and SWP is likely to jeopardize the existence of endangered Delta smelt and Sacramento River winter-run Chinook salmon, and threatened Central Valley spring-run Chinook salmon, Central Valley steelhead, and southern resident killer whales. The BOs identified Reasonable and Prudent Alternatives (RPAs) designed to enable the CVP/SWP to continue operations without jeopardizing those species. The RPAs include pumping restrictions, habitat restoration, specific monitoring and reporting requirements, fish passage improvements, temperature management tools, and gravel augmentation.

EPA 2

EPA supports full implementation of the RPAs, assuming that habitat restoration sites and methods are carefully selected to avoid increasing the production and distribution of methylmercury. The No Action Alternative and Alternative 5 would each fully implement the RPAs; Alternatives 1, 2, 3 and 4 would not implement, or would only selectively implement, them. Because Reclamation did not identify a preferred alternative in the DEIS, we are rating all alternatives and the document. We are rating the No Action Alternative and Alternative 5 as *Environmental Concerns* (EC); and Alternatives 1, 2, 3, and 4 as *Environmental Objections* (EO). We are rating the document as *Insufficient Information* (2) (see enclosed "Summary of EPA Rating Definitions"). While we have concerns about all of the alternatives, as discussed below and in the enclosed Detailed Comments, we believe that Alternatives 1-4, in particular, would not protect aquatic life beneficial uses and would perpetuate the poor habitat conditions that have characterized the past fifteen years of declining resident and migratory fish

EPA 2
continue

populations in the Sacramento and San Joaquin river systems and estuary. Because Alternatives 1, 3, and 4 would implement few, if any, of the measures included in the RPAs, they appear less likely to avoid jeopardy to listed species. Alternative 2 includes the operational RPA actions, but not the important structural improvements, such as fish passage, gravel augmentation, improvements to hatchery operations, or fish collection facility improvements. Alternatives 1-4 introduce possible mitigation measures for water quality and aquatic and terrestrial resources that appear to reflect the BOs and RPAs, but the DEIS provides no details as to how the mitigation would differ from the No Action Alternative.

EPA 3

EPA 4

It is important to note that the Delta estuary ecosystem, habitat conditions in the upper watershed rivers, and populations of resident and migratory fish continue to decline, despite the partial implementation of the RPAs that has already occurred, and this decline is expected to continue even as implementation of the RPAs proceeds. The DEIS indicates that, even with full implementation of the RPAs, aquatic life beneficial uses and threatened and endangered fishes may not be fully protected for the duration of the project study period, which ends in 2030:

> "*Currently low levels of relative abundance do not bode well for the Delta Smelt or other fish species in the Delta in 2030. Challenges to fish species in the Delta are many, and would continue in the future under the No Action Alternative, including high water temperatures, reduced flows, habitat degradation, barriers, predation, low dissolved oxygen, contamination, entrainment, salvage, poaching, disease, competition, non-native species, and lack of available food*" (page 9-139).

Many of these stressors are a function of the timing, magnitude, and duration of freshwater flow in the Sacramento and San Joaquin rivers, upper tributaries, and estuary. Alleviating them to allow native fishes to persist in the watershed will likely necessitate additional changes to CVP/SWP (including dams) operations and species management. We encourage Reclamation to make full use of the iterative evaluation and adjustment processes outlined in the BOs to further improve conditions in those waters.

EPA 5

We appreciate the opportunity to review and comment on this DEIS, and are available to discuss the recommendations provided. When the FEIS is released for public review, please send one hard copy and one CD to the address above (Mail Code: ENF 4-2). Should you have any questions, please contact me at (415) 972-3873, or contact Jean Prijatel, the lead reviewer for the project. Jean can be reached at (415) 947-4167 or prijatel.jean@epa.gov.

Sincerely,

Kathleen H. Johnson, Director
Enforcement Division

Enclosures:	Summary of EPA Rating Definitions EPA Detailed Comments
cc:	Kim S. Turner, U.S. Fish and Wildlife Service, Bay-Delta Office Garwin Yip, National Oceanic and Atmospheric Administration, West Coast Region

SUMMARY OF EPA RATING DEFINITIONS*

This rating system was developed as a means to summarize the U.S. Environmental Protection Agency's (EPA) level of concern with a proposed action. The ratings are a combination of alphabetical categories for evaluation of the environmental impacts of the proposal and numerical categories for evaluation of the adequacy of the Environmental Impact Statement (EIS).

ENVIRONMENTAL IMPACT OF THE ACTION

"LO" (Lack of Objections)

The EPA review has not identified any potential environmental impacts requiring substantive changes to the proposal. The review may have disclosed opportunities for application of mitigation measures that could be accomplished with no more than minor changes to the proposal.

"EC" (Environmental Concerns)

The EPA review has identified environmental impacts that should be avoided in order to fully protect the environment. Corrective measures may require changes to the preferred alternative or application of mitigation measures that can reduce the environmental impact. EPA would like to work with the lead agency to reduce these impacts.

"EO" (Environmental Objections)

The EPA review has identified significant environmental impacts that should be avoided in order to provide adequate protection for the environment. Corrective measures may require substantial changes to the preferred alternative or consideration of some other project alternative (including the no action alternative or a new alternative). EPA intends to work with the lead agency to reduce these impacts.

"EU" (Environmentally Unsatisfactory)

The EPA review has identified adverse environmental impacts that are of sufficient magnitude that they are unsatisfactory from the standpoint of public health or welfare or environmental quality. EPA intends to work with the lead agency to reduce these impacts. If the potentially unsatisfactory impacts are not corrected at the final EIS stage, this proposal will be recommended for referral to the Council on Environmental Quality (CEQ).

ADEQUACY OF THE IMPACT STATEMENT

"Category 1" (Adequate)

EPA believes the draft EIS adequately sets forth the environmental impact(s) of the preferred alternative and those of the alternatives reasonably available to the project or action. No further analysis or data collection is necessary, but the reviewer may suggest the addition of clarifying language or information.

"Category 2" (Insufficient Information)

The draft EIS does not contain sufficient information for EPA to fully assess environmental impacts that should be avoided in order to fully protect the environment, or the EPA reviewer has identified new reasonably available alternatives that are within the spectrum of alternatives analysed in the draft EIS, which could reduce the environmental impacts of the action. The identified additional information, data, analyses, or discussion should be included in the final EIS.

"Category 3" (Inadequate)

EPA does not believe that the draft EIS adequately assesses potentially significant environmental impacts of the action, or the EPA reviewer has identified new, reasonably available alternatives that are outside of the spectrum of alternatives analysed in the draft EIS, which should be analysed in order to reduce the potentially significant environmental impacts. EPA believes that the identified additional information, data, analyses, or discussions are of such a magnitude that they should have full public review at a draft stage. EPA does not believe that the draft EIS is adequate for the purposes of the NEPA and/or Section 309 review, and thus should be formally revised and made available for public comment in a supplemental or revised draft EIS. On the basis of the potential significant impacts involved, this proposal could be a candidate for referral to the CEQ.

*From EPA Manual 1640, Policy and Procedures for the Review of Federal Actions Impacting the Environment.

1

U.S. EPA DETAILED COMMENTS ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR COORDINATED LONG-TERM OPERATION OF THE CENTRAL VALLEY PROJECT AND STATE WATER PROJECT, MULTIPLE COUNTIES, CA SEPTEMBER 29, 2015

Aquatic Resources

EPA 6

In 2009, several federal agencies, including Reclamation and EPA, declared that the Sacramento-San Joaquin River Delta ecosystem, part of the larger San Francisco estuary, was in a state of collapse.[1] This declaration was made after several years of sharp population declines in four resident fishes, commonly referred to as the pelagic organism decline (POD), followed by sharp drops in Chinook salmon abundance. Two of the POD fishes were already rare while the other two were formerly the most abundant fishes in the estuary. Low Chinook salmon populations resulted in a multi-year closing of commercial and recreational fishing.

Populations of all the species covered by the 2008 Fish and Wildlife Service and 2009 National Marine Fisheries Service Biological Opinions (BOs), as well as several non-listed resident and migratory fishes, have continued to decline since the BOs were finalized. For example, the 2015 summer townet survey for Delta smelt recorded a zero juvenile Delta smelt abundance index.[2]

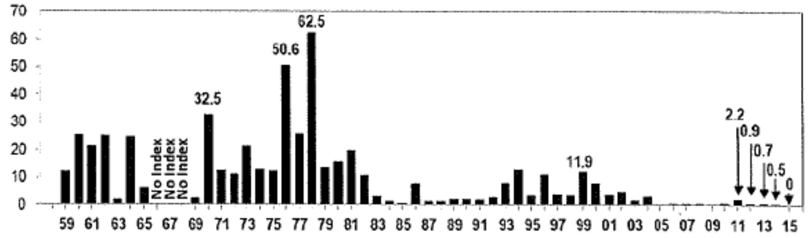


Figure 1. Summer Townet Survey Age-0 Delta Smelt Abundance Indices, 1959-2014

The continued decline of resident and migratory fish populations suggests that the suite of Reasonable and Prudent Alternatives implemented to date, plus commitments[1] to improve protection for aquatic habitat in the San Francisco estuary watershed, have not yet been successful in protecting aquatic habitat, reversing population declines, actually avoiding jeopardy, and/or improving aquatic life beneficial use protection. The pace and severity of the decline highlight the urgent need to move forward with full implementation of the RPAs and, perhaps, additional measures in an adaptive management context to ensure their effectiveness. Alternatives 1, 2, 3 and 4 would discontinue implementation, or would only selectively implement, the Reasonable and Prudent Alternative (RPA) actions identified in the BOs, which are designed to improve riverine and estuarine aquatic habitat to avoid jeopardizing the existence of multiple threatened and endangered species. The DEIS fish analysis for Delta smelt and longfin smelt show that Alternatives 1, 3 and 4 would result in adverse impacts to these species relative to the No Action Alternative. Discontinuation of RPA actions is likely to also negatively impact non-listed fishes that benefit from improved aquatic habitat conditions the RPAs provide. Full

EPA 7

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[1] California Bay-Delta MOU (http://www2.epa.gov/sites/production/files/documents/baydeltamousigned.pdf); Interim Federal Action Plan (https://www.doi.gov/sites/doi.gov/files/migrated/news/doinews/upload/CAWaterWorkPlan.pdf)

[2] California Department of Fish and Wildlife Memorandum (June 26, 2015) to Scott Wilson from Felipa La Luz regarding 2015 Summer Townet Survey Age-0 Delta Smelt Abundance Index.

EPA 7 continued

implementation of the RPAs, as would occur under the No Action Alternative and Alternative 5, may minimize adverse effects of the CVP/SWP operations on fishes, but may not be sufficient to increase fish populations and improve aquatic life beneficial use protection in the estuary and upper watershed.

EPA 8

> ***Recommendations***: For the No Action Alternative and Alternative 5 in the FEIS, provide a timeline for implementation of the remaining measures in the RPAs and disclose any impacts that the timing of various measures may have on their effectiveness in avoiding jeopardy for subject species. Indicate how changing conditions in the study area would be incorporated into managing operations and implementation of the RPAs.

EPA 9

> For Alternatives 1, 2, 3, and 4 in the FEIS, provide a detailed description of proposed mitigation measures (page 9-421) that would reduce the anticipated adverse impacts to fish species, including implementing fish passage and coordinating operations between Reclamation, Department of Water Resources, FWS, and NMFS.

EPA 10

The DEIS fish impact analysis presents many results that are contrary to the NMFS BO. Alternative 1 describes the project area without the RPAs, and the No Action Alternative (NAA) assumes full implementation of the RPAs. These two alternatives are the most divergent of the 6 alternatives considered; however, the DEIS analysis often concludes that there is little difference between impacts to fish species between Alternative 1 and the NAA. Some fish analyses in the DEIS even suggest that implementing the BO RPAs in the NAA would have slightly greater adverse impacts than not implementing the BO RPAs in Alternative 1. These conclusions are inconsistent with the conclusions in the BOs and the intent of the RPAs.

EPA 11

Conclusions of no difference among alternatives in the DEIS' fish analysis rely on analytical tools that are not precise enough to identify such differences, specifically with regard to water temperature. Temperature is an important aquatic habitat element that is a driver of early life stage survival for fish species addressed in the BOs. Temperature criteria for protecting fish are often based on a daily or weekly averaging period; however, available temperature and flow models, including those relied upon for the DEIS' fish analysis, are currently limited to using a monthly time step (page 9-109). Monthly temperature averages mask the biologically meaningful differences among alternatives. For example, a temperature threshold of 56 degrees as a daily average is identified as protective of spawning and egg incubation for several salmonid species; however, the temperature analysis estimates a monthly temperature average, which could include many days that exceed 56 degrees by many degrees. Thus, reliance on monthly averages in the DEIS obscures the daily temperature differences among alternatives. Temperature analyses will not be useful for distinguishing among alternatives until daily temperature and flow models are built and validated using daily observations.

EPA 12

The DEIS analysis of impacts to striped bass and American shad is based solely on water temperature; however, changes in salinity gradient impacts, as approximated by Delta outflow or X2, are correlated with striped bass abundance and should be included in the analysis.

EPA 13

> ***Recommendations***: In the FEIS, include a discussion about the limitations of the available models and analytical tools in making distinctions between impacts to fish species among the alternatives, particularly with regard to monthly average temperatures. Revise conclusions about the differences, or lack thereof, in impacts to fish species among the alternatives accordingly.

EPA 14

> Include a discussion of salinity gradient in the impact analysis for striped bass and American shad.

