CHAPTER 5

Revisions to the Draft EIS/EIR

5.1 Introduction

This chapter presents changes to the text of the Draft EIS/EIR made in response to comments (as presented in Chapters 3 and 4) or to clarify and provide applicable updates of the text in the Draft EIS/EIR. The text revisions in this chapter represent four main categories of changes: (1) clarifications/refinements made in response to comments; (2) updated information due to project revisions; (3) clarification/refinement due to updated information; and (4) clarifications/corrections made due to editorial errors. Text changes are prefaced by a brief explanation, including where appropriate, reference to the master response in Chapter 3 or comment number in Chapter 4. In each change, new language is underlined, while deleted text is shown in ~~strikethrough~~, except where the text is indicated as entirely new, in which case no underlining is used for easier reading.

Text changes presented here are shown in select text sections of the Draft EIS/EIR only; particularly in the sections that present impact conclusions and/or mitigation measures. Text revisions are not shown for all related text sections throughout the Draft EIS/EIR. For example, neither the Draft EIS/EIR Executive Summary text nor Chapter 3, Project Description, text has been fully revised to reflect the three project facility refinements presented in detail in Section 2.3.1 of this response to comments documents (Vol. 4, of the Final EIS/EIR). However, revisions are shown to select sections of the impact summary table from the Draft EIS/EIR Executive Summary since a revised version of this table forms the basis for the CEQA Mitigation Monitoring and Reporting Program as well as the template for developing the CEQA Findings. The Final EIS/EIR is comprised of all four volumes and it is necessary to review the revisions made to the text presented in this section to understand what aspects of the Draft EIS/EIR have been updated and superceded.

5.2 Selected Text Revisions to the Draft EIS/EIR

Text changes to the Draft EIS/EIR text are shown below following the order of sections in the Draft EIS/EIR. Text revisions have only been made in select sections; there are no revisions in most sections.

Executive Summary

The following paragraph is inserted immediately following the fifth full paragraph on page ES-36 of the Draft EIS/EIR (Vol. 1, Executive Summary) to clarify that Western Area Power Administration (Western) would issue a Record of Decision (ROD) should an action to provide power and associated facilities be approved as part of the project.

> **Western.** As a Cooperating Agency under NEPA, Western is responsible for coordinating with Reclamation in completing the EIS/EIR to comply with the Department of Energy's NEPA implementing regulations. Western would rely on the EIS/EIR when taking action to provide power and associated facilities, and would document that action in a Record of Decision.

Table ES-7, CEQA Environmental Impacts and Mitigation Measures

The numbering of Mitigation Measure 4.5.2 on page ES-44 of the Draft EIS/EIR (Vol. 1, Executive Summary) is corrected as follows to correlate with the numbering of Impact 4.5.4 (Draft EIS/EIR, Vol. 1, Section 4.5, pp. 4.5-26 through 4.5.28).

4.5.4: Project alternatives would not create or contribute runoff water that would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff during operation.	No Action: Alternative 1: Alternative 2: Alternative 3: Alternative 4:	NI LSM LSM LSM LSM	**Measure 4.5.~~2~~4:** CCWD shall design facilities with introduced impervious surfaces with stormwater control measures that are consistent with the Regional Water Quality Control Board's NPDES municipal stormwater runoff requirements. The stormwater control measures shall be designed and implemented to reduce the discharge of stormwater pollutants to the maximum extent practical. Stormwater controls such as bioretention facilities, flow-through planters, detention basins, vegetative swales, covering pollutant sources, oil/water separators, retention ponds, shall be designed to control stormwater quality to the maximum extent practical. In addition, CCWD shall prepare and implement a Stormwater Facility Operation and Management Plan that assigns responsibility for maintenance of stormwater facilities for the life of the project.	No Impact Less Than Significant

Mitigation Measures 4.6.2a on pages ES-47 and ES-48 of the Draft EIS/EIR (Vol. 1, Executive Summary) is revised to further protect wetland resources along pipeline corridors.

4.6.2: Project construction could affect potentially jurisdictional wetlands or waters, and streambeds and banks regulated by CDFG.	No Action: Alternative 1: Alternative 2: Alternative 3: Alternative 4:	NI LSM LSM LSM LSM	**Measure 4.6.2a:** Final project design shall avoid and minimize the fill of wetlands and other waters to the greatest practicable extent. No access vaults would be installed within the jurisdictional drainages that occur along any pipeline corridors. Areas that are avoided shall be subject to best management practices under the General National Pollutant Discharge Elimination System Permit, as described in Measure 4.5.1. The fill of wetlands at the proposed Western substation site shall be avoided by siting facilities within the study area so as to avoid impacts to such areas.	No Impact Less Than Significant

Mitigation Measure 4.6.5 on page ES-54 of the Draft EIS/EIR (Vol. 1, Executive Summary) is revised to further mitigate and reduce aquatic habitat impacts to western pond turtle.

4.6.5: Project construction would result in direct and indirect impacts on existing populations of and habitat for the western pond turtle.	No Action: Alternative 1: Alternative 2: Alternative 3: Alternative 4:	NI LSM LSM LSM LSM	The implementation of Mitigation Measure 4.6.5, which includes biological monitoring and turtle relocation, would reduce project impacts on western pond turtle populations and habitat to a less-than-significant level: **Measure 4.6.5:** Before construction activities begin, a qualified biologist shall conduct western pond turtle surveys within creeks and in other ponded areas affected by the project. Upland areas shall also be examined for evidence of nests as well as individual turtles. The project biologist shall be responsible for the survey and for the relocation of turtles. Construction shall not proceed until a reasonable effort has been made to capture and relocate as many western pond turtles as possible to minimize take. However, some individuals may be undetected or enter sites after surveys, and would be subject to mortality. If a nest is observed, a biologist with the appropriate permits and prior approval from CDFG shall move eggs to a suitable location or facility for incubation, and release hatchlings into the creek system the following autumn. In addition, concurrent with mitigation commitments to create and enhance aquatic sites for California red-legged frog (Measure 4.6.4b), CCWD shall include habitat elements in the aquatic habitat and tiger salamander plan that benefit western pond turtle. Such elements may include logs or rafts for emergent basking sites where needed and the maintenance of upland areas adjacent to ponds in a relatively open condition. ~~w~~Western pond turtles shall be included in the fish rescue operation described in Mitigation Measure 4.3.3 (Alternatives 1 and 2 only).	No Impact Less Than Significant

Mitigation Measure 4.6.10b on page ES-66 of the Draft EIS/EIR (Vol. 1, Executive Summary) is revised to include additional protection for Alameda whipsnake habitat.

4.6.10: Project construction and increased reservoir water levels would result in temporary and permanent loss of potential and occupied habitat for Alameda whipsnakes.	No Action: Alternative 1: Alternative 2: Alternative 3: Alternative 4:	NI LSM LSM LSM LSM	**Measure 4.6.10b:** Consistent with MSCS guidelines, CCWD shall provide compensation for permanent and temporary loss of upland scrub habitat that may support Alameda whipsnakes by either (1) compensating for permanent habitat losses by acquiring, protecting, and managing 2 to 5 acres of existing occupied habitat for every acre within the same area of occupied habitat that would be affected, and/or (2) enhancing or restoring 2 to 5 acres of suitable habitat near the affected areas for every acre of occupied habitat affected (CALFED, 2000). Concurrent with other project requirements to mitigate for impacts to grasslands and oak woodland habitat, as summarized in Table 4.6-17, a portion of the total grassland and oak woodland mitigation requirement shall be chosen and preserved in perpetuity to provide linkages between other chaparral and scrub habitat, or to serve as foraging and movement habitat for Alameda whipsnake near existing scrub habitat patches. Mitigation shall be provided at a 1.1:1 mitigation ratio for all areas within 2,500 feet of core scrub habitat. Therefore, under Alternatives 1, 2 and 3, about 503.1 acres of the total grassland and oak woodland mitigation commitment would be located within 2,500 feet of areas that are considered to provide core Alameda whipsnake habitat. Under Alternative 4, about 173.9 acres of grassland mitigation lands would be provided for this purpose.	No Impact Less Than Significant

Mitigation Measure 4.6.15b on page ES-71 of the Draft EIS/EIR (Vol. 1, Executive Summary) is revised to explain the benefit to special status bats of implementing Mitigation Measure 4.6.1b.

4.6.15: Project construction activities could affect nonlisted special-status mammal species (American badger, special-status bats, and San Joaquin pocket mouse).	No Action: Alternative 1: Alternative 2: Alternative 3: Alternative 4:	NI LSM LSM LSM LSM	**Measure 4.6.15b:** CCWD shall minimize impacts on special-status bats by performing preconstruction surveys and creating no-disturbance buffers around active bat roosting sites. Before construction activities (i.e., ground clearing and grading, including trees or shrub removal) within 200 feet of trees that could support special-status bats, a qualified bat biologist shall survey for special-status bats. If no evidence of bats (i.e., direct observation, guano, staining, or strong odors) is observed, no further mitigation shall be required. If evidence of bats is observed, CCWD and its contractors shall implement the	No Impact Less Than Significant

			following measures to avoid potential impacts on breeding populations: • A no-disturbance buffer of 250-feet shall be created around active bat roosts during the breeding season (April 15 through August 15). Bat roosts initiated during construction are presumed to be unaffected by the indirect effects of noise and construction disturbances. However, the direct take of individuals will be prohibited. • Removal of trees showing evidence of active bat activity shall occur during the period least likely to affect bats, as determined by a qualified bat biologist (generally between February 15 and October 15 for winter hibernacula, and between August 15 and April 15 for maternity roosts). If the exclusion of bats from potential roost sites is necessary to prevent indirect impacts due to construction noise and human activity adjacent, bat exclusion activities (e.g., installation of netting to block roost entrances) shall also be conducted during these periods. If special status bats are identified in the dam or special allowances must be made to relocate bats, CCWD will coordinate the effort in advance with CDFG. Implementation of Mitigation Measure 4.6.1b requires the creation, enhancement and preservation of a variety of habitat types, including valley oak, blue oak woodlands and Fremont cottonwood series. These habitats and this mitigation would additionally benefit special status bats and provide potential roosting habitat.	

Mitigation Measure 4.8.2b on page ES-75 of the Draft EIS/EIR (Vol. 1, Executive Summary) is revised to increase the ratio of the agricultural conservation easement required and to clarify how the easements are to be negotiated.