Water Quality Impacts

EPA 15 The water quality discussion in the DEIS includes a description of constituents of concern, water quality standards, and designated beneficial uses in the study area, but does not include a quantitative water quality analysis that is compared to all water quality standards and objectives described. EPA notes that there are many quantitative and qualitative water quality standards that apply to CVP/SWP operations, as described in the Water Boards' Basin Plans and Water Rights Decision 1641. We also observe that no key is provided for Table 6.2 Designated Beneficial Uses within Project Study Area (page 6-12). We have assumed that "E" signifies *existing* and "P" signifies *potential*.

> EPA 16 ***Recommendation***: In the FEIS, discuss how each alternative would affect water quality with respect to narrative and numeric water quality objectives, highlight any predictions of exceeded water quality standards, and identify mitigation strategies that would prevent such exceedances.

EPA 17 The DEIS discusses how droughts are incorporated into the CalSim model for water supply and quality impact analysis, and acknowledges that drought can and has altered hydrology in the Delta (page 9-139); however, contingency procedures for severe droughts are not discussed in the document. In our existing drought conditions, multiple water quality objectives have not been met for the last two years, resulting in a substantial impact on aquatic life beneficial uses throughout the study area.[3]

> ***Recommendations***: In the FEIS, discuss the need to develop drought contingency procedures that protect aquatic life beneficial uses, including the protection of ESA listed species, during drought conditions. Provide a description of the adjustments to the RPAs made during the current drought conditions and report their impacts on covered fishes. EPA recommends that Reclamation commit to include in its ongoing monitoring and reporting program any deviations from the RPAs for drought conditions.

X2

EPA 18 EPA appreciates that the DEIS includes a year-round X2 (2 parts per thousand salinity isohaline) analysis to evaluate Delta outflow, changes to estuarine habitat, and migration conditions. The DEIS does not, however, include an interpretation of the results with respect to aquatic life beneficial use protection, other than to note that the location of X2 is important for aquatic life and water supply beneficial uses (page 6-17). More recently than the 2008 and 2009 BOs, multiple scientific panels have identified the need for more freshwater outflow, signified by a lower X2 position, in the estuary to reverse the decline of several resident and migratory fish.[4] This recommendation is based largely on the

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[3] California Department of Fish and Wildlife Memorandum (June 26, 2015) to Scott Wilson from Felipa La Luz regarding 2015 Summer Townet Survey Age-0 Delta Smelt Abundance Index; California Department of Fish and Wildlife Fall Midwater Trawl Indices for Select Fish http://www.dfg.ca.gov/delta/data/fmwt/indices.asp; 95% mortality of 2014 winter-run Chinook salmon juveniles as estimated in NMFS 2015 Juvenile Production Estimate http://www.westcoast.fisheries.noaa.gov/publications/Central_Valley/Water%20Operations/20150116_nmfs_winter-run_juvenile_production_estimate_nr.pdf.

[4] This broad scientific agreement is illustrated in the following reports:
(a) Public Policy Institute of California (2013) Scientist and Stakeholder Views on the Delta Ecosystem "a strong majority of scientists prioritizes habitat and flow management actions that would restore more natural processes within and upstream of the delta" (p. 2). http://www.ppic.org/content/pubs/report/R_413EHR.pdf
(b) State Water Resources Control Board (2010) Development of Flow Criteria for the Sacramento-San Joaquin Delta Ecosystem Flows Report, p.7. "Both flow improvements and habitat restoration are essential to protecting public trust resources [defined as "native and valued resident and migratory species habitats and ecosystem processes" p. 10].
(c) National Academy of Sciences Natural Resource Council Committee on Sustainable Water Management in California's Bay-Delta (2012) Report: Sustainable Water and Environmental Management in California's Bay-Delta "…sufficient

EPA 18 continued

X2-abundance correlations, regardless of the mechanistic knowledge gap.[5] The State Water Resources Control Board D-1641 provides criteria that require reservoir releases from CVP and SWP from February through June to protect aquatic life in the western Delta. The FWS BO includes an additional salinity requirement for September and October in wet and above normal water years. Alternative 5 in the DEIS provides for additional flows in April and May in all water year types beyond those provided in SWRCB D-1641 and the FWS BO.

As an editorial note, the X2 analysis is referenced to the wrong appendix in Chapter 6 of the DEIS (page 6-86).

> ***Recommendations***: In the FEIS, include a discussion of the impacts of Delta outflow, as documented by X2 location, on aquatic life beneficial uses, utilizing the references provided above and including relative impacts from each of the alternatives. Update the text to reflect that the X2 tables are in Appendix 5A, Section C, not appendix 6E as stated in DEIS Chapter 6.

Selenium

EPA 19

EPA is in the process of updating its national recommended chronic aquatic life criterion for selenium in freshwater and revising selenium water quality criteria for San Francisco Bay to reflect the latest scientific information, which indicates that toxicity to aquatic life is driven by dietary exposures. These criteria may be lower than the threshold used in comparison in the DEIS.

The selenium water quality analysis in the DEIS concludes that there would be minimal difference in estimated selenium water column and fish tissue concentrations among the project alternatives. However, average selenium concentrations in sturgeon tissue for all alternatives are near to or slightly exceed the low toxicity 5 mg/kg threshold established by Presser and Luoma[6] (see Table 6D.17 Summary of Annual Average Selenium Concentrations in Whole-body Sturgeon). FWS also uses a lower threshold of 4 mg/kg for sensitive species such as sturgeon and salmon.[7] This suggests that all alternatives have the potential to adversely impact fish tissue concentrations by establishing conditions that enhance selenium exposure and uptake in sensitive species such as sturgeon.

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reductions in outflow due to diversions would tend to reduce the abundance of these organisms ["these organisms" = 8 Bay Delta aquatic species at various trophic levels]." Page 60 and "Thus, it appears that if the goal is to sustain an ecosystem that resembles the one that appeared to be functional up to the 1986-93 drought, exports of all types will necessarily need to be limited in dry years, to some fraction of unimpaired flows that remains to be determined." Page 105

(d) California Department of Fish and Wildlife (2010) Quantifiable Biological Objectives and Flow Criteria "...current Delta water flows for environmental resources are not adequate to maintain, recover, or restore the functions and processes that support native Delta fish." Page 1 in Executive Summary

[5] National Academy of Sciences Natural Resource Council Committee on Sustainable Water Management in California's Bay Delta (2012) Report: Sustainable Water and Environmental Management in California's Bay-Delta "*...this implies that sufficient reductions in outflow due to diversions would tend to reduce the abundance of these organisms*." Page 60 and "*Thus, it appears that if the goal is to sustain an ecosystem that resembles the one that appeared to be functional up to the 1986-93 drought, exports of all types will necessarily need to be limited in dry years, to some fraction of unimpaired flows that remains to be determined*." Page 105

[6] Toxicity thresholds are those reported in Presser and Luoma (2013) Low = 5 mg/kg, dw and High = 8 mg/kg, dw. Presser (2010) Ecosystem-scale Selenium Modeling in Support of Fish and Wildlife Criteria Development for the San Francisco Bay-Delta Estuary, California. Administrative Report December. Reston, Virginia: U.S. Geological Survey; Ecosystem-scale Selenium Model for the San Francisco Bay-Delta Regional Ecosystem Restoration Implementation Plan. San Francisco Estuary and Watershed Science 11(1):1-39. http://www.escholarship.org/uc/item/2td0b99t

[7] lower FWS threshold of 4mg/kg dw in Lemly, A.D. 1996. Selenium in aquatic systems. In: W.N. Beyer, G.H. Heinz and A.W. Redmon-Norwood, eds., Environmental contaminants in Wildlife: Interpreting tissues concentrations. CRC Press, Lewis Publishers, Boca Raton, Florida. p. 427-445.

EPA 19 continued

The CVP supplies irrigation water for agricultural lands that discharge irrigation return water with high concentrations of selenium. A pending prohibition to discharge in 2019 will take effect if selenium loads from some of these lands are not sufficiently reduced to protect aquatic life and meet selenium standards in the San Joaquin River.[8] We encourage Reclamation to work with its CVP partners to improve selenium source control and reduce fish impacts in the Delta and San Francisco Bay.

> ***Recommendation***: In the FEIS, identify measures that could reduce the selenium load coming into the San Joaquin River from agricultural lands through source control, such as meeting or exceeding the selenium load reductions outlined in the 2009 Agreement for the Continued Use of the San Luis Drain (Appendix C).[9]

Mercury

EPA 20

EPA agrees that restoring wetlands and floodplains in and near the Delta is an essential component of reviving the Estuary's health; however, nearly all the locations targeted for habitat restoration in the Delta have been, or are at risk of being, contaminated with mercury from historical mining sources and ongoing air deposition from industry. Sport fish in the Delta are already burdened with higher concentrations of mercury than anywhere else in the State[10] and the presence of this powerful neurotoxin in the food web poses a threat to public health and the ecosystem as a whole. For this reason, health advisories have been issued for the Delta and several upstream rivers.

The NMFS BO requires floodplain restoration in the lower Sacramento River Watershed. The DIES identifies the Yolo Bypass as a restoration area with high potential to improve juvenile salmonid survival to the ocean by restoring access to, and improving, rearing habitat that has substantial food resources and is safe from predators, relative to the mainstem Sacramento River. The Bay Delta Conservation Plan DEIS, however, says that the Yolo Bypass may contribute up to 40% of the total methylmercury production in the entire Sacramento watershed (p. 25-63). The State Water Board has also observed that, when the Yolo Bypass is flooded, it becomes the dominant source of methylmercury to the Delta, and that restoration activities could exacerbate the existing mercury problem.[11] The current DEIS discloses that, for all alternatives, values for mercury concentrations in largemouth bass throughout the study area "exceed the threshold of 0.24 milligram/ kilogram wet weight (mg/kg ww) for mercury" (page 6-86).

EPA strongly supports restoration of aquatic habitat in the Delta, however caution must be exercised to ensure that it does not result in unintended consequences that adversely affect water quality. Minimizing the formation and mobilization of methylmercury in wetlands is critical.

> ***Recommendation:*** In the FEIS, explain how habitat restoration locations and methods will be selected to avoid methylmercury production that cannot otherwise be reduced or mitigated.

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[8] California Central Valley Water Board (2010) Resolution R5-2010-0046 Amendment to the Water Quality Control Plan for the Sacramento and San Joaquin River Basins for the control of Selenium in the Lower San Joaquin River Basin, Attachment A, p. 1 http://www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/resolutions/r5-2010-0046_res.pdf

[9] http://www.waterboards.ca.gov/centralvalley/water_issues/grassland_bypass/gbp_2010_2019_use_agree.pdf

[10] SWAMP- Surface Water Ambient Monitoring Program http://www.waterboards.ca.gov/water_issues/programs/swamp/rivers_study.shtml

[11] Alpers, C.N., Fleck, J.A., Marvin-DiPasquale, M., Stricker, C.A., Stephenson, M., and Taylor, H.E., Mercury cycling in agricultural and managed wetlands, Yolo Bypass, California: Spatial and seasonal variations in water quality: Science of The Total Environment, Volume 484, 15 June 2014, Pages 276–287 http://dx.doi.org/10.1016/j.scitotenv.2013.10.096; Ackerman, J. "Agricultural Wetlands as Potential Hotspots for mercury bioaccumulation: experimental evidence using caged fish" Environmental Science and Technology 2010, 44, 1451-1457. Draft Bay Delta Conservation Plan DEIS http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/periodic_review/docs/periodicreview2009.pdf

Pesticides

The discussion of "Other pesticides" (page 6-24) in the DEIS does not include pyrethroid pesticides. They are mentioned briefly in "other sources of toxicity" in the Sacramento River Region description of existing conditions/existing environment; however this is insufficient discussion of this group of pesticides as water quality stressors. EPA 21

> ***Recommendation***: In the FEIS, include a description of pyrethroid pesticides, their sources, and their role as water quality stressors in the study area.

Mitigation Measures

The DEIS provides a very brief description of mitigation measures for each of the action alternatives, particularly in the water quality, aquatic resources, and terrestrial resources chapters. Mitigation for Alternatives 1, 2, 3, and 4 would include provisions that appear similar to the No Action Alternative and the BOs (aquatic resources page 9-421; water quality page 6-118; terrestrial biological resource page 10-89), including fish passage and coordinating operations with FWS, NMFS, and the Department of Water Resources. The mitigation measures are not well described, their expected effectiveness is not disclosed, and they are not identified as commitments. EPA 22

> ***Recommendation***: In the FEIS, further define the mitigation measures and explain how those for Alternatives 1, 2, 3, and 4 are similar to or different from the No Action Alternative and BOs. Provide an analysis of the measures' predicted effectiveness in mitigating impacts from the Alternatives.

Climate Change

EPA appreciates the consideration that the DEIS gives to the impacts that climate change will have on the operations of the CVP/SWP. The DEIS explains that the project's study period only extends to 2030 because climate change, sea level rise, and other factors will likely impact operations in that timeframe and will necessitate new consultations with FWS and NMFS (page 1-12). The FWS and NMFS BOs and RPAs include fish passage at several dams, and the DEIS acknowledges that improving passage to provide access to additional cold water habitat will be particularly important, considering anticipated climate change scenarios (page 9-117). EPA 23

The DEIS references the California Climate Change Portal 2007 as the source for potential effects of a warming climate in California and references the climate change analysis conducted for the Bay Delta Conservation Plan DEIS for its modeling. The current DEIS briefly summarizes climate change impacts at several points in the document, but does not provide a summary of the climate change and sea level rise assumptions in the discussion of any of the alternatives. While much of this information is available in appendices, the descriptions of alternatives in Chapter 3 would benefit from a discussion of the assumed changes to snow pack, seasonal flows, and sea level.