4.8.2: The project would permanently convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to nonagricultural use.	No Action: Alternative 1: Alternative 2: Alternative 3: Alternative 4:	NI SU SU LSM LS	**Measure 4.8.2b:** CCWD will provide the following mitigation for the permanent conversion of Important Farmland. For each acre of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance that is permanently converted to nonagricultural use, 1.5 acres of agricultural conservation easement will be obtained. An agricultural conservation easement is a voluntary, recorded agreement between a landowner and a holder of the easement that preserves the land for agriculture. The easement places legally enforceable restrictions on the land. The exact terms of the easement are to be negotiated in coordination with a local agriculture land trust, but restricted	No Impact. Significant and unavoidable for Alternatives 1 and 2. These mitigation measures would reduce the impact of the proposed conversion of Farmland of Statewide Importance to nonagricultural uses, but not to a less-than-significant level. Less than Significant for Alternatives 3 and 4.

			activities will include subdivision of the property, non-farm development, and other uses that are inconsistent with agricultural production. The mitigation lands must be of equal or better quality (according to the latest available FMMP data) and have an adequate water supply. In addition, the mitigation lands must be within the same county. Information presented in Table 4.8-6 indicates that this compensatory mitigation would require acquisition of easements on about ~~22~~<u>33</u> acres <u>(22 acres of impact x 1.5 acres mitigation)</u> acres of Farmland of Statewide Importance <u>or better quality farmland</u>, preferably within Contra Costa County.	

The following text under Impact 4.8.4 on page ES-75 of the Draft EIS/EIR (Vol. 1, Executive Summary) is revised to clarify that with implementation of Mitigation Measures 4.8.1, 4.8.2a and revised Mitigation Measure 4.8.2b, the contribution to cumulative impacts from conversion of Important Farmland to nonagricultural uses under Alternatives 1 and 2 would be reduced to Less-than-Significant With Mitigation.

4.8.4: The project would involve changes in the environment that, due to their location or nature, could contribute to cumulative impacts from conversion of Important Farmland to nonagricultural uses.	No Action: Alternative 1: Alternative 2: Alternative 3: Alternative 4:	NI ~~SU~~ <u>LSM</u> ~~SU~~ <u>LSM</u> LSM LS	Implementation of Agricultural Resources Mitigation Measures 4.8.1 and 4.8.2 (a and b) would ~~minimize potential impacts under Alternatives 1 and 2; however, those measures would not~~ reduce cumulative impacts to less-than-significant levels <u>for Alternatives 1 and 2</u>. ~~The level of significance after mitigation would be a significant and unavoidable cumulative impact for Alternatives 1 and 2.~~ With Mitigation Measure 4.8.2a, Alternative 3 would not result in a cumulatively considerable contribution to a significant impact on agriculture.	No Impact <u>Less Than Significant</u> ~~Significant and Unavoidable for Alternatives 1 and 2; Less than Significant for Alternatives 3 and 4~~

Mitigation Measure 4.15.1b on page ES-85 of the Draft EIS/EIR (Vol. 1, Executive Summary) is revised to include mitigation to protect the Byron Vernal Pools Regional Preserve, and Mitigation Measure 4.15.1 is revised to include an additional measure (Mitigation Measure 4.15.1c) to ensure timely completion of recreational facilities.

4.15.1: Construction of the project alternatives would result in a short-term reduction of recreational opportunities in the project area due to construction activities outside the watershed and closure of the watershed to the public during the construction period, but would enhance recreational opportunities in the long-term.	No Action: Alternative 1: Alternative 2: Alternative 3: Alternative 4:	NI LSM LSM LSM LSM	**Measure 4.15.1a:** Before any recreational facilities are closed in the watershed, CCWD shall prepare and implement a public outreach program and promote the program via the web, billing inserts, and other methods to inform current and potential recreational users of the temporary closure of the Los Vaqueros Reservoir day-use facilities and inform customers of other recreational opportunities in the area. **Measure 4.15.1b:** If EBRPD's proposed Delta Trail Extension<u> or Byron Vernal Pools Regional Preserve </u>is developed and open to the public before or during construction of the new Delta Intake and Pump Station<u> and Transfer-Bethany</u>	No Impact Less Than Significant

			Pipeline, respective; CCWD shall provide EBRPD with an anticipated closure schedule; prepare and implement a public outreach program and promote the program via the web, billing inserts, and other methods to inform current and potential recreational trail users of the temporary closure of the Delta Trail Extension or Byron Vernal Pools Regional Preserve and inform customers of other recreational ~~trail~~ opportunities in the area; and place signage to the north and south of the new Delta Intake and Pump Station site or Byron Vernal Pools Regional Preserve along the trail or Armstrong Road to inform recreational users of the trail/preserve closure, alternative ~~trail~~ recreational options, and anticipated timing for the reopening. **Measure 4.15.1c:** Proposed recreational facilities displaced by reservoir expansion would be replaced within one year of completion of construction activities associated with all major facility components.	

Mitigation Measure 4.16.1 is revised to include an additional measure (Mitigation Measure 4.16.1i) in response to comment S_Caltrans-02.

4.16.1: Construction and management of project components would cause a substantial adverse change in the significance of a historical and/or unique archaeological resource as defined in Section 15064.5 or historic property or historic district, as defined in Section 106 of the NHPA (36 CFR 800), or in a previously undiscovered cultural resource.	No Action: Alternative 1: Alternative 2: Alternative 3: Alternative 4:	NI LSM LSM LSM LSM	Under both federal and state law, the first mitigation measure to be considered for a significant impact to a cultural resource is relocation of project elements so that the impact is avoided. For all project alternatives, some project elements could not be relocated to avoid impacts on cultural resources. **Measure 4.16.1i**: Los Vaqueros Reservoir Expansion; Dam Modification; and Other Sites Where Cultural Resources Cannot Be Avoided. In the event there is an inadvertent archaeological or burial discovery within State ROW, the Caltrans Office of Cultural Resources Studies, District 4, Oakland, shall be immediately contacted at (510)286-5618. A staff archaeologist will evaluate the finds within one business day of being contacted by CCWD representatives. A data recovery plan and all subsequent reports for investigations within State ROW will need to be approved by the Office of Cultural Resources Studies, District 4.	No Impact Less Than Significant

The following text for Impact 4.17.5 on page ES-91 is corrected to refer to permanent loss rather than temporary loss of agricultural land uses and revised to clarify that with implementation of Mitigation Measures 4.8.1, 4.8.2a and revised Mitigation Measure 4.8.2b, the contribution to cumulative impacts from conversion of Important Farmland to nonagricultural uses under

Alternatives 1 and 2 would be reduced to Less-than-Significant With Mitigation. Related revisions to agricultural impacts and mitigation are also provided in this chapter.

4.17.5: Construction of the project alternatives, when combined with construction of other future projects, could have a potential cumulative effect on Contra Costa County's economy as a result of permanent~~temporary~~ loss of agricultural land uses.	No Action: Alternative 1: Alternative 2: Alternative 3: Alternative 4:	NI ~~SU~~LSM ~~SU~~LSM LS LS	**Implementation of Agricultural Resources Mitigation Measures 4.8.1 and 4.8.2 (a and b):** Implementation of Agricultural Resources Mitigation Measures 4.8.1 and 4.8.2 (a and b) would minimize potential impacts under Alternatives 1 and 2;~~ however, those measures~~ and would ~~not~~ reduce cumulative impacts to less than significant levels. The level of significance after mitigation would be less than significant with mitigation ~~a significant and avoidable cumulative impact~~.	No Impact Less Than Significant ~~Significant and Unavoidable~~ for Alternatives 1 or 2; Less than Significant for Alternatives 3 and 4.

Chapter 2, Project Background

The last sentence of the first full paragraph on page 2-6 of the Draft EIS/EIR (Vol. 1, Chapter 2) is revised to reflect the change in status of the Rock Slough Fish Screen.

> ~~Reclamation has received an extension on fish screen construction until December 2008, and is preparing a request for further extension until 2018 because the requirements for screen design will change when CCWD completes the ongoing project to encase the earth-lined portion of the canal.~~ Construction of the Rock Slough Fish Screen commenced in September 2009; the screen is expected to be operational by the end of 2011.

The fourth sentence in the first full paragraph on page 2-7 of the Draft EIS/EIR (Vol. 1, Chapter 2) is removed to clarify that Western makes purchases to deliver power and is not exclusively hydroelectric.

> Power is transmitted to the Old River Intake and Pump Station over lines owned and operated by Western Area Power Administration (Western). A 230-kV line being operated at 69 kV runs from the Tracy substation near the CVP Jones Pumping Plant to the Old River Intake and Pump Station, and is being extended to the AIP. The delivered power is from one of two sources: CVP power and Modesto Irrigation District (MID) power. ~~CVP power used by CCWD is exclusively hydroelectric power.~~ MID power is generated from a variety of sources including renewables and large hydropower (48 percent), coal (28 percent), and natural gas (24 percent) (Smith, 2007). Power needs at the Transfer Facility and within the watershed are met by Pacific Gas & Electric (PG&E) through their Brentwood substation. PG&E's portfolio includes natural gas (40 percent), renewables and large hydropower (34 percent), and nuclear (24 percent) (PG&E, 2008).

Chapter 3, Description of Project Alternatives

The second paragraph on page 3-46 of the Draft EIS/EIR (Vol. 1, Chapter 3) is revised to clarify the anticipated period when recreational activities in the Los Vaqueros Watershed would be restricted under Alternatives 1, 2 and 3.

> The existing reservoir would need to be drained prior to construction, which is projected to take 6 months to one year to accomplish. During the reservoir draining period, recreation activities at the reservoir would be increasingly restricted as water levels drop. The reservoir~~It~~ would remain drained and out of service throughout the estimated 3-year construction period. ~~and refilled f~~ Following construction completion, the reservoir would be refilled, which would take approximately one year. During this refilling period, recreation activities would be reopened in phases in response to the increasing water levels. The process of draining the reservoir is described below (see “Construction”).

The second full paragraph on page 3-66 of the Draft EIS/EIR (Vol. 1, Chapter 3) is revised to more accurately reflect the location of the Transfer-Bethany Pipeline alignment.

> As shown on Figure 3-21, the Transfer-Bethany Pipeline would start on the eastern side of Vasco Road near the Expanded Transfer Facility with a connection to the Delta-Transfer Pipeline and extend approximately 8.5 to 8.9 miles southeast to Bethany Reservoir. The alignment would extend southeast generally parallel to Vasco Road for about ~~3.8~~ 3.0 miles, then move away from Vasco Road to the southeast and then south for approximately 1.0 mile to connect with Armstrong Road ~~to the corner of~~ where Armstrong Road turns south. The pipeline would continue south along Armstrong Road for about 1.3 miles and then traverse southeast overland approximately 1.5 miles to a point close to the California Aqueduct. At this point, there are two options for the final southern segment of the pipeline to the Bethany Reservoir Tie-in: a Westside Option and an Eastside Option. As described below, both of these options include tunnel segments (see Figure 3-23).