On December 24, 2014, the Council on Environmental Quality released revised draft guidance for public comment that describes how federal departments and agencies should consider the effects of greenhouse gas emissions and climate change in their NEPA reviews.[12] The revised draft guidance supersedes the draft greenhouse gas and climate change guidance released by CEQ in February 2010. The new draft guidance explains that agencies should consider both the potential effects of a proposed action on climate change, as indicated by its estimated greenhouse gas emissions, and the implications of climate EPA 24

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[12] www.whitehouse.gov/sites/default/files/docs/nepa_revised_draft_ghg_guidance_searchable.pdf

EPA 24 continued

change for the environmental effects of a proposed action. Neither the 2010 nor the 2014 guidance are included in the regulatory framework section of the DEIS.

> ***Recommendations***: In the FEIS, we recommend including a summary discussion of climate change assumptions for each alternative. We also recommend adding a description of CEQ's draft guidance for greenhouse gas emissions and climate change impacts to the regulatory requirements section of the FEIS. EPA recommends that Reclamation enhance its consideration of future climate scenarios by including a review the U.S. Global Change Research Program[13] assessments to assist with identification of potential project impacts that may be exacerbated by climate change and to inform consideration of measures to adapt to climate change impacts.

EPA 25

Groundwater

The DEIS describes beneficial impacts on groundwater resources under Alternatives 1, 3, and 4 because they would provide more water deliveries than would the No Action Alternative (page 7-125-133). It states that increases in surface water supplies as a result of these alternatives would result in diminished use of groundwater; however, no documentation is provided to support this assumption.

The assumption that groundwater use would decrease with increased water deliveries under Alternatives 1, 3, and 4 is used to conclude that, under the other alternatives, including No Action, groundwater quality would diminish, overdrafts from groundwater basins would occur more frequently, and irreversible subsidence would occur. On the contrary, EPA believes it is reasonable to expect that provision of more water could result in more water being used, including as much groundwater as allowed, rather than in strict substitution of surface water for groundwater. Without management of groundwater resources, it is not clear that the pressure on groundwater resources would be diminished as a result of Alternatives 1, 3, and 4.

The DEIS discusses the California Sustainable Groundwater Management Act, which requires the formation of Groundwater Sustainability Plans by 2020 or 2022. Sustainable groundwater operations must be achieved within 20 years following completion of the plans. The DEIS analysis assumes that the groundwater users will have developed their plans by 2030, and may begin to plan, design, and build facilities and operations to achieve compliance with those plans; however, the analysis also assumes that the plans will not be implemented by the end of the study period, and does not account for reductions in groundwater use that will be associated with those plans (page 7-109).

> ***Recommendations:*** Explain the basis for the assumption that increases in surface water supplies would result in diminished use of groundwater. Discuss the likelihood and potential impacts of increased use of surface water supplies for aquifer storage and recovery.
>
> Consider development of a mitigation measure to address management of groundwater resources in the interim period before implementation of the Groundwater Sustainability Plans.

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[13] www.globalchange.gov/

1A.1.2.1 Responses to Comments from U.S. Environmental Protection Agency

EPA 1: Comment noted.

EPA 2: The Final EIS has been modified to address the comments from the U.S. Environmental Protection Agency (EPA), as described under comments EPA – 8, 9, 13, 14, 16 through 22, 25, and 28. The commenter's support is acknowledged for inclusion of the 2008 U.S. Fish and Wildlife Service (USFWS) and 2009 National Marine Fisheries Service (NMFS) biological opinions, including the Reasonable and Prudent Alternative (RPA), in the No Action Alternative and Alternative 5. USEPA's opposition to alternatives that do not include full implementation of the RPAs is acknowledged, including Alternatives 1, 2, 3, and 4.

EPA 3: This comment addresses mitigation measures related to water quality, aquatic resources, and water temperature impacts presented in the EIS. The discussion of mitigation measures in each of the applicable resource chapters has been expanded in the Final EIS.

Chapter 6: Surface Water Quality Mitigation Measures

Water quality conditions under the No Action Alternative are assumed to be compliant with State Water Quality Control Board existing water quality requirements and identified Total Maximum Daily Load criteria in the Year 2030 with climate change and sea level rise conditions. The results of the salinity modeling, as presented in Appendix 6E, Analysis of Delta Salinity Indicators, of the EIS, indicate that salinity would increase substantially under Alternatives 1, 3, and 4 as compared to the No Action Alternative. It should be noted that even though the models operate the CVP and SWP in accordance with salinity and other water quality requirements, operational decisions made with real-time monitoring data can account for many factors that cannot be simulated by the best available models used by Reclamation and DWR due to the uncertainty inherent in the models used for planning studies.

Under all alternatives, Reclamation and DWR would continue to monitor Delta water quality conditions and adjust operations of the CVP and SWP in real-time as necessary to meet water quality objectives. However, considering real-time changes in surface water flows, discharges from point and non-point sources to surface waters, and continuous CVP and SWP operational decisions it is likely that water quality degradation could occur (as projected in the EIS water quality models) that may not be addressed through real-time operations. In those instances, mitigations measures could be considered to reduce the incremental adverse changes in water quality attributable to implementation of the alternatives as compared to the No Action Alternative. Mitigation measures related to salinity and other water quality constituents would include increased salinity monitoring in time and location, use of the additional monitoring data with updated short-term models to improve salinity forecasts, and development of related operational relationships that would modify real-time CVP and SWP operations (within Reclamation's discretion under federal and state agency requirements, including

California water right permits) based on short-term projected changes in Delta hydrodynamic conditions.

Chapter 9: Fish and Aquatic Resources

The results of the temperature modeling, as presented in Appendix 6B, Surface Water Temperature Modeling, of the EIS, indicate that high water temperatures downstream of CVP reservoirs would cause adverse impacts to fisheries during some lifestages, as described in Chapter 9, Fish and Aquatic Resources under the No Action Alternative and Alternatives 1 through 5. It should be noted that even though the models operate the CVP and SWP in accordance with temperature requirements, operational decisions made with real-time monitoring data account for many factors that cannot be simulated by the best available models used by Reclamation and DWR due to uncertainty inherent in the models used for planning studies. In addition, the No Action Alternative and Alternative 5 include fish passage programs around the CVP dams to reduce the effects of these high temperatures. Therefore, the adverse effects of high temperatures under Alternatives 1 through 4, which do not include fish passage, would be greater than under the No Action Alternative. Mitigation measures related to high temperatures would include increased water temperature monitoring in time and location, use of the additional monitoring data with updated short-term models to improve temperature forecasts, and development of related operational relationships that would modify real-time CVP and SWP operations (within Reclamation's discretion under federal and state agency requirements, including California water right permits) based on short-term projected changes in surface water temperatures downstream of CVP reservoirs. Mitigation measures also could include implementation of fish passage programs, as described in the No Action Alternative and Alternative 5.

EPA 4: Reclamation has and will continue to participate in the on-going process of working with the USFWS, NMFS, and other agencies to develop and implement real-time actions based upon real-time monitoring data to address identified challenges for threatened and endangered fish species, as described in the BOs and other regulatory requirements issued by state agencies, such as State Water Resources Control Board.

EPA 5: Comment noted.

EPA 6: It is acknowledged that the condition of aquatic resources has deteriorated over the past 7 years and it is likely that the current drought in California has undoubtedly resulted in profound effects on aquatic resources, especially on those species with already declining populations. Both the drought and the resultant management actions have contributed to this condition. A brief discussion of the current drought has been added to Section 9.3 of Chapter 9, Fish and Aquatic Resources.

EPA 7: The 2008 USFWS BO and the 2009 NMFS BO considered if the coordinated long-term operation of the CVP and SWP would jeopardize the continued existence of the listed species (as analyzed in this EIS); or adversely modify critical habitat associated with these species. The RPAs contained in the

BOs provide actions to modify the operations in order to avoid jeopardy of listed species or adverse modifications or destruction of critical habitat. As noted in the comment the RPA may not be sufficient to increase fish populations and improve aquatic life beneficial use protection in the estuary and upper watershed beyond the ESA Section 7(a)(2) threshold.

The Purpose and Need for this EIS (see Chapter 2, Purpose and Need) did not include the objective of increasing fish populations or improving aquatic life beneficial use protection; therefore, this concept was not included in the development of the alternatives.

EPA 8: The latest status for the 2009 NMFS BO RPA actions is presented in the RPA Summary Matrix of the NMFS Long-term Operations BiOp RPA that can be found on the Delta Science Program website at http:/www.deltacouncil.ca.gov/science-program-event-products (dated October 13, 2014). Reporting requirements for the 2008 USFWS RPA actions are addressed in the Smelt Working Group Annual Report, also available at the aforementioned website. Please refer to these documents for the status of the RPA actions.

EPA 9: As described in response to Comment EPA 3, the final EIS includes additional details in the description of the mitigation measures in each resource chapter that includes mitigation measures.

EPA 10: The presentation of the results of the qualitative analyses and the integrated results of the quantitative and qualitative results have been modified to provide more clarity in the Final EIS. Presentation of an alternative analytical approach to consider effects on sturgeon also have been included in the Final EIS.

EPA 11: The 2009 NMFS BO recommendations is for real-time operations. The same level of temporal analysis cannot be captured in an impact analysis study. The Draft EIS uses average monthly temperatures to provide a comparison on ability of operations considered under alternatives to meet temperature objectives for species. As described in Section 5A.A.3.6, temperature modeling is subsequent to CalSim II modeling that simulates operations on a monthly basis. As mentioned in Section 5A.A.3.5, regarding CalSim II model results and model results interpretations dependent on CalSim II, there are certain components in the model that are downscaled to daily time step (simulated or approximated hydrology) such as an air-temperature-based trigger for a fisheries action, the results of those daily conditions are always averaged to a monthly time step (for example, a certain number of days with and without the action is calculated and the monthly result is calculated using a day-weighted average based on the total number of days in that month), and operational decisions based on those components are made on a monthly basis. Therefore, reporting sub-monthly results from CalSim II or from any other subsequent model that uses monthly CalSim results as an input is not considered an appropriate use of model results.

It is acknowledged that temperature operations in real-time would be dependent on daily variations of meteorological conditions, reservoir operations, fish presence, and other external factors such as prolonged drought. It is unfortunately not possible to capture all of these on a daily basis in a model. Therefore, the Draft EIS uses model results in a comparative manner to provide a trend analysis rather than interpreting these results as absolute effects, which would be speculative. This level of detail is deemed appropriate for a NEPA analysis.

Changes in water temperature depend on upstream reservoir storage, monthly flow patterns, and the needs of species for each month and each life stage. Detailed discussion of such changes are provided in the EIS.

EPA 12: The comment is consistent with the impact analysis presented in Chapter 9, Fish and Aquatic Resources.

EPA 13: Due to the complexity of the methodologies for the different analytical tools and qualitative analyses, the extent of the analytical coverage with the limitations and uncertainties of each method are presented in Chapters 5 through 21 and in the appendices that provide the modeling methodologies (see Appendices 5A, 6B through 6E, 7A, 8A, 9C through 9O, 12A, and 19A through 19B).

EPA 14: The text has been modified in Section 9.4 of Chapter 9, Fish and Aquatic Resources, in the Final EIS to address the relationship of salinity gradients and abundance of Striped Bass and American Shad.

EPA 15: The water quality requirements specifically associated with CVP and SWP operations are included in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations, of the EIS. The Final EIS text in Sections 6.3.1.2 and 6.3.3.4 of Chapter 6, Surface Water Quality, have been modified to include references to Appendix 3A. The footnotes for Table 6.2 based upon the Regional Water Quality Control Board and State Water Resources Control Board references were inadvertently deleted in the Draft EIS, and have been included in the Final EIS.

EPA 16: As noted in the Appendix 5A Section B, all the alternatives are required to meet the SWRCB D-1641 water quality objectives. The CalSim II modeling of the Alternatives only includes a portion of the water quality objectives, namely: Emmaton, Jersey Point, Rock Slough and Collinsville. CalSim II adjusts SWP and CVP operations to comply with these specific D-1641 standards. CalSim II, however, is a model with a monthly time-step, whereas a number of SWRCB D-1641 standards are described in shorter time-steps. It relies on the ANN model to mirror DSM2 modeled flow-salinity relationships in the Delta. To refine CalSim II simulation results on a shorter time-step, and to account for other localized model assumptions (e.g. tide), the DSM2 model, which utilizes a 15 minute time-step and more Delta-specific assumptions, also is used.

DSM2 salinity results were compared to the SWRCB D-1641 objectives, and the results are presented in the Appendix 6E. In general, SWRCB D-1641 Delta salinity standards are met in all alternatives except for few dry and critical years where there is no stored fresh water available for release The differences in salinity between alternatives mostly point to results of other operations beyond meeting the SWRCB D-1641 salinity standards; such as whether or not reservoirs are releasing to meet 2008 USFWS BO Action 4 (Fall X2), Delta Cross Channel operations, or whether or not south Delta exports are allowed in a particular month. As a result, changes in salinity for each location in Delta shows wide month to month variation between alternatives. Please refer to Appendix 6E for detailed comparison of salinity between the alternatives, and comparison to the SWRCB D-1641 objectives.

The variation in the monthly time-step of CalSim II and 15-min time-step of DSM2 can create an unintended consequence of CalSim II correctly adjusting modeled reservoir releases and exports in order to maintain compliance over a monthly average, while DSM2 potentially reporting an exceedance over part of the month. Therefore, DSM2 results in these cases may be viewed as a system failure to meet SWRCB D-1641 standards. However, in these cases, this is a modeling anomaly.

It should be noted that many of the modeling results showing exceedance of SWRCB D-1641 standards reported in Appendix 6E are the result of the mismatch in modeling time-step, known shortcomings in the ANN model to mirror DSM2 modeled flow-salinity interaction, and/or CalSim II model's limited ability to simulate real-time operational adjustments to avoid exceedance of the objectives in shorter time-steps. Many of the exceedances reported could potentially be eliminated by fine-tuning the reservoir storage, flows and/or exports in real-time. DWR and USBR plan to meet the SWRCB D-1641 standards while operating SWP and CVP facilities and any changes to SWRCB D-1641, as adopted by the SWRCB. Actual operations are continuously adjusted to respond to reservoir storages, river flows, exports, in-Delta demands, tides, and other factors to insure compliance to regulatory requirements to the extent possible.