The first paragraph on page 3-74 of the Draft EIS/EIR (Vol. 1, Chapter 3) is revised to clarify that, under Power Option 1, Western would provide all additional electric system infrastructure required under Alternatives 1, 2, and 3, and that Western would deliver power to project facilities, not “supply” power, which implies that Western would also generate that power.

> Under this option, Western would provide all the additional ~~electrical~~ electric system infrastructure to deliver power supply required for the expanded Los Vaqueros Reservoir system. For Alternatives 1 and 2, Western would supply additional power to both the new Delta Intake and Pump Station and the Expanded Transfer Facility. For Alternative 3, Western would ~~supply~~ deliver additional power to both the Expanded Old River Intake and Pump Station and the Expanded Transfer Facility.

The first sentence of the second paragraph on page 3-74 of the Draft EIS/EIR (Vol. 1, Chapter 3) is revised to clarify that Western would deliver power to project facilities, not “supply” power which implies that Western would also generate that power.

> Western would use its existing 230-kV transmission line from the Tracy substation to ~~supply~~ deliver power supply to a new substation.

The fifth paragraph on page 3-74 of the Draft EIS/EIR (Vol. 1, Chapter 3) is revised to clarify that, under Power Option 2, Western would provide additional electric system infrastructure required under Alternatives 1, 2 and 3.

> Under this power option, Western would provide the additional electric system infrastructure to deliver ~~electrical~~ power supply for either the new Delta Intake and Pump Station (Alternatives 1 and 2) or the Expanded Old River Pump Station (Alternative 3), but PG&E would provide the additional electrical power supply to the Expanded Transfer Facility (Alternatives 1, 2, and 3) (see **Figure 3-27**).

The first sentence in the last paragraph on page 3-74 of the Draft EIS/EIR (Vol. 1, Chapter 3) is revised to clarify that Western would deliver power to project facilities, not "supply" power, which implies that Western would also generate that power.

> Western would use its existing 230-kV transmission line corridor from the Tracy substation to ~~supply~~ deliver power supply to the Delta intakes by constructing a single-circuit, 69-kV powerline to the terminus of the existing single-circuit, 69-kV line that currently supplies power to the Old River Intake and Pump Station.

The second paragraph on page 3-91 of the Draft EIS/EIR (Vol. 1, Chapter 3) is revised to clarify that Western would issue a ROD should an action to provide power and associated facilities be approved as part of the project.

> **Western.** As a Cooperating Agency under NEPA, Western is responsible for coordinating with Reclamation in completing the EIS/EIR to comply with the Department of Energy's NEPA implementing regulations. Western would rely on the EIS/EIR when taking action to provide power and associated facilities, and would document that action in a Record of Decision. Consistent with those implementing regulations, a Purpose and Need statement specific to Western's limited role as a cooperating agency is provided.

Table 3-8, Permits and Approvals Potentially Needed For Implementation Of Los Vaqueros Reservoir Expansion Alternatives on page 3-93 of the Draft EIS/EIR (Vol. 1, Chapter 3) is revised to change Permitting Authority "State of California Reclamation Board" to "Central Valley Flood Protection Board" in response to comment S_CVFPB-01.

Encroachment Permit	~~State of California Reclamation Board~~Central Valley Flood Protection Board	Facilities within designated floodway or floodplain Facilities affecting levees under state authority

Section 4.5 Local Hydrology, Drainage, and Groundwater

The first full paragraph on page 4.5-6 of the Draft EIS/EIR (Vol. 1, Section 4.5) is revised to accurately reflect the jurisdiction of the Contra Costa County Flood Control and Water Conservation District (CCCFC), in response to comment L_CCCFC-05.

> **Contra Costa County, Flood Control and Water Conservation District**
>
> The Contra Costa County, Flood Control and Water Conservation District (CCCFC) works with local communities to provide flood protection and stormwater management for areas within its jurisdiction. ~~is empowered to control flooding and stormwater within its service area.~~ The CCCFC ~~FCWCD~~ is staffed by the County Flood Control Engineering Division staff, with the purpose of developing and implementing storm~~-~~drainage systems in Contra Costa County.

The numbering of Mitigation Measure 4.5.2 on page 4.5-29 of the Draft EIS/EIR (Vol. 1, Section 4.5) is corrected as follows to correlate with the numbering of Impact 4.5.4 (Draft EIS/EIR, Vol. 1, Section 4.5, pp. 4.5-26 through 4.5.28).

> **Measure 4.5.~~2~~4:** CCWD shall design facilities with introduced impervious surfaces with stormwater control measures that are consistent with the Regional Water Quality Control Board's NPDES municipal stormwater runoff requirements. The stormwater control measures shall be designed and implemented to reduce the discharge of stormwater pollutants to the maximum extent practical. Stormwater controls such as bioretention facilities, flow-through planters, detention basins, vegetative swales, covering pollutant sources, oil/water separators, retention ponds, shall be designed to control stormwater quality to the maximum extent practical. In addition, CCWD shall prepare and implement a Stormwater Facility Operation and Management Plan that assigns responsibility for maintenance of stormwater facilities for the life of the project.

Section 4.6 Biological Resources

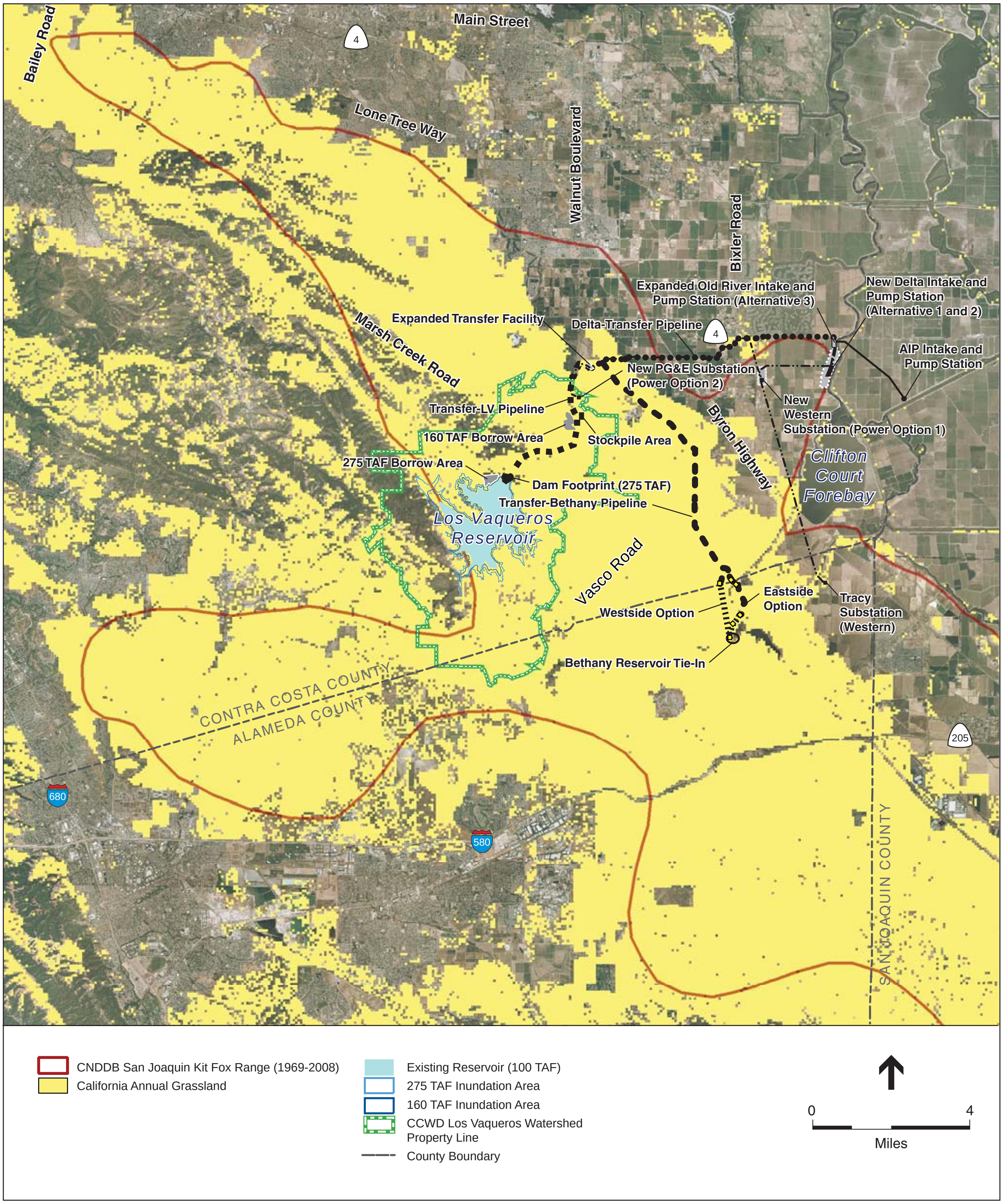
In response to comments that several Draft EIS/EIR maps lack important project components that are needed to determine wildlife impacts, **Figures 4.6-11, 4.6-15** and **4.6-16** in the Draft EIS/EIR have been updated to provide requested information.

- Figure 4.6-11 Regional Distribution of San Joaquin Kit Fox (Draft EIS/EIR, Vol. 2, Section 4.6 Biological Resources, page 4.6-53 is revised to include the location of project components.

- Figure 4.6-15 Location of Wetlands Created for California Red-Legged Frog and Stockponds within the Los Vaqueros Watershed (Draft EIS/EIR, Vol. 2, Section 4.6 Biological Resources, page 4.6-68 is revised to include names of the created wetlands and stock ponds that occur within the 275-TAF inundation zone.

- Figure 4.6-16 Existing Access Restrictions within the Los Vaqueros Watershed (Draft EIS/EIR, Vol. 2, Section 4.6 Biological Resources, page 4.6-69 is revised to include additional GIS data used in the impact assessment.