EPA 17: Droughts have occurred throughout California's history, and are constantly shaping and innovating the ways in which Reclamation and DWR balance both public health standards and urban and agricultural water demands while protecting the Delta ecosystem and its inhabitants. The most notable droughts in recent history are the droughts that occurred in 1977, 1982, and the ongoing drought. More details have been included in Section 5.3.3 of Chapter 5, Surface Water Resources and Water Supplies, in the Final EIS to describe historical and on-going actions by federal and state agencies, including Reclamation and DWR, in response to drought conditions. Reclamation continues to be committed preparation of drought contingency plans and procedures with its federal and state partners, and include ongoing monitoring and reporting actions, as part of its drought response actions.

EPA 18: The discussion of the relationship of Delta outflow and aquatic life conditions are presented in Section 9.4 of Chapter 9, Fish and Aquatic Resources.

The reference in Section 6.4.3.1.1 of Chapter 6, Surface Water Quality, has been modified to refer to Appendix 5A, Section C. Several similar modifications have also been completed in this chapter.

EPA 19: It is acknowledged that USFWS and some other entities use 4 mg/kg threshold per Lemly (1996) as a conservative benchmark for whole-body selenium concentrations to be protective for avoidance of reproductive effects in sensitive fish species; this benchmark was used in the EIS for evaluation of alternatives when comparing results for trophic level four (TL-4) fish such as salmonids based on the Delta-wide model. Both the 4 mg/kg threshold and the low-effects benchmark used for sturgeon (5 mg/kg threshold per Presser and Luoma 2013) are well below the whole-body criterion element of the freshwater ambient water quality criterion (AWQC) proposed by EPA (2015) as a protective concentration for fish (8 mg/kg whole body), including special-status species such as salmonids and green sturgeon. In addition, Chapter 5 (by DeForest and Adams 2011) in the updated edition of Environmental Contaminants in Biota: Interpreting Tissue Concentrations supports use of 8.1 mg/kg as a protective benchmark for reproductive effects. The analysis provided by EPA (2015) in Section 6.3 of the draft AWQC indicates the proposed criterion (8 mg/kg whole body) would be protective for juvenile salmonids as well as for reproductive effects.

Reclamation is actively engaged with the Grassland Area Farmers who discharge subsurface agricultural drainage waters through the Grassland Bypass Project, which is a significant source of selenium to the San Joaquin River and to the Delta. Reclamation and the Grassland Area Farmers are continuing to reduce the amount of agricultural drainage water produced in the Grassland Drainage Area, preventing the discharge of this water into local Grassland wetland water supply channels, and improving the quality of water in the San Joaquin River. The Grassland Bypass Project is based upon an agreement between Reclamation and the San Luis and Delta-Mendota Water Authority to use a 28-mile segment of the San Luis Drain to convey agricultural subsurface drainage water from the Grassland Drainage Area to Mud Slough (North), a tributary of the San Joaquin River. An extensive monitoring program (e.g., San Francisco Estuary Institute [SFEI] 2013) continues to document the effectiveness of actions such as source control and other measures being taken by the Grassland Area Farmers.

The FEIS will include a summary of the actions the Grassland Area Farmers have implemented toward reducing discharge of subsurface drainage waters to the San Joaquin River; these are described in Chapter 2 of SFEI 2013). These activities have included the Grassland Bypass Project and the San Joaquin River Improvement Project, formation of a regional drainage entity, newsletters and other communication with the farmers, a monitoring program, using State Revolving Fund loans for improved irrigation systems, installing and using drainage recycling systems to mix subsurface drainage water with irrigation supplies under strict limits, tiered water pricing and a tradable loads programs.

References

DeForest, D.K., and W.J. Adams. 2011. Selenium accumulation and toxicity in freshwater fishes. Pp. 193-229 In Beyer, W.N., and J.P. Meador (Eds.) *Environmental Contaminants in Biota: Interpreting Tissue Concentrations, Second Edition.* CRC Press.

U.S. Environmental Protection Agency (USEPA). 2015. *Draft Aquatic Life Ambient Water Quality Criterion for Selenium – Freshwater 2015*. Office of Water. EPA 822-P-15-001. July.

San Francisco Estuary Institute. November 2013. *Grassland Bypass Project Annual Report 2010-2011.*

EPA 20: The minimization and mitigation of restoration-related mercury methylation will be accomplished primarily through implementation of project-specific mercury management plans for each restoration project. Site-specific factors that determine methylation potential can be more accurately assessed, efforts can be coordinated with ongoing research, and the best approaches to restoration design and adaptive management can be implemented.

For each restoration project, a project-specific methylmercury management plan would be developed and would include a brief review of available information on levels of mercury expected in site sediments/soils based on proximity to sources and existing analytical data, a determination if sampling for characterization of mercury concentrations and/or post-restoration monitoring is warranted, a plan for conducting the sampling, if characterization sampling is recommended, and a determination of the potential for the restoration action to result in increased mercury methylation. If a potential for increased mercury methylation under the restoration action is identified, the plan will also include identification of any restoration design elements, mitigation measures, adaptive management measures that could be used to mitigate mercury methylation, and the probability of success of those measures including uncertainties, and conclusion on the resultant risk of increased mercury methylation, and if appropriate, consideration of alternative restoration areas.

EPA 21: The descriptions of pyrethroid pesticides are included in both Sections 6.3.1.7.3 and 6.3.3.1.1 of Chapter 6, Surface Water Quality of the EIS. These descriptions have been expanded and similar information was added to the affected environment description for the lower San Joaquin Valley in Section 6.3.3.2.1.

EPA 22: As described in response to Comment EPA 3, the final EIS includes additional details in the description of the mitigation measures in each resource chapter that includes mitigation measures.

EPA 23: Detailed information related to climate changes and sea level is presented in Appendix 5A, Section A, CalSim II and DSM2 Modeling. A summary of this information is included in Chapter 3, Description of Alternatives, of the Final EIS.

EPA 24: The Council on Environmental Quality's 2014 Draft Guidance on the consideration of the effects of climate change and greenhouse gas (GHG) emissions is included in Section 4A.1.20 of Appendix 4A, Federal and State Policies and Regulations, in the Draft EIS.

Estimation of changes in greenhouse gas (GHG) emissions are included in Chapter 16, Air Quality and Greenhouse Gas Emissions, of the EIS. As described in Section 16.4.2.1 of Chapter 16, the primary man-made processes that result in GHG emissions include burning of fossil fuels for transportation, heating and electricity generation, agricultural practices, and industrial practices. Additional information related to the effects of changes in GHG emissions on climate change, as included in Section 16.5.3 of Chapter 16 of the Final EIS, indicate that potential for GHG emissions and associated climate change would be similar under Alternatives 1 through 5 as compared to the No Action Alternative because the amount of land in agricultural production and municipal land uses would be similar under all of the alternatives. The amount of net electrical generation from CVP and SWP facilities would be similar or greater than under the No Action Alternative; therefore, the need for additional use of fossil fuels for electricity generation would be similar or less than under the No Action Alternative.

Section 16.4.2.3.1 of Chapter 16 in the Final EIS also includes a discussion of a review of findings from the U.S. Global Change Research Program National Climate Assessment related to potential changes in GHG emissions.

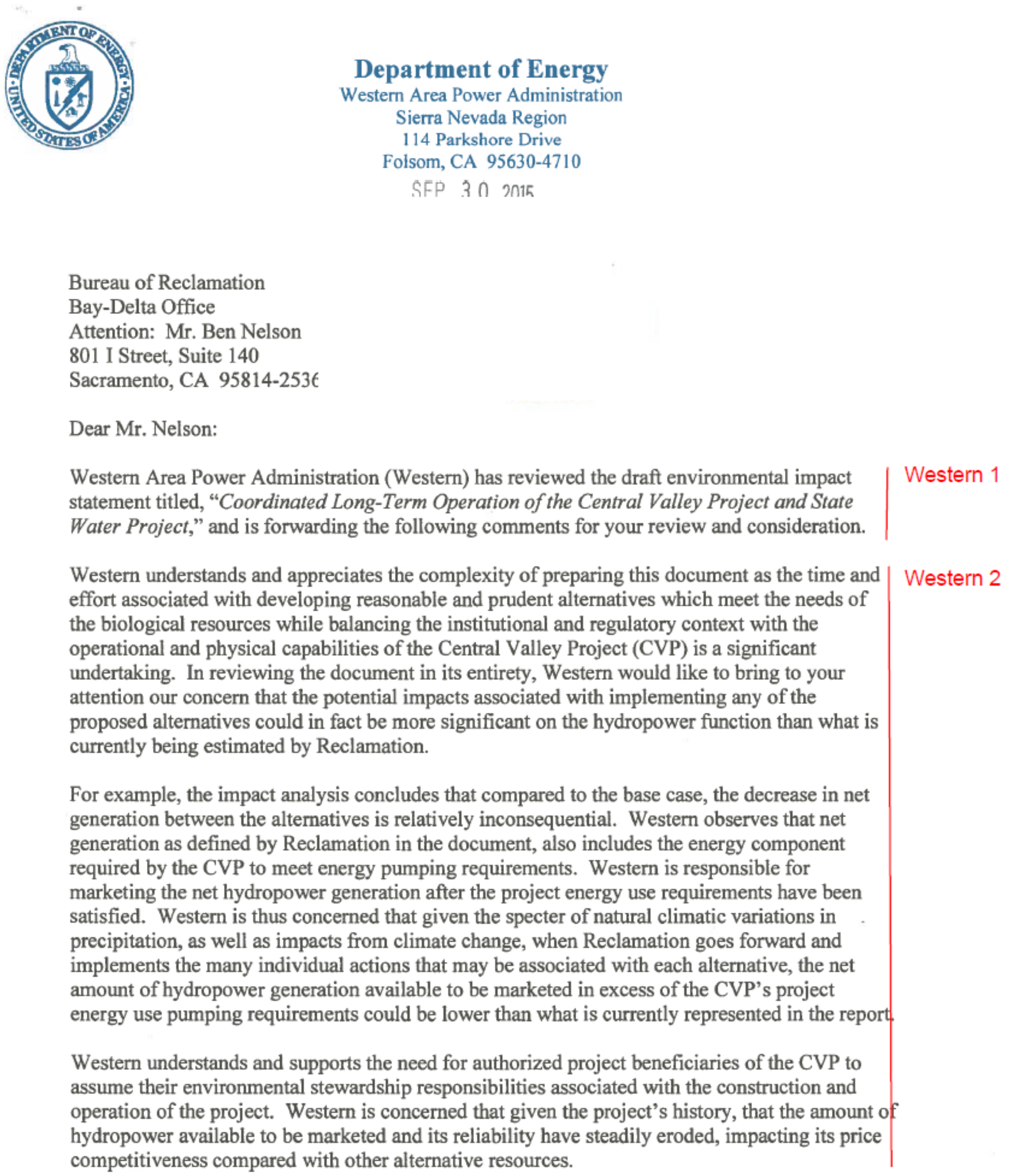
EPA 25: The analysis in the EIS assumes that water supplies and uses for non-CVP and non-SWP water users would be the same under the No Action Alternative, Second Basis of Comparison, and Alternatives 1 through 5. The analysis also assumes that projected land uses and population growth would occur as projected in the current land use plans for 2030; and would be the same under the No Action Alternative, Second Basis of Comparison, and Alternatives 1 through 5. Therefore, the surface water and groundwater supply analyses in the EIS focused on changes to users of CVP and SWP water supplies at the Year 2030. It is possible that water use by non-CVP and non-SWP water users could change in response to other factors, including water transfers or water uses not involving Reclamation or DWR.

Historically, as described in Section 12.3 of Chapter 12, Agricultural Resources, agricultural water users of CVP and SWP water supplies have prioritized use of surface water as compared to groundwater because of the increased cost of and generally poorer quality of groundwater as compared to water rights and CVP and SWP water supplies. As described in Section 7.3 of Chapter 7, Groundwater Resources and Groundwater Quality, when CVP and SWP water deliveries have increased in past years, groundwater elevations also have increased as agricultural water users reduce groundwater use.

Many of the municipal water users, especially SWP water users in southern California, operate their water supplies within adjudicated basins. Therefore, increased groundwater withdrawals would not necessarily be possible on a long-term basis in these areas; and other water supplies, such as recycle water, would be used.

No mitigation measures were included in the EIS for groundwater conditions because groundwater pumping would be similar or decrease and groundwater elevations would be similar or rise under Alternatives 1 through 5 as compared to the No Action Alternative. The Second Basis of Comparison does not comply with the definition of the No Action Alternative under the NEPA guidelines. Therefore, mitigation measures have not been considered for changes under Alternatives 1 through 5 and the No Action Alternative as compared to the Second Basis of Comparison. The EIS analysis was conducted with assumed conditions for Year 2030; and did not analyze sequential changes that could occur prior to 2030. However, it is assumed that changes between Alternatives 1 through 5 as compared to the No Action Alternative conditions that would occur between now and 2030 also would not result in long-term adverse impacts. Section 7.4.2 of the EIS does describe potential increased groundwater elevation declines as compared to the existing conditions. It is understood that in any one year with drought conditions, water users may make short-term choices that could involve more crop idling than increased use of groundwater. However, the analysis of water use in Chapters 5, 7, and 12 of the EIS represent long-term operation assumptions that would occur by 2030.