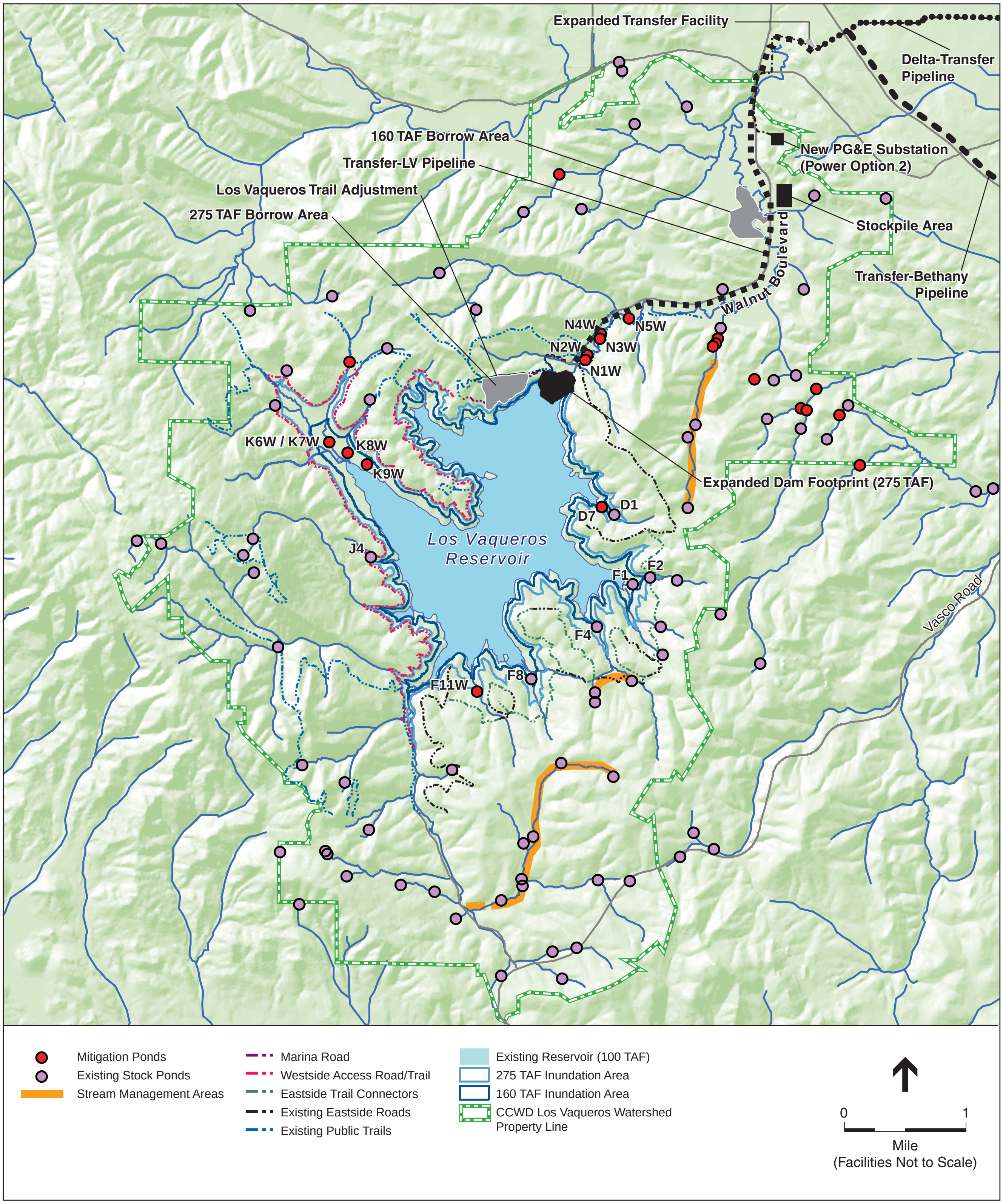
The revised figures are included on the following pages.



SOURCE: CDF, 2002; USDA, 2006; CNDDB, 2006; ESRI, 2006; ESA, 2008; and ESA, 2010

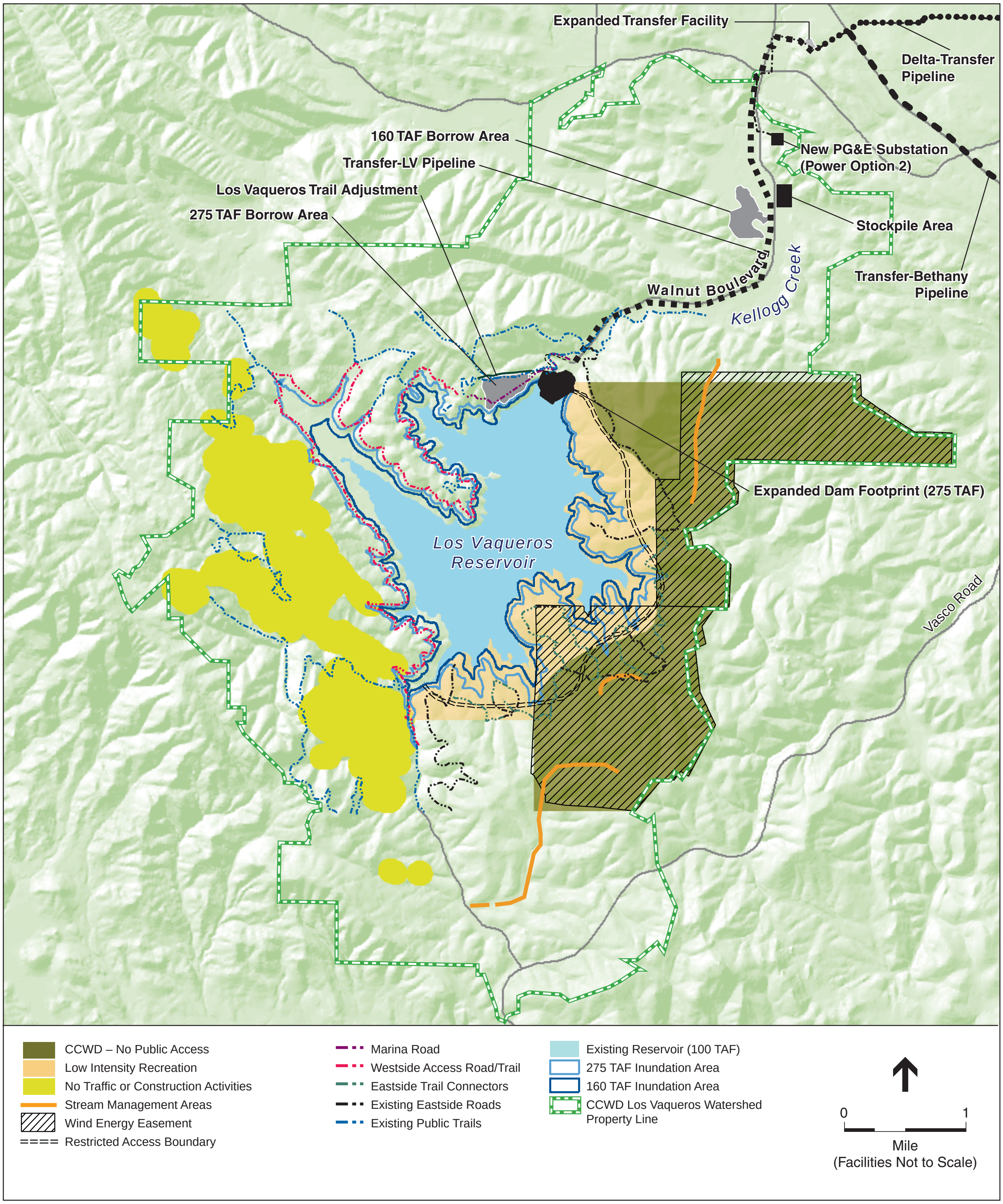
Los Vaqueros Reservoir Expansion Project EIS/EIR . 201110

Revised Draft EIS/EIR Figure 4.6-11
Regional Distribution of San Joaquin Kit Fox



SOURCE: USGS, 1993 (base map); ESA, 2006; and ESA, 2010

Revised Draft EIS/EIR Figure 4.6-15
Location of Wetlands Created for California Red-Legged Frog and Stockponds within the Los Vaqueros Watershed



SOURCE: USGS, 1993 (base map); CCWD, 2007; ESA, 2007; and ESA, 2010

Los Vaqueros Reservoir Expansion Project EIS/EIR . 201110

Revised Draft EIS/EIR Figure 4.6-16
Existing Access Restrictions within the Los Vaqueros Watershed

The last sentence of the first paragraph on page 4.6-17 of the Draft EIS/EIR (Vol. 2, Section 4.6) is revised as follows to reflect vernal pool conditions:

> Vernal pool conditions occur in a portion of the Transfer-Bethany Pipeline alignment on Armstrong Road near Byron Airport, and in areas farther south along this alignment, and are being created though are not yet functional at the adjacent Byron Vernal Pools Regional Preserve.

Mitigation Measure 4.6.2a on page 4.6-102 of the Draft EIS/EIR (Vol. 2, Section 4.6) is revised as follows to further protect wetland resources along pipeline corridors, in response to comment S_DFG-07.

> **Measure 4.6.2a:** Final project design shall avoid and minimize the fill of wetlands and other waters to the greatest practicable extent. No access vaults would be installed within the jurisdictional drainages that occur along any pipeline corridors. Areas that are avoided shall be subject to best management practices under the General National Pollutant Discharge Elimination System Permit, as described in Measure 4.5.1. The fill of wetlands at the proposed Western substation site shall be avoided by siting facilities within the study area so as to avoid impacts to such areas.

Mitigation Measure 4.6.10b on page 4.6-158 of the Draft EIS/EIR (Vol. 2, Section 4.6) is revised to include additional protection for Alameda whipsnake habitat, in response to comment S_DFG-14.

> **Measure 4.6.10b:** Consistent with MSCS guidelines, CCWD shall provide compensation for permanent and temporary loss of upland scrub habitat that may support Alameda whipsnakes by either (1) compensating for permanent habitat losses by acquiring, protecting, and managing 2 to 5 acres of existing occupied habitat for every acre within the same area of occupied habitat that would be affected, and/or (2) enhancing or restoring 2 to 5 acres of suitable habitat near the affected areas for every acre of occupied habitat affected (CALFED, 2000).
>
> Concurrent with other project requirements to mitigate for impacts to grasslands and oak woodland habitat, as summarized in Table 4.6-17, a portion of the total grassland and oak woodland mitigation requirement shall be chosen and preserved in perpetuity to provide linkages between other chaparral and scrub habitat, or to serve as foraging and movement habitat for Alameda whipsnake near existing scrub habitat patches. Mitigation shall be provided at a 1.1:1 mitigation ratio for all areas within 2,500 feet of core scrub habitat. Therefore, under Alternatives 1, 2 and 3, about 503.1 acres of the total grassland and oak woodland mitigation commitment would be located within 2,500 feet of areas that are considered to provide core Alameda whipsnake habitat. Under Alternative 4, about 173.8 acres of grassland mitigation lands would be provided for this purpose.

In response to comment O_SMD-07, Mitigation Measure 4.6.15b on pages 4.6-171 through 4.6-172 of the Draft EIS/EIR (Vol. 2, Section 4.6) is revised to add the following text after the second bullet on page 4.6-172 to explain the benefit to special status bats of implementing Mitigation Measure 4.6.1b.

> Implementation of Mitigation Measure 4.6.1b requires the creation, enhancement and preservation of a variety of habitat types, including valley oak, blue oak woodlands and Fremont cottonwood series. These habitats and this mitigation would additionally benefit special status bats and provide potential roosting habitat.