1A.1.3 Western Area Power Administration



Department of Energy
Western Area Power Administration
Sierra Nevada Region
114 Parkshore Drive
Folsom, CA 95630-4710

SEP 30 2015

Bureau of Reclamation
Bay-Delta Office
Attention: Mr. Ben Nelson
801 I Street, Suite 140
Sacramento, CA 95814-2536

Dear Mr. Nelson:

Western 1

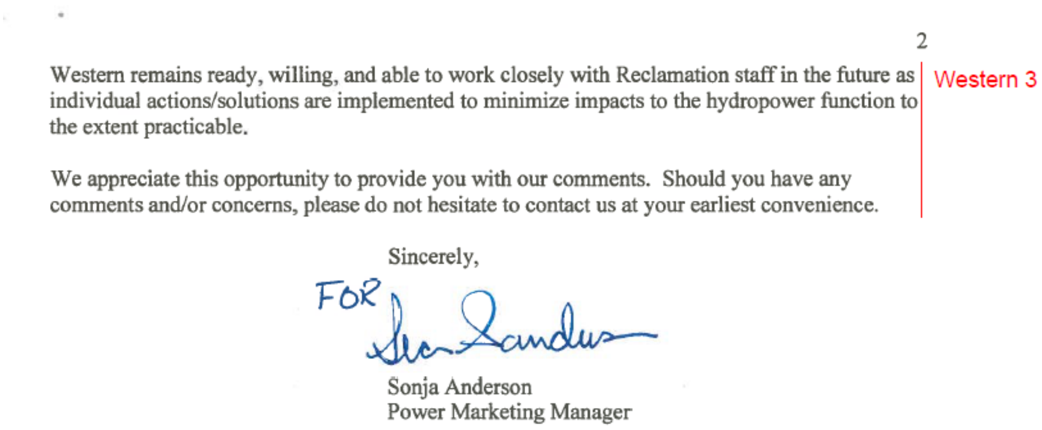
Western Area Power Administration (Western) has reviewed the draft environmental impact statement titled, "*Coordinated Long-Term Operation of the Central Valley Project and State Water Project*," and is forwarding the following comments for your review and consideration.

Western 2

Western understands and appreciates the complexity of preparing this document as the time and effort associated with developing reasonable and prudent alternatives which meet the needs of the biological resources while balancing the institutional and regulatory context with the operational and physical capabilities of the Central Valley Project (CVP) is a significant undertaking. In reviewing the document in its entirety, Western would like to bring to your attention our concern that the potential impacts associated with implementing any of the proposed alternatives could in fact be more significant on the hydropower function than what is currently being estimated by Reclamation.

For example, the impact analysis concludes that compared to the base case, the decrease in net generation between the alternatives is relatively inconsequential. Western observes that net generation as defined by Reclamation in the document, also includes the energy component required by the CVP to meet energy pumping requirements. Western is responsible for marketing the net hydropower generation after the project energy use requirements have been satisfied. Western is thus concerned that given the specter of natural climatic variations in precipitation, as well as impacts from climate change, when Reclamation goes forward and implements the many individual actions that may be associated with each alternative, the net amount of hydropower generation available to be marketed in excess of the CVP's project energy use pumping requirements could be lower than what is currently represented in the report.

Western understands and supports the need for authorized project beneficiaries of the CVP to assume their environmental stewardship responsibilities associated with the construction and operation of the project. Western is concerned that given the project's history, that the amount of hydropower available to be marketed and its reliability have steadily eroded, impacting its price competitiveness compared with other alternative resources.



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Western remains ready, willing, and able to work closely with Reclamation staff in the future as individual actions/solutions are implemented to minimize impacts to the hydropower function to the extent practicable.

We appreciate this opportunity to provide you with our comments. Should you have any comments and/or concerns, please do not hesitate to contact us at your earliest convenience.

Western 3

Sincerely,

FOR

Sonja Anderson
Power Marketing Manager

1A.1.3.1 Responses to Comments from Western Area Power Administration

Western 1: Comment noted.

Western 2: The EIS alternatives include consistent climate change conditions without consideration of potential regulatory or operational changes due to climate conditions in the future. Potential climate-related operational changes are currently unknown and it would be speculative to develop such assumptions for a NEPA analysis. Similarly, due to unique nature of each drought period, assuming a prescriptive “drought operation” would also be considered speculative. The Draft EIS acknowledges these uncertain conditions that cannot be quantitatively analyzed at this point; and attempts to qualitatively assess the effects of changes from current affected environment to conditions in 2030 in Section 8.4.2 of Chapter 8, Energy. The impact analysis compares conditions under the Alternatives 1 through 5 to the No Action Alternative; and under the No Action Alternative and Alternatives 1 through 5 to the Second Basis of Comparison. This comparative approach eliminates effects of future uncertainty that cannot be modeled because the uncertainty would occur under all compared alternatives.

Western 3: Comment noted.

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Appendix 1B

Comments from State Agencies and Responses

This section contains copies of comment letters from state agencies on the Draft Environmental Impact Statement (EIS) for the Coordinated Long-term Operation of the Central Valley Project (CVP) and State Water Project (SWP). Each comment in the comment letters was assigned a number, in sequential order. The numbers were combined with the agency name (example: CDFW 1). The comments with the associated responses are arranged alphabetically by agency name, and appear in the chapter in that order.

Copies of the comments are provided in Section 1B.1. Responses to each of the comments follow the comment letters, and are numbered in accordance with the numbers assigned in the letters. None of the comments from the state agencies included large attachments.

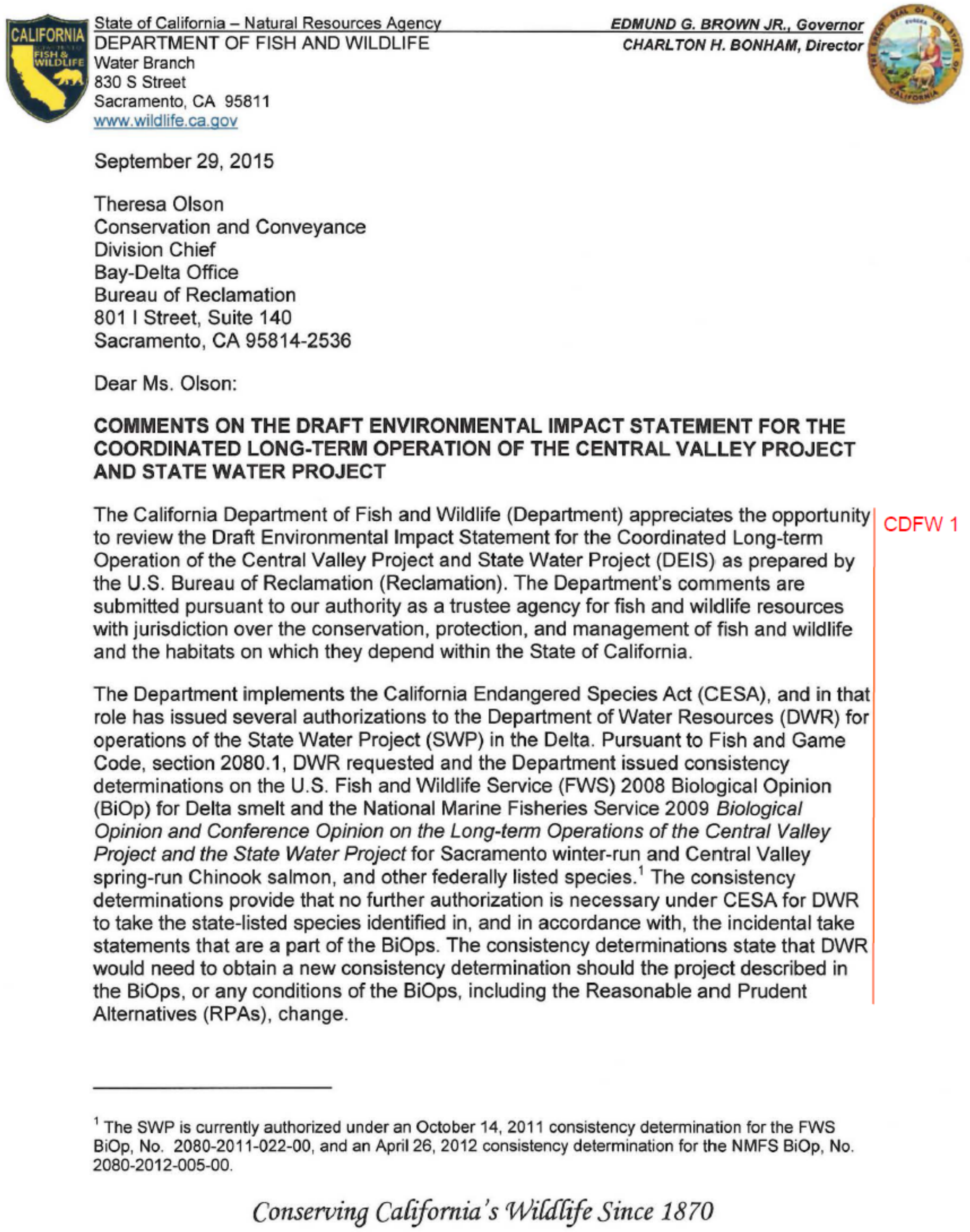
1B.1 Comments and Responses

The agencies listed in Table 1B.1 provided comments on the Draft EIS.

Table 1B.1 State Agencies Providing Comments on the Draft Environmental Impact Statement

Acronym	Commenter
CDFW	California Department of Fish and Wildlife
DSC	Delta Stewardship Council
DWR	California Department of Water Resources

1B.1.1 California Department of Fish and Wildlife



State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
Water Branch
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EDMUND G. BROWN JR., Governor
CHARLTON H. BONHAM, Director

September 29, 2015

Theresa Olson
Conservation and Conveyance
Division Chief
Bay-Delta Office
Bureau of Reclamation
801 I Street, Suite 140
Sacramento, CA 95814-2536

Dear Ms. Olson:

COMMENTS ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR THE COORDINATED LONG-TERM OPERATION OF THE CENTRAL VALLEY PROJECT AND STATE WATER PROJECT

CDFW 1

The California Department of Fish and Wildlife (Department) appreciates the opportunity to review the Draft Environmental Impact Statement for the Coordinated Long-term Operation of the Central Valley Project and State Water Project (DEIS) as prepared by the U.S. Bureau of Reclamation (Reclamation). The Department's comments are submitted pursuant to our authority as a trustee agency for fish and wildlife resources with jurisdiction over the conservation, protection, and management of fish and wildlife and the habitats on which they depend within the State of California.

The Department implements the California Endangered Species Act (CESA), and in that role has issued several authorizations to the Department of Water Resources (DWR) for operations of the State Water Project (SWP) in the Delta. Pursuant to Fish and Game Code, section 2080.1, DWR requested and the Department issued consistency determinations on the U.S. Fish and Wildlife Service (FWS) 2008 Biological Opinion (BiOp) for Delta smelt and the National Marine Fisheries Service 2009 *Biological Opinion and Conference Opinion on the Long-term Operations of the Central Valley Project and the State Water Project* for Sacramento winter-run and Central Valley spring-run Chinook salmon, and other federally listed species.[1] The consistency determinations provide that no further authorization is necessary under CESA for DWR to take the state-listed species identified in, and in accordance with, the incidental take statements that are a part of the BiOps. The consistency determinations state that DWR would need to obtain a new consistency determination should the project described in the BiOps, or any conditions of the BiOps, including the Reasonable and Prudent Alternatives (RPAs), change.

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[1] The SWP is currently authorized under an October 14, 2011 consistency determination for the FWS BiOp, No. 2080-2011-022-00, and an April 26, 2012 consistency determination for the NMFS BiOp, No. 2080-2012-005-00.

Conserving California's Wildlife Since 1870

CDFW 1 continued

In addition, pursuant to Fish and Game Code, section 2081, subdivision (b), in 2009 the Department issued DWR Incidental Take Permit (ITP) No. 2081-2009-001-03, authorizing take of CESA listed longfin smelt incidental to SWP Delta operations. Condition 4 of the ITP states that the ITP may require an amendment if there is any modification to the FWS BiOp.

Therefore, DWR's existing CESA authorizations would no longer be valid if Reclamation were to adopt any DEIS alternative that deviates from the No Action Alternative[2] (NAA). The Department's issuance of new or amended authorizations would require that the modified project meets CESA's standards, which include that all impacts of the authorized taking must be minimized and fully mitigated, and the project cannot jeopardize the continued existence of the species.

CDFW 2

The Department recognizes and commends the considerable time and effort the preparers put into developing the DEIS as evidenced by the extensive information and modeling results contained within the document. Due to the large size of the document and time constraints, the Department technical staff focused review on Chapter 3: Description of Alternatives, Chapter 4: Approach to Environmental Analyses, Chapter 5: Surface Water Resources and Water Supplies, Chapter 6: Surface Water Quality, Chapter 9: Fisheries and Aquatic Resources, and related appendices.

Based on the Department's limited review, our comments focus on the following general areas: policies, procedures, and regulations, environmental impact and effects analysis, dry year scenarios, and modeling. These general areas of concern inhibited the DEIS' ability to provide accurate and thorough review of project impacts and prevented meaningful comparisons between project alternatives. Please find more detailed comments below.

Policies, Procedures, and Regulations:

Trap and haul

CDFW 3

Alternatives 3 and 4 of the DEIS contain trap and haul programs that would capture fishes that are listed under CESA and federal Endangered Species Act (ESA) in areas of the eastern Delta, and barge those fishes to release sites in the San Francisco Bay. The document lacks a clear description of the trap and haul procedures, as well as clear analyses of the potential effects of these actions on the target listed species and non-target species, most importantly at the population level.

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[2] The NAA is described as the coordinated long-term operation of the CVP and SWP under the current management direction and intensity, including full implementation of the RPAs set forth in the modified FWS and NMFS BiOps.

1

There are limited studies available on the potential benefits to barging and there is much uncertainty on the effects to growth, survival, and stray rates of fish in addition to the mortality associated with handling and releasing these fish. Furthermore, trapping and barging listed species does not contribute to the Department's goal of providing improved habitat conditions for volitional passage. Trap and haul programs and barging are not part of the Department's routine operations and are only implemented under emergency conditions, such as drought, whereby natural, extreme conditions are likely to greatly reduce survival. Any translocation of fish would likely require state-level environmental review and permitting from the Department and would likely require Department staffing and resources for operations.

CDFW 3 continued

Fishing regulations, ocean harvest, and predator control programs

Alternatives 3 and 4 of the DEIS contain actions to change fishing regulations, ocean harvest, and implement predator control programs to reduce pressures on listed species. The Department has several concerns with the alternatives that contain these types of actions. First, the DEIS alternatives do not provide a clear description of the proposed control programs and regulatory changes, nor do they provide clear analyses of the potential effects of these actions on the target predators, non-target species, and the population level effects on listed species. Secondly, any fishing regulation proposal would require review and approval from the California Fish and Game Commission and potentially the Pacific Fisheries Management Council before implementation by the Department. Any alternatives that rely on regulatory changes outside of the authority of the project proponents to implement are uncertain to occur. Additionally, the effectiveness of predator control programs is highly uncertain and the population level effects on target predators are unknown. A key aspect of the Department's mission is to manage the state's fish and wildlife species for their use and enjoyment by the public; the analysis of any predator control program or changes in fishing regulations would need to clearly demonstrate that key recreational and commercial fisheries would remain viable.

CDFW 4

CDFW 5

As described at the Predation Workshop in 2013, there is significant uncertainty regarding the extent of predation pressures on Central Valley salmonids. Although there have been numerous studies on predation, the results are often conflicting, the population level effects are indeterminate, and the tagging technology is still insufficient to answer crucial remaining questions. Given this information, the Department acknowledges that predation is currently a challenge for some of the state's listed species. The Predation Workshop panel emphasized the effects of habitat conditions and ecosystem processes such as flow, temperature, water quality, and aquatic invasive species on predation rates and subsequent survival of listed species. These conditions also result in physiological stress and directly affect the condition of native fishes.

1

CDFW 5 continued

The DEIS alternatives that suggest actions to implement predator control programs fail to acknowledge that predation can provide a key ecological function in an ecosystem and that only excessive predatory pressure should be addressed through management actions. The DEIS does not provide a sufficient analysis of the effects of the habitat variables on predation rates and native fish condition and does not sufficiently analyze the effects of alternative operations on these biotic and abiotic variables that drive predator populations and ultimately listed species population abundances. Reducing predator populations through control programs or changes in fishing regulations does not address the underlying issue of poor environmental conditions driven in part by operations.

Environmental Impacts and Effects Analysis:

CDFW 6

In general the Department found that the lack of specific detail related to alternatives and how their component actions would be implemented made it difficult to assess the environmental consequences, and the lack of discussion of reasonably foreseeable future actions made it correspondingly difficult to evaluate the cumulative effects analysis sections.

CDFW 7

The Department is concerned that the NAA alternative does not adequately describe or analyze implementation of the RPAs. The DEIS assumes that RPAs will be implemented and that they will be beneficial, but does not provide specific discussion or analysis of the ways in which the full suite of RPAs would address adverse impacts of CVP and SWP operations.

CDFW 8

Similarly, the DEIS states that its cumulative impacts analysis includes the projects identified under the reasonably foreseeable future projects in Chapter 3.5, however the analysis in Chapters 4 and 5-22 provides little in the way of detail to explain how these projects were incorporated into or informed the analysis of each alternative.

Longfin smelt

CDFW 9

The effects analysis for Longfin smelt would benefit from analyses of changes to entrainment and/or entrainment related effects between scenarios. For example, Longfin smelt adults and larvae are particularly susceptible to entrainment into the south Delta during the December through February period. The DEIS does not address this issue, which is particularly concerning for alternatives which do not operate to the BiOps. The Department suggests conducting an analysis using a particle tracking model, such as DSM2, to estimate differences in entrainment between the NAA and the five alternatives.

CDFW 9 continued

The Department recommends using the methods found in the effects analysis of the California Department of Fish and Wildlife's 2009 Longfin smelt ITP for the SWP as a framework for an analysis to be included in the DEIS.[3]

Salmonids

CDFW 10

Many of the flow and temperature effects on different life stages when compared between the NAA and Second Basis of Comparison (SBC) seem contradictory; based on our concerns with the modeling discussed further below, we suspect that many of the discrepancies are likely caused by uncertainties associated with the models which do not adjust results based on water operation actions that would be taken to meet requirements of the RPAs under the NAA. The Department recognizes the challenges of presenting alternatives in the context of changing conditions brought on by climate change, drought, and other conditions. However, it is imperative that the DEIS makes a meaningful and consistent effort to conduct these analyses to truly understand the impacts of the alternatives; this is especially true for the NAA since the NAA represents full implementation of the BiOps with the RPAs, many of which were targeted at addressing project operations under a changing climate.

For example, at page 9-126 through 9-127, the DEIS explains that the NAA will have difficulties in meeting temperature requirements due to climate change, increased demand by 2030 and less water being diverted from the Trinity River. The DEIS goes on to describe a variety of measures under the RPAs that are meant to compensate for these effects. However, in the analysis that follows, comparing the NAA to the SBC, the DEIS concluded that temperature-related egg mortality was significantly higher under the NAA than under the SBC. Additionally, the DEIS concludes that temperature- and flow-related fry mortality, as well as temperature-related juvenile mortality was higher under the NAA when compared to the SBC. SALMOD also showed juvenile production would be the same under the NAA and SBC, which is contradictory to the expected outcome associated with RPA implementation. Furthermore, escapement and entrainment under the NAA were found to be similar to the SBC, despite reduced export rates.

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[3] CDFW's Effects Analysis for the Longfin smelt ITP is available at http://www.dfg.ca.gov/delta/data/longfinsmelt/documents/LongfinSmeltIncidentalTakePermitNo.2081-2009-001-03.asp.

1

The BiOp RPAs were developed specifically to improve growth, survival, and general viability through changes in management of flows and temperature that reduce stressors on targeted life stages of listed fishes; therefore, it is unclear how future conditions without implementation of the RPAs (i.e., under the SBC) would have similar or higher benefits than future conditions with full implementation of the RPAs (i.e., the NAA). These results need further explanation and the modeling inputs need to be verified to account for all BiOp RPAs; if results seem contradictory, please provide clear rationale for the discrepancies within the discussion of the model results themselves, as well as in the summary of impacts. (See page 9-164.) CDFW 11

Additionally, Section 9.4.1.5 briefly discusses fish passage and the impacts that dams have on access to available habitat and colder headwaters. This section cites Alternatives 3 and 4 as containing trap and haul activities that address these impacts, however those trap and haul activities do not target fish passage as it relates to dams and access to colder headwaters. CDFW 12

Sturgeon

The analysis in Chapter 9 for sturgeon focuses specifically on the effects of changes in upstream temperature without consideration of the primary environmental driver underlying sturgeon population dynamics, namely the magnitude of winter-spring river flows. We recommend that the DEIS include a flow analysis that demonstrates how operations under each alternative affect mean monthly and seasonal flows at key riverine and Delta locations. This analysis should also display how the alternatives affect the frequency at which flows exceed certain thresholds necessary to produce strong year-classes. The Department is willing to assist in developing these analyses. CDFW 13

White sturgeon

The white sturgeon life history account lacks sufficient detail on the importance of specific environmental attributes to sustaining the population, as well has how project facilities and operations contribute to incremental changes in those attributes. Section 9B.4.3 states that the white sturgeon populations are relatively stable. However, recent survey information clearly indicates that the white sturgeon population is actually in a state of severe decline, in large part due to the infrequency of high flow years associated with good production. This section should make clear the fact that existing reservoirs reduce the frequency and magnitude of these population-sustaining winter-spring high flow events, which has had both incremental and cumulative effects on white sturgeon. Section 9B.4.4 also lacks accurate population trend information vital to interpreting the differences in incremental effects between alternatives. In addition, Section 9B.4.3.3 does not address the outflow-related project operation impacts on overbite clam distribution and abundance.

1

Lastly, the DEIS overstates the importance of the San Joaquin River drainage on production and distracts from the essential point that spawning and rearing in the Sacramento River system sustains the population. CDFW 14

Dry Year Scenarios:

The DEIS inconsistently evaluates drought scenarios and their potential to exacerbate the impacts of alternatives on species. Chapter 6 briefly mentions potential changes in selenium concentrations and the effect on sturgeon during drought years. However, Chapter 9 instead simply states that the "abundance and habitat conditions for Delta smelt and other fish species in the Delta under the No Action Alternative in 2030 are difficult to predict" and that "currently low levels of relative abundance do not bode well for the Delta smelt or other fish species in the Delta in 2030." The DEIS should include a complete and consistent analysis of the ways in which drought would affect the impacts of the various alternatives on all species, especially given the recent dry years and the impact they have had on Delta smelt, winter-run Chinook Salmon, and other species, as well as the altered project operations implemented with the goal of balancing water supply with ensuring water quality standards and environmental protections. Much information has been learned and could be used to develop and evaluate drought scenarios consistently through the alternatives. CDFW 15

Modeling:

Calibration, validation, time steps, and uncertainty

The models used in the DEIS analyses have vastly different temporal resolutions; as a result, linkage of these models requires aggregation/disaggregation of data which could cause significant errors in the modeling results. In addition, models with inappropriate time steps were used to draw conclusions about project effects on fisheries resources. For example, CalSim II uses a monthly averaging to analyze the effects of flow and water temperature on anadromous fish species, which fails to account for the needed daily or even hourly effects of these variables on critical life stages. Furthermore, the modeling does not account for compounding impacts on successive life stages within and between years; given that anadromous fishes are a multi-year species, the failure to account for additive impacts prevents sufficient determination of population level impacts. CDFW 16

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In addition, many of the models used in the DEIS were not accompanied by sensitivity analyses, calibration results, or disclosure of all uncertainties, thereby further inhibiting our ability to determine effects directly attributable to the proposed actions versus modeling errors.

CDFW 16 continued

The Department appreciates the continued opportunity to work with you and your staff in developing the DEIS. Should you have any questions or need additional information, please contact Chad Dibble at (916) 445-1202 or by email at chad.dibble@wildlife.ca.gov.

CDFW 17

Sincerely,

Scott Cantrell

Scott Cantrell
Chief

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Department of Fish and Wildlife

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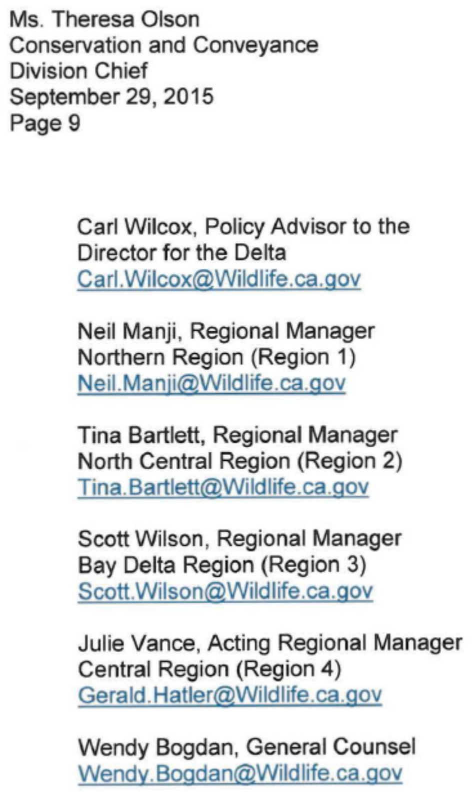

Ms. Theresa Olson
Conservation and Conveyance
Division Chief
September 29, 2015
Page 9

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1B.1.1.1 Responses to Comments from California Department of Fish and Wildlife

CDFW 1: Comment noted.

CDFW 2: Please see responses to Comments CDFW 3 through CDFW 16.

CDFW 3: Comment noted. The description of the trap and haul program assumptions and methodologies presented in Chapter 9 of the Draft EIS were not extensive. Additional information has been included on the text from page 9-316 of the Draft EIS, and additional information has been provided in Appendix 9O of the Final EIS. The additional information includes a discussion of the need for review and potential permits from California Department of Fish and Wildlife (CDFW) to translocate fish either by CDFW or other entities.

CDFW 4: The discussion in Section 3.4.5 of Chapter 3, Description of Alternatives, has been modified in the Final EIS to include references of the review and approval process for changes in harvest limits by other agencies, including the California Fish and Game Commission and Pacific Fisheries Management Council. It should be noted that under the National Environmental Policy Act (NEPA), the range of alternatives evaluated in this EIS is not limited by Reclamation's authorized purposes. Therefore, the range of alternatives includes actions that Reclamation would require approvals and authorizations by other agencies for implementation.

CDFW 5: The uncertainty associated with predator control programs as well as their potential for unintended consequences are acknowledged in the Final EIS. The concerns expressed in this comment are consistent with the discussion of predator control on page 9-274 of the Draft EIS. The EIS acknowledges the uncertainty regarding the extent of predation on listed species, the influence of habitat loss, and the potential for unintended consequences of a predator control program.