Table 4.6-9 on page 4.6-84 of the Draft EIS/EIR (Vol. 2, Section 4.6) is revised to correctly show that vernal pool impacts are permanent, not temporary, in response to comment F_EPA-02. The corrections are shown on the second page of revised Table 4.6-9, below.

Section 4.8 Agriculture

Mitigation Measure 4.8.2b on pages 4.8-21 through 4.8-22 of the Draft EIS/EIR (Vol. 2, Section 4.8) is revised to increase the ratio of the agricultural conservation easement required and to clarify how the easements are to be negotiated in response to comments S_DOC-4 and L_EBRPD-38.

> **Measure 4.8.2b:** CCWD will provide the following mitigation for the permanent conversion of Important Farmland:
>
> For each acre of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance that is permanently converted to nonagricultural use, 1.5 acres of agricultural conservation easement will be obtained. An agricultural conservation easement is a voluntary, recorded agreement between a landowner and a holder of the easement that preserves the land for agriculture. The easement places legally enforceable restrictions on the land. The exact terms of the easement are to be negotiated in coordination with a local agriculture land trust, but restricted activities will include subdivision of the property, non-farm development, and other uses that are inconsistent with agricultural production. The mitigation lands must be of equal or better quality (according to the latest available FMMP data) and have an adequate water supply. In addition, the mitigation lands must be within the same county. Information presented in Table 4.8-6 indicates that this compensatory mitigation would require acquisition of easements on about ~~22~~33 acres (22 acres of impact x 1.5 acres mitigation) of Farmland of Statewide Importance or better quality farmland, preferably within Contra Costa County.
>
> **Impact Significance after Mitigation:** Significant and unavoidable. These mitigation measures would reduce the impact of the proposed conversion of Farmland of Statewide Importance to nonagricultural uses, but not to a less than significant level.

Impact 4.8.4 on page 4.8-24 of the Draft EIS/EIR (Vol. 2, Section 4.8) regarding the project's contribution to cumulative impacts from conversion of Important Farmland to nonagricultural uses is revised to reflect the reduction in the project's contribution to cumulative effects under Alternatives 1 and 2 would be reduced to Less-than-Significant With Mitigation associated with the increased ratio of the agricultural conservation easement required under revised Mitigation Measure 4.8.2b:

> **Impact 4.8.4: The project would involve changes in the environment that, due to their location or nature, could contribute to cumulative impacts from conversion of Important Farmland to nonagricultural uses. (Less-than-Significant for Alternative 4; Less-than-Significant with Mitigation for Alternatives 1, 2, and 3~~; Significant and Unavoidable for Alternatives 1 or 2~~)**

REVISED DRAFT EIS/EIR TABLE 4.6-9
SENSITIVE PLANT COMMUNITY IMPACTS BY PROJECT COMPONENT (ACRES)[a]

	Alternatives 1 and 2			Alternative 3			Alternative 4		
Project Component	**Temporary**	**Permanent**	**Total**	**Temporary**	**Permanent**	**Total**	**Temporary**	**Permanent**	**Total**
In-Watershed Facilities									
Reservoir Inundation Footprint and Dam									
Blue oak series	0.00	68.61	68.61	0.00	68.61	68.61	0.00	17.55	17.55
Bulrush-cattail series	0.00	2.50	2.50	0.08	2.50	2.50	0.00	1.95	1.95
Fremont cottonwood series	0.00	0.94	0.94	0.00	0.94	0.94	0.00	0.00	0.00
Purple needlegrass series	0.00	0.34	0.34	0.00	0.34	0.34	0.00	0.00	0.00
Saltgrass series	0.00	0.08	0.08	0.00	0.08	0.08	0.00	0.08	0.08
Valley oak series	0.00	29.15	29.15	0.00	29.15	29.15	0.00	16.42	16.42
Valley oak mitigation plantings	0.00	128.03	128.03	0.00	128.03	128.03	0.00	128.03	128.03
Blue oak mitigation plantings	0.00	9.02	9.02	0.00	9.02	9.02	0.00	9.02	9.02
Subtotal	**0.00**	**238.67**	**238.67**	**0.08**	**238.67**	**238.67**	**0.00**	**173.04**	**173.04**
Other In-Watershed Facilities [b]									
Bush seepweed series	0.38	0.00	0.38	0.38	0.00	0.38	0.38	0.00	0.38
Blue oak series	5.73	18.79	24.53	5.73	18.79	24.53	3.25	11.84	15.09
Bulrush-cattail series	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.09
Fremont cottonwood series	0.02	0.05	0.07	0.02	0.05	0.07	0.02	0.07	0.09
Purple needlegrass series	0.09	0.23	0.32	0.09	0.23	0.32	0.04	0.08	0.12
Valley oak series	0.31	0.64	0.95	0.31	0.64	0.95	0.43	0.94	1.37
Valley oak mitigation plantings	0.00	4.1	4.1	0.00	4.1	4.1	0.00	0.00	0.00
Subtotal	**6.53**	**19.71**	**26.25**	**6.53**	**19.71**	**26.25**	**4.12**	**13.02**	**17.14**
Delta Intake Facilities									
Bulrush-cattail series	0.08	0.22	0.30	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	**0.08**	**0.22**	**0.30**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Delta-Transfer Pipeline									
Saltgrass series	0.30	0.00	0.30	0.30	0.00	0.30	0.00	0.00	0.00
Valley oak series	1.63	0.00	1.63	1.63	0.00	1.63	0.00	0.00	0.00
Subtotal	**1.93**	**0.00**	**1.93**	**1.93**	**0.00**	**1.93**	0.00	0.00	0.00
Transfer-LV Pipeline									
Bulrush-cattail series	0.24	0.00	0.24	0.24	0.00	0.24	0.00	0.00	0.00
Fremont cottonwood series	0.11	0.00	0.11	0.11	0.00	0.11	0.00	0.00	0.00
Saltgrass series	0.22	0.00	0.22	0.22	0.00	0.22	0.00	0.00	0.00
Valley oak series	0.10	0.00	0.10	0.10	0.00	0.10	0.00	0.00	0.00
Subtotal	**0.67**	**0.00**	**0.67**	**0.67**	**0.00**	**0.67**	**0.00**	**0.00**	**0.00**

REVISED DRAFT EIS/EIR TABLE 4.6-9
SENSITIVE PLANT COMMUNITY IMPACTS BY PROJECT COMPONENT (ACRES)[a]

	Alternatives 1 and 2			Alternative 3			Alternative 4		
Project Component	**Temporary**	**Permanent**	**Total**	**Temporary**	**Permanent**	**Total**	**Temporary**	**Permanent**	**Total**
Transfer-Bethany Pipeline									
Bulrush-cattail series	0.23	0.00	0.23	0.00	0.00	0.00	0.00	0.00	0.00
Bush seepweed	0.22	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00
Saltgrass series	0.95	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00
Northern claypan vernal pool	~~0.86~~ 0.00	~~0.00~~ 0.86	0.86	0.00	0.00	0.00	0.00	0.00	0.00
Subtotal	**~~2.26~~ 1.40**	**~~0.00~~ 0.86**	**2.26**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Power Option 1[c]									
Northern claypan vernal pool	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bulrush-cattail series	<0.1	0.00	<0.1	<0.1	0.00	<0.1	0.00	0.00	0.00
Bush seepweed	0.0	0.00	0.0	0.0	0.00	0.0	0.00	0.00	0.00
Subtotal	**<0.1**	**0.00**	**<0.1**	**<0.1**	**0.00**	**<0.1**	**0.00**	**0.00**	**0.00**
Power Option 2 [c]									
Northern claypan vernal pool	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bulrush-cattail series	<0.1	0.00	<0.1	<0.1	0.00	<0.1	0.00	0.00	0.00
Bush seepweed	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fremont cottonwood	**<0.1**	0.00	**<0.1**	**<0.1**	0.00	**<0.1**	0.00	0.00	0.00
Subtotal									
Total Impacts to Sensitive Habitats									
Bush seepweed series	6.73	1.32	8.05	6.50	1.32	7.82	0.38	0.00	0.38
Blue oak series	5.73	87.40	93.14	5.73	87.40	93.14	3.25	29.39	32.64
Bulrush-cattail series	1.40	2.72	4.11	1.40	2.72	4.11	0.00	2.03	2.03
Fremont cottonwood series	0.18	0.99	1.18	0.18	0.99	1.18	0.02	0.07	0.09
Northern claypan vernal pool	~~0.93~~ 0.07	~~0.00~~ 0.86	0.93	0.07	0.0	0.07	0.00	0.00	0.00
Purple needlegrass series	0.09	0.56	0.66	0.09	0.56	0.66	0.04	0.08	0.12
Saltgrass series	1.48	0.08	1.56	0.52	0.08	0.60	0.00	0.08	0.80
Valley oak series	2.03	29.79	31.83	2.04	29.79	31.83	0.43	17.36	17.79
Valley oak mitigation plantings	0.00	132.13	132.13	0.00	132.13	132.13	0.00	132.13	132.13
Blue oak mitigation plantings	0.00	9.02	9.02	0.00	9.02	9.02	0.00	9.02	9.02

[a] "Temporary" impacts, as used in this analysis, include habitats that would be degraded or similarly impaired, with features being restored *in situ* to emulate pre-project conditions. "Permanent" impacts are those that would permanently destroy features, with compensatory mitigation provided in alternate locations.
[b] Other in-watershed facilities under Alternatives 1, 2, and 3 include the marina, marina access road, borrow area, picnic areas, trailhead parking, westside access road, eastside trail, stockpile area, and parking areas. Facilities under Alternative 4 include the above facilities, and 160 TAF borrow area.
[c] Note that plant community impacts for Power Supply Infrastructure do not include the acreage of features that will be avoided by facilities or spanned by powerlines.

SOURCE: ESA unpublished data, 2006-2008

Text under the discussions for Alternatives 1 and 2 under Impact 4.8.4 on pp 4.8-25 through 4.8-26 of the Draft EIS/EIR (Vol. 2, Section 4.8) is revised as follows to reflect the reduction in the project's contribution to cumulative effects associated with the increased ratio of the agricultural conservation easement required under revised Mitigation Measure 4.8.2b:

Alternative 1

Text on Draft EIS/EIR page 4.8-25, final paragraph under the Alternative 1 discussion is revised as follows:

The incremental contribution of farmland conversion associated with the proposed project would be a cumulatively considerable contribution to a significant cumulative impact. This impact would be significant but would be mitigated to Less-than-Significant with implementation of Mitigation Measures 4.8.2a and 4.8.2b, which provide for minimizing construction effects on farmland during and following project construction activities as well as compensation through acquisition of agricultural conservation easements at a ratio of 1.5 to 1.

Alternative 2

Text on Draft EIS/EIR, pp 4.8-25 and 4.8-26, under the Alternative 2 discussion is revised as follows:

Under Alternative 2, which would construct the same facilities as Alternative 1, the proposed project would contribute to a significant cumulative impact with respect to the cumulative conversion of Farmland of Statewide Importance to nonagricultural use~~, even with implementation of Mitigation Measure 4.8.2a and 4.8.2b~~. The incremental contribution of farmland conversion associated with the proposed project would be a cumulatively considerable contribution to a significant cumulative impact. Under Alternative 2, this impact would ~~therefore~~ be significant, but would be mitigated to a less than significant level with implementation of Mitigation Measures 4.8.2a and 4.8.2b, which provide for minimizing construction effects on farmland during and following project construction activities as well as compensation through acquisition of agricultural conservation easements at a ratio of 1.5 to 1.

The last two paragraphs under Impact 4.8.4 on page 4.8-26 of the Draft EIS/EIR (Vol. 2, Section 4.8) are revised to clarify that with implementation of Mitigation Measures 4.8.1, 4.8.2a and revised Mitigation Measure 4.8.2b, the contribution to cumulative impacts from conversion of Important Farmland to nonagricultural uses under Alternatives 1 and 2 would be reduced to Less-than-Significant With Mitigation.

Mitigation Measure

Implementation of Agricultural Resources Mitigation Measures 4.8.1 and 4.8.2 (a and b) would ~~minimize potential impacts under Alternatives 1 and 2; however, those measures would not~~ reduce cumulative impacts to less than significant levels for Alternatives 1 and 2. ~~The level of significance after mitigation would be a significant and unavoidable cumulative impact for Alternatives 1 and 2.~~ With Mitigation Measure 4.8.2a, Alternative 3 would not result in a cumulatively considerable contribution to a significant impact on agriculture.

> **Impact Significance after Mitigation:** ~~Significant and Unavoidable for Alternatives 1 or 2;~~ Less-than-Significant ~~for Alternatives 3 and 4~~.

Section 4.9 Transportation and Circulation

The last bullet on page 4.9-9 of the Draft EIS/EIR (Vol. 2, Section 4.9) is revised to clarify that the bullet item is referring to the pipeline work site and not the project work sites in response to comment L_CCCDCD-03.

> An estimated 25 percent of the excavated soil would be hauled away from the pipeline work sites for disposal or reuse elsewhere.

Section 4.10 Air Quality

Table 4.10-10 on page 4.10-34 of the Draft EIS/EIR (Vol. 2, Section 4.10) is revised to include the incremental increase in project generated electrical use GHG emissions when compared to existing conditions, and to clarify that the last column reflects the incremental increase in the future without the project.

TABLE 4.10-10 (REVISED)
INDIRECT GHG EMISSIONS FROM PROJECT ELECTRICITY USE (METRIC TONS/YEAR)[1]

Operational Emissions	Total Metric Tons/Year CO_2E	Incremental Increase (vs Existing)[3]	Incremental Increase (vs Future Without Project)[4] ~~Increase in Metric Tons/Year CO_2E[3]~~
Existing	23,300	n/a	n/a
Future Without Project[2]	26,000	2,700	n/a
Alternative 1	33,800	10,500	7,900
Alternative 2	34,900	11,600	9,000
Alternative 3	30,400	7,100	4,400
Alternative 4	26,400	3,100	500

1 Metric tons/year of CO_2E were calculated using the *California Climate Action Registry General Reporting Protocol* emission factors and methodology. See Appendix H for more details.
2 "Future Without Project" includes power required for pumping at Banks and Jones Pumping Plants needed to deliver water to the SBA, SCVWD via San Luis Reservoir, and power required at CCWD's pumping facilities.
3 "Incremental Increase (vs Existing)" shows the increase in the total emissions for each alternative compared existing conditions.
4~~3~~ "Incremental Increase (vs Future Without Project)"~~"Increase in Metric Tons/Year"~~ shows the increase in the total emissions for each alternative compared to the emissions for "Future Without Project" conditions

SOURCE: ESA, 2008; California Climate Action Registry, 2008; CCWD, 2008

The third full paragraph on page 4.10-36 of the Draft EIS/EIR (Vol. 2, Section 4.10) is revised to clarify what information is presented in the revised Table 4.10-10.

> With implementation of the project alternatives GHG emissions during construction for a worse-case year would range from approximately 19,600 metric tons CO_2E (Alternative 4) to 22,550 metric tons CO_2E (Alternatives 1 and 2). These construction emissions represent

approximately 0.02 to 0.03 percent, of Bay Area GHGs emitted in 2002, respectively.[1] As shown in Table 4.10-10, the increase in indirect GHG emissions from project electricity use for each alternative versus the "Existing" scenario would be no more than 11,600 metric tons/year CO_2E. Also~~As~~ shown in Table 4.10-10~~8~~, the increase in indirect GHG emissions from project electricity use for each alternative versus the "Future Without Project" scenario would be no more than 9,000 metric tons/year CO_2E. In comparison to Bay Area GHG emissions, the project alternatives' ~~future~~ increases in annual operational emissions versus "Existing" and versus "Future Without Project", respectively, represent approximately 0.01 and 0.009 percent (Alternative 1), 0.01 and 0.01 percent (Alternative 2), 0.008 and 0.005 percent (Alternative 3), and 0.004 and 0.0006 percent (Alternative 4) of total Bay Area GHGs emitted in 2002. The 2020 GHG emissions limit for California, as adopted by CARB in December of 2007 is approximately 427 million metric tons of CO_2E. In comparison to this emissions limit, ~~T~~the proposed project's annual ~~contribution~~ operational emissions versus "Existing" and versus "Future without Project", respectively, represent ~~would be~~ approximately 0.002 and 0.002 percent (Alternative 1), 0.003 and 0.002 percent (Alternative 2), 0.002 and 0.001 percent (Alternative 3), and 0.0007 and 0.0001 percent (Alternative 4) of this total 2020 emissions limit.

Section 4.12 Utilities and Public Service Systems

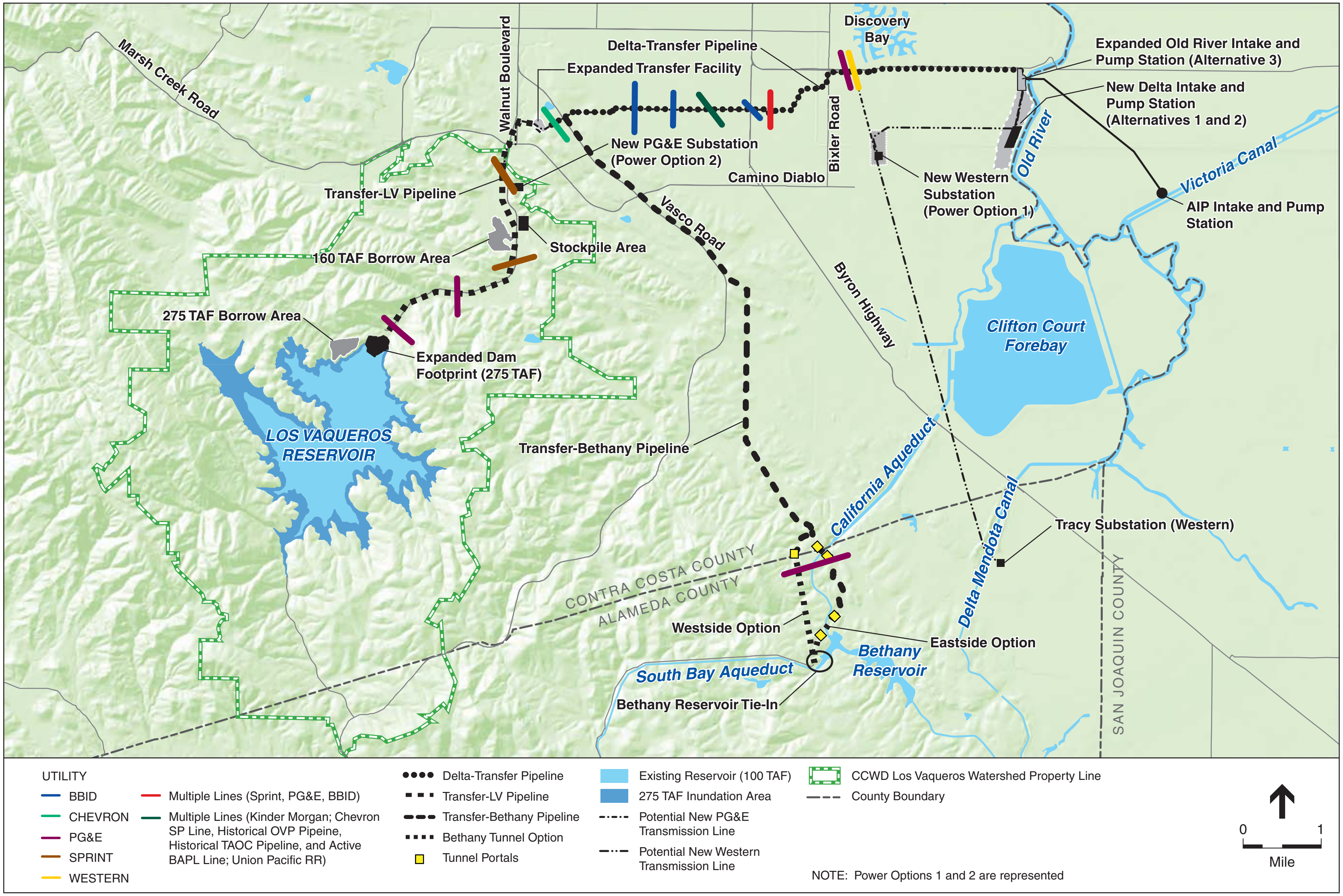
Figure 4.12-1 Potential Utility Crossings, on page 4.12-3 of the Draft EIS/EIR (Vol. 2, Section 4.12) is revised as shown on the following page. The revised figure shows both active and historic utility pipelines in response to comment O_CEMC-01.

The third full paragraph on page 4.12-5 of the Draft EIS/EIR (Vol. 2, Section 4.12) is revised to clarify the location of existing utility infrastructure in the Los Vaqueros Reservoir watershed in response to comment O_CEMC-01**.**

Utility Infrastructure

Major utility infrastructure within the Los Vaqueros Reservoir watershed includes three buried natural gas pipelines; an overhead PG&E electricity transmission line; two buried PG&E gas lines; and a buried fiber-optic communications line operated by Sprint. To the northeast of the Los Vaqueros Reservoir watershed lie several irrigation lines owned by BBID, ~~two~~ multiple buried petroleum pipelines (active and historical) owned and operated by Chevron/Unocal and Kinder Morgan, a few Sprint fiber-optic cable lines, a PG&E natural gas line, and an overhead electricity line operated by Western.