CDFW 6: The alternatives are described in Section 3.4 of Chapter 3, Description of Alternatives. Additional details about the No Action Alternative are provided in Appendix 3A: No Action Alternative: Central Valley Project and State Water Project Operations. Details about the operational assumptions for all of the alternatives are presented in and Appendix 5A, Section B, CalSim II and DSM2 Modeling Simulations and Assumptions. The cumulative effects actions are described in Section 3.5 of Chapter 3; and the effects of implementing Alternatives 1 through 5 with the cumulative effects actions as compared to implementation of the No Action Alternative with the cumulative effects actions are presented in the next to last section of each of the resource chapters (Chapters 5 through 21).

CDFW 7: The No Action Alternative and Alternative 5 assume that the 2008 U.S. Fish and Wildlife Service (USFWS) Biological Opinion (BO) Reasonable and Prudent Alternative (RPA) and the 2009 National Marine Fisheries Service (NMFS) BO RPA will be implemented. However, most of the actions listed in the RPAs would not be implemented in Alternatives 1, 3, and 4 and the Second Basis of Comparison; and some of the actions would not be implemented in Alternative 2. Comparison of resource conditions under Alternative 1 as compared to the No Action Alternative in Chapters 5 through 21 indicate differences between alternatives with and without RPA actions.

CDFW 8: The discussion of cumulative effects analyses in Chapters 5 through 21 have been modified to provide more clarity in the Final EIS.

CDFW 9: As documented in Grimaldo et al (2009), combined Old and Middle River flows are strongly correlated with the annual adult delta smelt, longfin smelt, and age-1 striped bass salvage. Chapter 9, Fish and Aquatic Resources, includes a discussion of entrainment assessment for Longfin Smelt based on Old and Middle River flow comparisons between the alternatives and No Action Alternative and Second Basis of Comparison (see Table 9.4). The results of this analysis indicate that Alternatives 1, 3, and 4 would have more adverse impacts on Longfin Smelt as compared to the No Action Alternative than Alternatives 2 and 5.

CDFW 10: It is unclear as to which model output and for which species this comment refers to, but it appears to be the SALMOD output for winter-run Chinook Salmon as the patterns in mortality described are consistent with the SALMOD analyses for that species and not the other runs of Chinook Salmon. No conclusion was presented regarding the "significance" of these results in the EIS. Some of the RPA actions cannot be simulated in the models; therefore, the results of the models are considered in conjunction with the results of a qualitative analysis. The results of the quantitative and qualitative analysis are similar in nature to previous reports.

The comment notes the lack of a strong distinction between the water temperature results for the No Action Alternative and the Second Basis of Comparison, and questions why the No Action Alternatives does not perform better for fish given the RPA actions intended to improve conditions. The analysis results can be explained in part by the similar flow conditions associated with both scenarios, as described in Chapter 5, Surface Water Resources and Water Supplies. This similarity in flow is translated into similar temperatures. In addition, the RPA actions not specifically included in the CalSim II and temperature models were addressed in the introductory discussions of the impact analysis, but not specifically discussed under each alternative in Chapter 9, Fish and Aquatic Resources. The text in the Final EIS has been modified to provide more clarity on the effects of the RPA actions that were not included in the models.

CDFW 11: The assumptions of inclusion of the RPA actions in the CalSim II and DSM2 models are presented in Appendix 5A, Section B, CalSim II and DSM2 Modeling Simulations and Assumptions. The models and assumptions for the models are presented in Appendices 6B through 6E and Appendices 9C through 9O. The modeling results do not include consideration of the non-flow related actions under the No Action Alternative that are intended to benefit fish, such as fish passage. The analysis of effects on fish contained in Chapter 9 of the Draft EIS qualitatively assesses the influence of those actions where appropriate, particularly the potential effects of fish passage. Text changes are included in the Final EIS to provide that additional clarification for the effects of the actions not included in the numerical models.

CDFW 12: The sentence regarding the trap and haul program has been removed from Section 9.4.1.5 and a new section (9.1.4.60) to discuss the trap and haul program was added to the Final EIS. In addition, a new appendix (Appendix 9O) detailing the qualitative analysis of the trap and haul program has been added to the Final EIS.

CDFW 13: In response to this comment, the description of impact mechanisms and impact analyses for sturgeon were augmented to include a flow analysis. The details and results of the analysis are presented in Appendix 9P of the Final EIS. An interpretation of the results in relation to the potential for effects of operations on sturgeon under each of the alternatives has been included in the impact analyses for sturgeon in Section 9.4 of Chapter 9 in the Final EIS.

In response to this comment, Section 9B4.3 has been revised to remove the assertion that White Sturgeon populations are relatively stable and Section 9B4.4 includes more recent information on population trends for White Sturgeon and the possible mechanisms for the noted decline.

CDFW 14: The text on page 9-89 of the Draft EIS was revised to clarify the relevance of the San Joaquin River drainage on production of White Sturgeon.

CDFW 15: The modeling tools used to analyze impacts on aquatic resources are based on the application of CalSim II, a model that assesses changes in hydrology under various operational scenarios based in an 82-year period of record. The period of record includes a full range of hydrologic conditions and water year types, including severe drought.

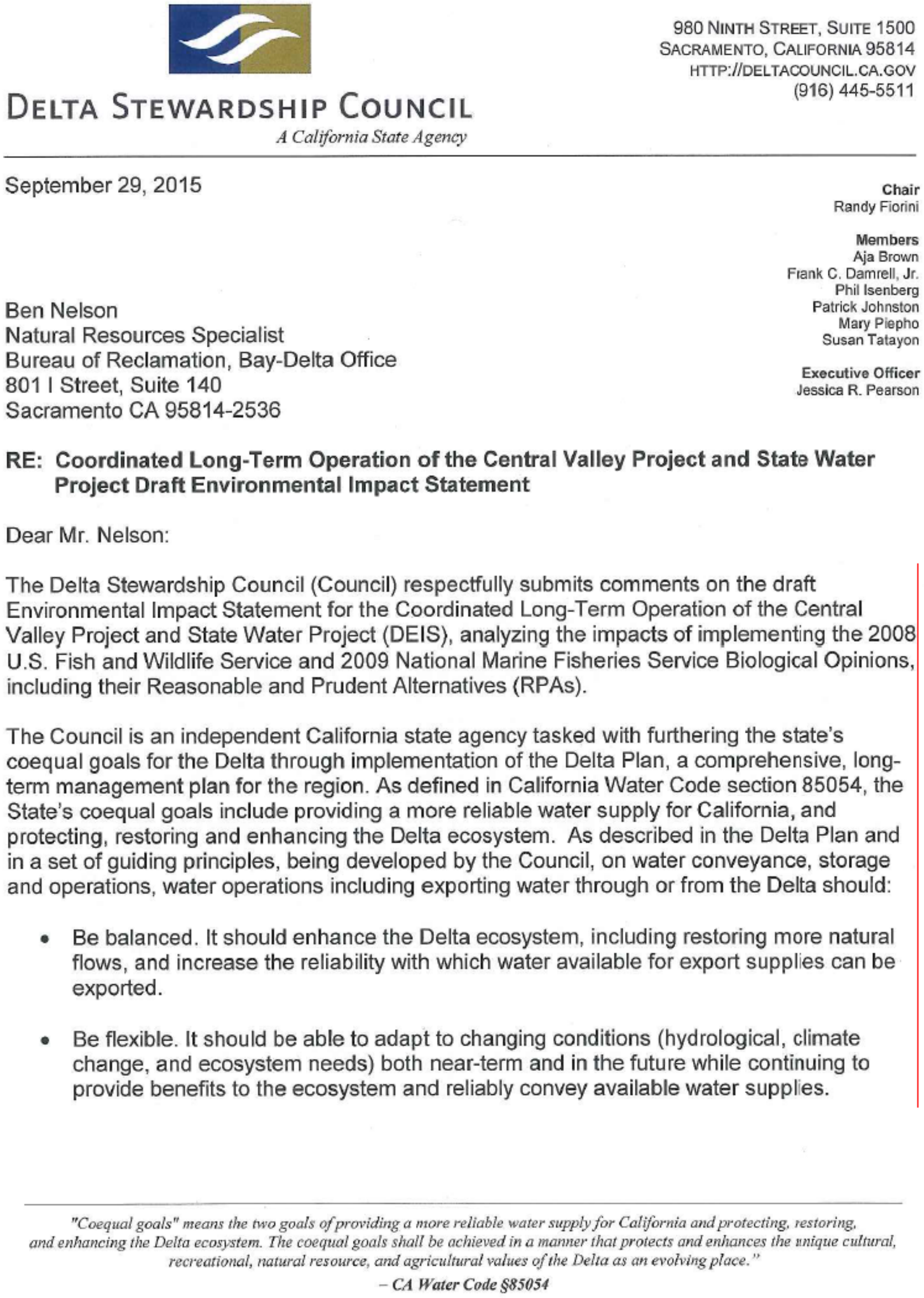
It is recognized that droughts have occurred throughout California's history, and are constantly shaping and innovating the ways in which Reclamation and DWR balance both public health standards and urban and agricultural water demands while protecting the Delta ecosystem and its inhabitants. The most notable droughts in recent history are the droughts that occurred in 1976-77, 1987-92, and the ongoing drought. More details have been included in Section 5.3.3 of Chapter 5, Surface Water Resources and Water Supplies, and Section 9.3.8 of Chapter 9, Fish and Aquatic Resources, in the Final EIS to describe historical responses by CVP and SWP to these drought conditions and changes in fisheries resources.

CDFW 16: The physical models developed and applied in the EIS analysis are generalized and simplified representations of a complex water resources system. The models are not predictive models (in how they are applied in EIS); therefore the results cannot be considered as absolute within a quantifiable confidence interval. The model results are only useful in a comparative analysis, which is appropriate for a NEPA analysis and comparison of alternatives. As indicated in the comment, accounting for the compounding effects on successive life stages within and among years is important. It is acknowledged that the generalized models alone cannot be used to address these effects, but few tools are available that account for life cycle effects. These effects were considered in the EIS for winter-run Chinook Salmon by applying lifecycle models IOS and OBAN. These models account for successive life stages and produce comparative estimates of escapement potential (see Appendices 9H and 9I). In addition to these life cycle models, the effects on successive life stages within the same life cycle of Chinook Salmon are accounted for in the SALMOD and egg mortality models.

In recent years, there has been considerable emphasis placed on development of modeling tools to evaluate environmental changes associated with CVP and SWP operations. The modeling tools applied in the EIS are the same as those used in the most recent applications (e.g., Bay Delta Conservation Plan EIR/EIS). The modeled scenarios in the EIS are variations of the scenarios recently modeled. The relatively coarse level of resolution and degree of uncertainty associated with these models reflect the difficulty in representing a complex water system and the inherently uncertain ecosystem responses. Nonetheless, these tools represent the best available and appropriate tools for this application. The details of these models and their limitations are presented in Appendix 5A, Appendices 6B through 6E, and Appendices 9C through 9O.

CDFW 17: Comment noted.

1B.1.2 Delta Stewardship Council



DELTA STEWARDSHIP COUNCIL
A California State Agency

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September 29, 2015

Ben Nelson
Natural Resources Specialist
Bureau of Reclamation, Bay-Delta Office
801 I Street, Suite 140
Sacramento CA 95814-2536

RE: Coordinated Long-Term Operation of the Central Valley Project and State Water Project Draft Environmental Impact Statement

Dear Mr. Nelson:

DSC 1

The Delta Stewardship Council (Council) respectfully submits comments on the draft Environmental Impact Statement for the Coordinated Long-Term Operation of the Central Valley Project and State Water Project (DEIS), analyzing the impacts of implementing the 2008 U.S. Fish and Wildlife Service and 2009 National Marine Fisheries Service Biological Opinions, including their Reasonable and Prudent Alternatives (RPAs).

The Council is an independent California state agency tasked with furthering the state's coequal goals for the Delta through implementation of the Delta Plan, a comprehensive, long-term management plan for the region. As defined in California Water Code section 85054, the State's coequal goals include providing a more reliable water supply for California, and protecting, restoring and enhancing the Delta ecosystem. As described in the Delta Plan and in a set of guiding principles, being developed by the Council, on water conveyance, storage and operations, water operations including exporting water through or from the Delta should:

- Be balanced. It should enhance the Delta ecosystem, including restoring more natural flows, and increase the reliability with which water available for export supplies can be exported.
- Be flexible. It should be able to adapt to changing conditions (hydrological, climate change, and ecosystem needs) both near-term and in the future while continuing to provide benefits to the ecosystem and reliably convey available water supplies.

"Coequal goals" means the two goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem. The coequal goals shall be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place."
– CA Water Code §85054

DSC 1 continued

- More closely match water supplies available to be exported, based on water year type and consistent with the coequal goal of protecting, restoring, and enhancing the Delta ecosystem.
- Provide real benefits to the ecosystem, in contrast to protecting the ecosystem from further degradation.

DSC 2

In light of these principles, the Bureau should consider the most comprehensive and balanced approach for implementing the biological opinions to protect key endangered or threatened aquatic species. The Bureau may wish to consider several individual elements included in Alternatives 3, 4, and 5 such as;

- Implementing predator control programs for Black Bass, Striped Bass, and Pikeminnow to protect salmonids and Delta smelt, including establishment of new catch limits.
- Modify the requirements of the U.S. Army Corps of Engineers related to removal of vegetation on levees to allow for the planting of trees and shrubs along the levees, and installation of vegetation, woody material, and root re-enforcement material on the levees instead of riprap for erosion protection.