[1] The Bay Area Air Quality Management District reported regional Bay Area GHGs emissions in 2002 at approximately 85 million CO_2E tons. Bay Area 2002 GHG emissions are used as the baseline for determining whether a project's contributions are significant as these are the most recent emissions inventory for the Bay Area.



SOURCE: USGS, 1993 (base map); CEMC, 2009; ESA, 2008; and ESA, 2010

Los Vaqueros Reservoir Expansion Project EIS/EIR . 201110

Revised Draft EIS/EIR Figure 4.12-1
Potential Utility Crossings

The fourth full paragraph on page 4.12-12 of the Draft EIS/EIR (Vol. 2, Section 4.12) is revised to clarify that existing pipelines may potentially be disrupted during construction of Alternative 1 or 2 in response to comment O_CEMC-1.

> As shown in Figure 4.12-1, the Delta-Transfer Pipeline would cross as many as six BBID irrigation lines; three active petroleum pipelines (Chevron's Kettleman-Los Medanos Pipeline, Chevron's Bay Area Products Line, and one Kinder Morgan pipeline) and two historical petroleum pipelines (Chevron's double Tidewater Associated Oil Company Pipeline and Old Valley Pipeline); a Sprint fiber-optic cable line; a Western transmission overhead line; and two PG&E 500 kV overhead transmission lines. The Delta-Transfer pipeline would also cross the Union Pacific Railroad tracks. As described in Section 3.5.2, Pipeline Construction, the bore-and-jack method would be used to pass under the railroad crossing.

4.15 Recreation

The fourth full paragraph on page 4.15-12 of the Draft EIS/EIR (Vol. 2, Section 4.15) is revised to clarify the anticipated period when recreational activities in the Los Vaqueros Watershed would be restricted under Alternative 1.

> Alternative 1 has the potential to impact recreational opportunities and experiences in the short-term due to the 3-year closure of the watershed, additional 1-year reservoir draining period when recreation activities at the reservoir would be increasingly restricted and 1-year refilling period when recreation activities would be reopened in phases, ~~2-year restriction on water-related activities are restricted (i.e., water recreation would be closed a total of 5 years to allow for reservoir drainage, dam modification construction and expanded reservoir refill)~~, and a potential …

The first full paragraph on page 4.15-16 of the Draft EIS/EIR (Vol. 2, Section 4.15) is revised to correct data presented for Los Vaqueros Watershed visitor use in 2007-2008.

> According to CCWD staff, in 2002, about 90 percent of Los Vaqueros visitor use was for fishing (Nuzum, 2002). More recently, during the 2007-2008 fiscal year, 17,913 ~~20,237~~, or 75 ~~85~~ percent of the visitors to the reservoir, purchased daily fishing access pass permits.

The first paragraph under Impact 4.15-3 on page 4.15-19 of the Draft EIS/EIR (Vol. 2, Section 4.15) is revised to clarify the anticipated period when recreational activities in the Los Vaqueros Watershed would be restricted under Alternatives 1, 2 and 3.

> As described under Impact 4.15.1, the project under Alternatives 1, 2, and 3 would result in a short-term reduction of recreational opportunities during ~~the~~ reservoir ~~drawdown~~ construction ~~and subsequent refilling~~ due to the need to close the Los Vaqueros Watershed and all recreational activities to public use, and during the 1-year pre-construction draining period and 1-year post-construction refill period when recreation activities would be restricted.

Mitigation Measure 4.15.1b on page 4.15-15 of the Draft EIS/EIR (Vol. 2, Section 4.15) is revised to include mitigation to protect the Byron Vernal Pools Regional Preserve, in response to several comments about the new preserve.

> **Measure 4.15.1b:** If EBRPD's proposed Delta Trail Extension or Byron Vernal Pools Regional Preserve is developed and open to the public before or during construction of the new Delta Intake and Pump Station and Transfer-Bethany Pipeline, respectively, CCWD shall provide EBRPD with an anticipated closure schedule; prepare and implement a public outreach program and promote the program via the web, billing inserts, and other methods to inform current and potential recreational trail users of the temporary closure of the Delta Trail Extension or Byron Vernal Pools Regional Preserve and inform customers of other recreational ~~trail~~ opportunities in the area; and place signage to the north and south of the new Delta Intake and Pump Station site or Byron Vernal Pools Regional Preserve along the trail or Armstrong Road to inform recreational users of the trail/preserve closure, alternative ~~trail~~ recreational options, and anticipated timing for the reopening.

Mitigation Measure 4.15.1 of the Draft EIS/EIR (Vol. 2, Section 4.15, pg. 4.15-15) is added to ensure timely completion of recreational facilities.

> **Measure 4.15.1c:** Recreational facilities displaced by reservoir expansion would be replaced within one year of completion of construction activities associated with all major facility components.

4.16 Cultural and Paleontological Resources

Mitigation Measure 4.16.1 on pages 4.16-47 through 4.16-49 of the Draft EIS/EIR (Vol. 2, Section 4.16) is revised to include an additional mitigation measure in response to a comment S_Caltrans-02.

> **Measure 4.16.1i**: Los Vaqueros Reservoir Expansion; Dam Modification; and Other Sites Where Cultural Resources Cannot Be Avoided. In the event there is an inadvertent archaeological or burial discovery within State ROW, the Caltrans Office of Cultural Resources Studies, District 4, Oakland, shall be immediately contacted at (510)286-5618. A staff archaeologist will evaluate the finds within one business day of being contacted by CCWD representatives. A data recovery plan and all subsequent reports for investigations within State ROW will need to be approved by the Office of Cultural Resources Studies, District 4.

Section 4.17 Socioeconomics

Impact statement 4.17-5 on page 4.17-20 of the Draft EIS/EIR (Vol. 2, Section 4.17) is revised to correctly refer to permanent loss rather than temporary loss of agricultural land uses and to reflect the reduction in the project's contribution to cumulative effects associated with the increased ratio of the agricultural conservation easement required under revised Mitigation Measure 4.8.2b.

> **Impact 4.17.5: Construction of the project alternatives, when combined with construction of other future projects, could have a potential cumulative effect on Contra Costa County's economy as a result of ~~temporary~~ permanent loss of agricultural**

land uses. (Less-than-Significant for Alternatives 1 – 4.~~ 3 or 4; Significant and Unavoidable Less Than Significant for Alternatives 1 or and 2~~)

Text under the discussions for Alternatives 1 and 2 under Impact 4.17-5 on pp 4.17-20 through 4.17-21 of the Draft EIS/EIR (Vol. 2, Section 4.17) is revised as follows to reflect the reduction in the project's contribution to cumulative effects associated with the increased ratio of the agricultural conservation easement required under revised Mitigation Measure 4.8.2b:

Alternative 1

Impact 4.17.2 indicates that the socioeconomic impacts associated with temporary loss of agricultural land use resulting from construction activities would be Less-than-Significant. Due to the small area affected by these impacts and the temporary nature of the construction activities, these impacts were determined to be negligible in relation to the overall regional economy. However, in Section 4.8, the agricultural analysis determined that the project would have significant cumulative impact on the region's agricultural resources because the project would result in the permanent reduction of Important Farmland (Impact 4.8.4).

With or without the project, the trend of land conversion from agricultural uses to urban and other non-agricultural uses (e.g., wildlife habitat enhancement) in the Central Valley would continue. It is likely that other future projects~~, such as expansion of Discovery Bay into the Cecchini Ranch property~~ particularly large development projects that would require large tracts of land, would convert agricultural lands to non-agricultural uses; these lands may or may not be designated Prime Farmland, Unique Farmland, and Farmland of Statewide Importance and may or may not be under Williamson Act contracts.

As a number of the proposed projects listed in Appendix I, "Local Development Projects Considered in Cumulative Impact Analyses," are not yet in the environmental planning stage, the acreage of Prime Farmland, Unique Farmland, and Farmland of Statewide Importance that could be converted by these projects is not known. However, in general, the acreage of Prime Farmland, Unique Farmland, and Farmland of Statewide Importance in Contra Costa County and, to a lesser degree, in Alameda County, is expected to decline. The proposed project would contribute incrementally to this decline. However, with implementation of Mitigation measure 4.8.2b, which provides for acquisition of agricultural conservation easements at a ratio of 1.5:1 to protect farmland from future development, the incremental contribution of farmland conversion associated with the proposed project would not be a cumulatively considerable contribution to an existing significant cumulative impact. This impact would therefore be Less-than-Significant ~~and unavoidable~~ with Mitigation.

Alternative 2

Under Alternative 2, which would construct the same facilities as Alternative 1, the project would result in a Less-than-Significant ~~and unavoidable~~ cumulative impact with respect to the cumulative conversion of Farmland of Statewide Importance to non-agricultural use.~~, even~~ with implementation of mitigation Measure 4.8.2a and 4.8.2b. The incremental contribution of farmland conversion associated with the proposed project would not be a cumulatively considerable contribution to an existing significant cumulative impact. Under Alternative 2, this impact would ~~therefore~~ be Less-than-Significant ~~and unavoidable~~ with Mitigation.

The first two paragraphs on page 4.17-22 of the Draft EIS/EIR (Vol. 2, Section 4.17) are revised to clarify that with implementation of Mitigation Measures 4.8.1, 4.8.2a and revised Mitigation Measure 4.8.2b, the contribution to cumulative impacts from conversion of Important Farmland to nonagricultural uses would be reduced to Less-than-Significant.

Mitigation Measure

Implementation of Agricultural Resources Mitigation Measures 4.8.1 and 4.8.2 (a and b) would minimize potential impacts under Alternatives 1 and 2;~~ however, those measures~~ and would ~~not~~ reduce cumulative impacts to less than significant levels. The level of significance after mitigation would be Less-than-Significant with Mitigation ~~a significant and avoidable cumulative impact~~.

Impact Significance after Mitigation: Less-than-Significant~~ and Unavoidable for Alternatives 1 or 2; Less than Significant for Alternatives 3 and 4~~.

5.3 Updated Draft EIS/EIR Sections 4.2 and 4.3

This section contains updated Section 4.2, Delta Hydrology and Water Quality and Section 4.3 Delta Fisheries and Aquatic Resources, in their entirety from the Draft EIS/EIR (Vol. 1, Chapter 4) with text revisions that reflect the results of updated modeling analyses. The following introductory text explains why additional modeling analyses have been completed since publication of the Draft EIS/EIR and what they entailed.