The Delta Plan calls for similar efforts including;

- Regulatory policy **ER P5 (Avoid Introductions of and Habitat Improvements for Invasive Nonnative Species).** This policy requires that the potential for new introductions of or improved habitat conditions for nonnative invasive species, striped bass, or bass, as a result of ecosystem restoration, must be fully considered and avoided or mitigated in a way that appropriately protects the ecosystem.
- Recommendation **ER R6 (Regulate Angling for Nonnative Sport Fish to Protect Native Fish).** The Delta Plan recommends that the California Department of Fish and Wildlife should develop, for consideration by the Fish and Game Commission, proposals for new or revised fishing regulations designed to increase populations of listed fish species through reduced predation by introduced sport fish. The proposals should be based on sound science that demonstrates these management actions are likely to achieve their intended outcome and include the development of performance measures and a monitoring plan to support adaptive management.
- Recommendation **ER R4 (Exempt Delta Levees from the U.S. Army Corps of Engineers' Vegetation Policy).** This Delta Plan recommendation calls for considering the ecosystem value of remaining riparian and shaded riverine aquatic habitat along Delta levees, the U.S. Army Corps of Engineers should agree with the California Department of Fish and Wildlife and the California Department of Water Resources on a variance that exempts Delta levees from the U.S. Army Corps of Engineers' levee vegetation policy where appropriate.

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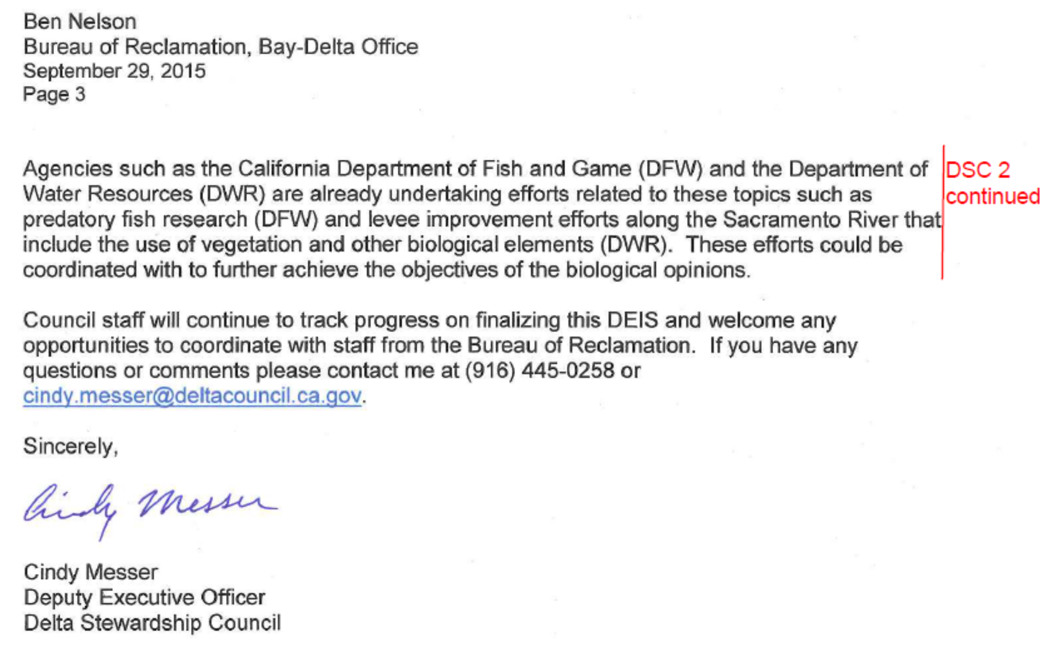

Ben Nelson
Bureau of Reclamation, Bay-Delta Office
September 29, 2015
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Agencies such as the California Department of Fish and Game (DFW) and the Department of Water Resources (DWR) are already undertaking efforts related to these topics such as predatory fish research (DFW) and levee improvement efforts along the Sacramento River that include the use of vegetation and other biological elements (DWR). These efforts could be coordinated with to further achieve the objectives of the biological opinions.

DSC 2 continued

Council staff will continue to track progress on finalizing this DEIS and welcome any opportunities to coordinate with staff from the Bureau of Reclamation. If you have any questions or comments please contact me at (916) 445-0258 or cindy.messer@deltacouncil.ca.gov.

Sincerely,

Cindy Messer

Cindy Messer
Deputy Executive Officer
Delta Stewardship Council

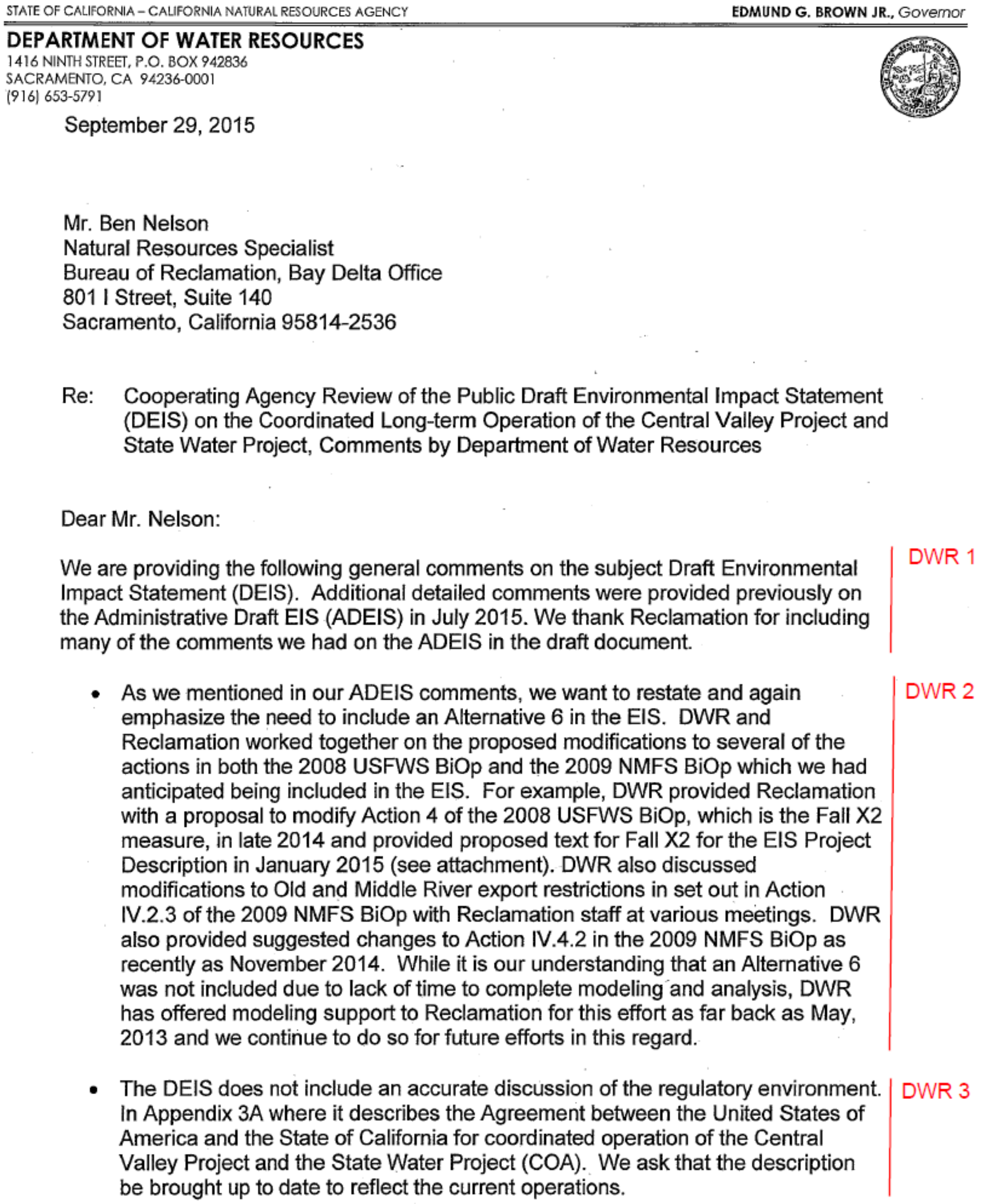
1B.1.2.1 Responses to Comments from Delta Stewardship Council

DSC 1: Comment noted.

DSC 2: Discussion in Section 9.3.4.12.9 of Chapter 9, Fish and Aquatic Resources, of the EIS includes information related to the 2013 expert panel review of predation conditions and research approaches.

Discussion in Section 10.3.3.1.2 of Chapter 10, Terrestrial Biological Resources, of the EIS has been modified by including more detailed discussion of changes under the U.S. Army Corps of Engineers vegetation policy. This information is currently provided in Section 10.4.1.4 of Chapter 10 and Section 3.4.6.2 of Chapter 3, Description of Alternatives.

1B.1.3 California Department of Water Resources



STATE OF CALIFORNIA – CALIFORNIA NATURAL RESOURCES AGENCY
EDMUND G. BROWN JR., *Governor*

DEPARTMENT OF WATER RESOURCES
1416 NINTH STREET, P.O. BOX 942836
SACRAMENTO, CA 94236-0001
(916) 653-5791

September 29, 2015

Mr. Ben Nelson
Natural Resources Specialist
Bureau of Reclamation, Bay Delta Office
801 I Street, Suite 140
Sacramento, California 95814-2536

Re: Cooperating Agency Review of the Public Draft Environmental Impact Statement (DEIS) on the Coordinated Long-term Operation of the Central Valley Project and State Water Project, Comments by Department of Water Resources

Dear Mr. Nelson:

DWR 1

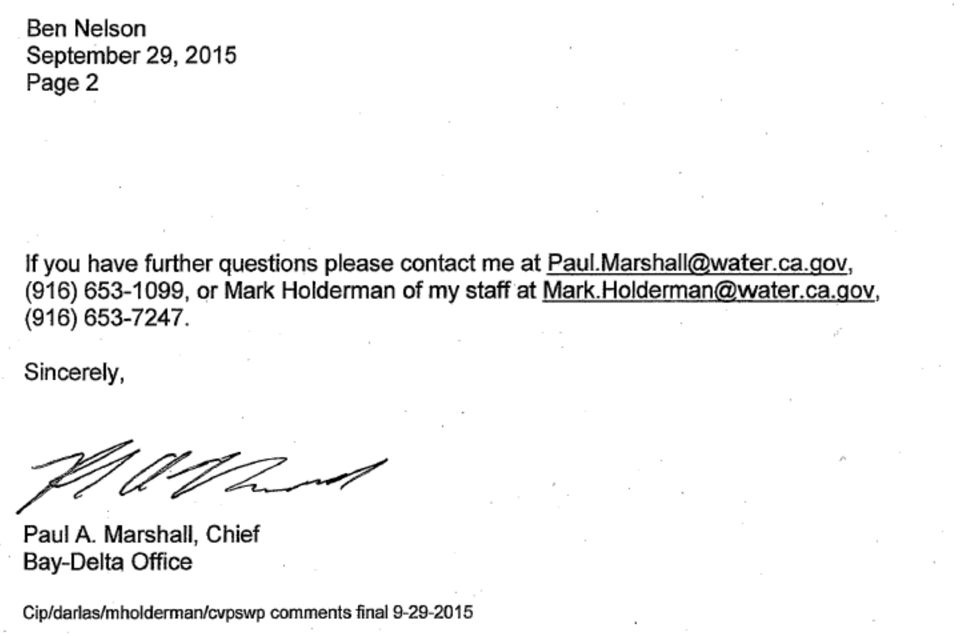
We are providing the following general comments on the subject Draft Environmental Impact Statement (DEIS). Additional detailed comments were provided previously on the Administrative Draft EIS (ADEIS) in July 2015. We thank Reclamation for including many of the comments we had on the ADEIS in the draft document.

DWR 2

- As we mentioned in our ADEIS comments, we want to restate and again emphasize the need to include an Alternative 6 in the EIS. DWR and Reclamation worked together on the proposed modifications to several of the actions in both the 2008 USFWS BiOp and the 2009 NMFS BiOp which we had anticipated being included in the EIS. For example, DWR provided Reclamation with a proposal to modify Action 4 of the 2008 USFWS BiOp, which is the Fall X2 measure, in late 2014 and provided proposed text for Fall X2 for the EIS Project Description in January 2015 (see attachment). DWR also discussed modifications to Old and Middle River export restrictions in set out in Action IV.2.3 of the 2009 NMFS BiOp with Reclamation staff at various meetings. DWR also provided suggested changes to Action IV.4.2 in the 2009 NMFS BiOp as recently as November 2014. While it is our understanding that an Alternative 6 was not included due to lack of time to complete modeling and analysis, DWR has offered modeling support to Reclamation for this effort as far back as May, 2013 and we continue to do so for future efforts in this regard.

DWR 3

- The DEIS does not include an accurate discussion of the regulatory environment. In Appendix 3A where it describes the Agreement between the United States of America and the State of California for coordinated operation of the Central Valley Project and the State Water Project (COA). We ask that the description be brought up to date to reflect the current operations.



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If you have further questions please contact me at Paul.Marshall@water.ca.gov, (916) 653-1099, or Mark Holderman of my staff at Mark.Holderman@water.ca.gov, (916) 653-7247.

Sincerely,

Paul A. Marshall, Chief
Bay-Delta Office

Cip/darlas/mholderman/cvpswp comments final 9-29-2015

1B.1.3.1 Responses to Comments from Department of Water Resources

DWR 1: Comment noted.

DWR 2: On October 9, 2015, the District Court granted a very short time extension to address comments received during the public review period, and requires Reclamation to issue a Record of Decision on or before January 12, 2016. This current court ordered schedule does not provide sufficient time for Reclamation to include additional alternatives, which would require recirculation of an additional Draft EIS for public review and comment, nor does Reclamation believe additional analysis is required to constitute a sufficient EIS. Reclamation is committed to continue working toward improvements to the USFWS and NMFS RPA actions through either the adaptive management process, Collaborative Science and Adaptive Management Program (CSAMP) with the Collaborative Adaptive Management Team (CAMT), or other similar ongoing or future efforts.

DWR 3: The description of the Coordinated Operations Agreement (COA) in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations, of the EIS, has been modified to reflect recent CVP and SWP operations.