Delta Hydrology and Water Quality

Section 4.2 of the Draft EIS/EIR has been updated to incorporate regulations influencing the affected environment and project assumptions that have occurred since the analysis presented in the Draft EIS/EIR was completed, as well as other modifications made in response to comments on the Draft EIS/EIR. The updated Section 4.2 presents modeling methodology and results of the analysis of potential effects on Delta hydrology and water quality, based on the updated modeling analysis performed for the Final EIS/EIR. The updated Section 4.3 presents modeling methodology and results of impacts analysis for Delta fisheries and aquatic resources. Additional information on modeling methodology and results for these updated analyses are presented in the updated Appendix C (Vol. 4 on CD).

The updates from the Draft EIS/EIR analysis that have been included in the modeling analysis performed for the Final EIS/EIR include:

- **An updated presentation of the 2008 U.S. Fish and Wildlife Services (USFWS) Operations Criteria and Plan (OCAP) Biological Opinion (BO) effects on Delta operations is included in the updated modeling analysis.** On December 15, 2008, USFWS issued an OCAP BO for delta smelt and its critical habitat governing the coordinated operations of CVP and SWP. The terms of the USFWS OCAP BO require changes to the prior operation of the CVP and SWP in the Delta. While this Biological Opinion was released prior to publication of the Draft EIS/EIR, the resulting changes in CVP and SWP operations had not yet been incorporated into the CalSim II model; instead two sets of assumptions were used in the Draft EIS/EIR (moderate restrictions and severe restrictions) to bracket the potential effects of the BO. To ensure that the modeling analysis of the Los Vaqueros Reservoir Expansion Project more precisely captures any effects of the project alternatives resulting from the operation of the CVP and SWP under the OCAP BOs, the analyses performed for this Final EIS/EIR have been updated to reflect the 2008 USFWS BO using CalSim II studies completed in August 2009 that incorporate the requirements of the OCAP BOs.

- **The effects of the 2009 National Marine Fisheries Service (NMFS) OCAP BO on Delta and upstream reservoir operations are included in the updated modeling analysis.** On June 4, 2009, the NMFS issued an OCAP BO for listed anadromous fish and marine mammal species and their critical habitats, including the Delta. The terms of the NMFS OCAP BO require changes to the prior operation of the CVP and SWP in the Delta. These changes to background conditions are now incorporated into the CalSim II model, and have been included in the updated modeling analysis presented in this section.

- **Assumptions about regulation of Old and Middle River (OMR) flow have been updated to reflect the terms of the USFWS and NMFS OCAP BOs.** The modeling analysis for the Draft EIS/EIR included restrictions on CVP and SWP exports from the Delta that were based on terms in the December 2007 court order in *NRDC vs. Kempthorne*, as modified to include further OMR flow requirements anticipated to be required for protection of longfin smelt. Due to uncertainty about future implementation of OMR flow restrictions at the time the Draft EIS/EIR analysis was performed, a bracketed approach was used in that analysis in which the best available information was used to predict the likely high and low bounds for OMR flow restrictions (moderate and severe restrictions). The analysis performed for the Final EIS/EIR incorporates updated modeling of CVP and SWP operations under the USFWS and NMFS OCAP BOs, which both include restrictions on OMR flows. Diversions at the CCWD Old River and AIP Intakes are included in the calculation of OMR net flow within the CalSim II model. The bracketed approach was not used in the CalSim II modeling. Remaining uncertainty regarding the implementation of OMR flow restrictions, which are adaptively managed based on real-time Delta water quality and fishery monitoring, is addressed in the Final EIS/EIR analysis through the use of multi-year model simulations, which capture a range of operations and potential effects.

- **Operations of the Los Vaqueros Reservoir Expansion Project were modified in response to comments received on the Draft EIS/EIR.** Both of the OCAP BOs described above contain new regulations on flow in OMR that are designed to protect the Delta fisheries. The studies include modeling assumptions that capture the export restrictions based on OMR flow. Operational assumptions have been updated for Alternatives 1 and 2 of the Los Vaqueros Reservoir Expansion Project so that increased diversions for Delta Supply Restoration or Dedicated Storage of Environmental Water are not made for those project alternatives when the new OMR flow regulations are controlling CVP and SWP exports from the Delta. Operations for Delta Supply Restoration and additional Dedicated Storage for Environmental Water are not included in Alternative 4; therefore, this updated assumption did not affect the analysis of Alternative 4.

- **Operational requirements from the new CCWD California Department of Fish and Game (CDFG) Incidental Take Permit (ITP) are included in the updated analysis.** In connection with permitting for the CCWD Alternative Intake Project (AIP), on November 5, 2009, the CDFG issued an ITP for the CCWD operations. This permit governs all CCWD operations in the Delta, and includes an extension to the no fill period for Los Vaqueros Reservoir. This modification is included in the updated analysis presented in this section.

- **The Rock Slough Fish Screen is assumed to be implemented under 2005 level of development with-project conditions and under 2030 level of development with- and without-project conditions.** As described in 3.1.3 of the Final EIS/EIR (Vol. 4, Section 3.1, Master Response 1: Project Purpose and Description), the Rock Slough Fish Screen is under construction; operation is scheduled to begin in 2011. Accordingly, the operation of the Rock Slough Fish Screen is included in model simulations of the project alternatives, and is also included in the Future Without Project condition. The Rock Slough Fish Screen is not included in model analysis of the Existing Condition because it was not approved when environmental review commenced.

- **Operational coordination between CCWD, Reclamation and DWR is included in the updated analysis based upon recent agency consultations.** CCWD, Reclamation and DWR have reviewed Delta water supply operations in light of the recently issued OCAP BOs and in light of comments on the Draft EIS/EIR, and have developed a potential set of modified operations for CCWD that improve overall coordination of Delta water operations, while maintaining water supply and water quality for CCWD, CVP and SWP. Operations include:

- The 75 to 90 day no fill period for Los Vaqueros Reservoir would be implemented in half or all of February and all of March and June, and the 30-day CCWD no diversion period would be implemented in March. This reduces the potential influence of filling Los Vaqueros Reservoir when OMR flow restrictions govern Delta operations. This operational modification is subject to consultation with USFWS, NMFS, and CDFG.

- During periods when OMR flow restrictions occur, the screened Rock Slough Intake would be used to the maximum extent possible for direct diversions to CCWD customers while maintaining the chloride delivery goal.

- Releases from Los Vaqueros Reservoir would be minimized from October through December, while still maintaining the chloride delivery goal for CCWD customers. Los Vaqueros Reservoir also would be filled during this period when water quality allows.

- When diversions from the Freeport Intake are available to CCWD pursuant to the agreement with EBMUD for shared use of this intake, these diversions would be used to fill Los Vaqueros Reservoir whenever other Delta water quality and CCWD operational conditions allow. This minimizes the potential effect of filling Los Vaqueros Reservoir on OMR flow.

These modified operations are included in the updated analysis of Alternatives 1, 2 and 4 presented in this section.

- Alternative 3 has not been included in the updated modeling analysis because the operations scenario presented in the Draft EIS/EIR is not environmentally superior to the proposed project or other alternatives. In the modeling analysis performed for the Draft EIS/EIR, Alternative 3 was found to have significant and unavoidable fishery impacts. Alternative 3 was considered as the Final EIS/EIR was prepared, but no improvement in environmental effects was anticipated with inclusion of the modified operations described above. Accordingly, Alternative 3 was not included in the updated modeling analysis performed for the Final EIS/EIR because it would not be environmentally superior to the other alternatives. See additional discussion of Alternative 3 in Chapter 2, Section 2.2, of the Final EIS/EIR (Vol. 4).

The results of the updated analysis, which are presented in the updated Sections 4.2 and 4.3, indicate that the analysis used in the Draft EIS/EIR captured the environmental impacts associated with the project alternatives. The updated modeling does not indicate any new or substantially more severe significant impacts on Delta water quality and aquatic resources. The coordinated operations evaluated in the Final EIS/EIR would further minimize the potential for the expansion project to adversely affect other CVP and SWP operations.

Delta Fisheries and Aquatic Resources

Section 4.3 of the Draft EIS/EIR has also been updated to include analysis based on the updated modeling analysis performed for the Final EIS/EIR. Updates to the analysis of potential impacts to fisheries and aquatic resources made since the Draft EIS/EIR include:

- The updated modeling described above for Delta hydrology and water quality is used as the basis for the analysis of Delta fisheries and aquatic resources presented in this section.

- The modeling analysis of potential impacts to fish in the Delta has been refined by adopting the Potential Entrainment Index methodology developed by DWR. This methodology is described in this section and in Appendix C (Vol. 4 on CD).

The updated Section 4.3 presents the results of analysis of potential effects on Delta fisheries and aquatic resources, based on the updated modeling analysis performed for the Final EIS/EIR. As described in Chapter 2 (Section 2.2) of this Final EIS/EIR (Vol. 4), Alternative 3 is not included in the updated modeling analysis. The Final EIS/EIR continues to analyze the physical features of Alternative 3 because it is possible that a future project could combine these physical features with substantially different operating assumptions. Therefore, in the Final EIS/EIR, all impact analyses that depend on the updated modeling analysis exclude Alternative 3 and all impact analyses that do not rely on modeling continue to address Alternative 3. For Section 4.3, this means that all impact analyses other than those describing Impacts 4.3.6, 4.3.7 and 4.3.9 continue to address Alternative 3.

The results of the updated analysis indicate changes to the estimated levels of project benefits in some cases, but do not indicate any changes in the conclusions of the potential environmental impacts of the project alternatives.

4.2 Delta Hydrology and Water Quality (Updated)

This section describes the existing surface water hydrology, supply, management, and water quality conditions of the Sacramento–San Joaquin Delta (the Delta), as well as the existing conditions within the Sacramento River downstream of Lake Shasta. The section also discusses the regulatory setting, including water rights and water service contracts, and provides an analysis of potential water supply, water quality, and water level impacts resulting from implementation of the project alternatives.

4.2.1 Affected Environment

Regulatory Setting

Federal

Clean Water Act

The Clean Water Act establishes the basic structure for regulating discharges of pollutants into "waters of the United States." The act specifies a variety of regulatory and non-regulatory tools to sharply reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff.

Section 303(d) requires states, territories, and authorized tribes to develop a list of water-quality limited segments of rivers and other water bodies under their jurisdiction. These waters on the list do not meet water quality standards, even after point sources of pollution have installed the minimum required levels of pollution control technology. The law requires that these jurisdictions establish priority rankings for waters on the list and develop action plans, called Total Maximum Daily Loads (TMDL), to improve water quality.

Delta waterways are included in the Central Valley Regional Water Quality Control Board's (CVRWQCB) list of 303(d) impaired waterways for the following constituents: chlorpyrifos, DDT (dichlorodiphenyltrichloroethane), diazinon, exotic species, group A pesticides, mercury, unknown toxicity, organic enrichment/low dissolved oxygen (Stockton Ship Canal), and electrical conductivity(water export area). Of these constituents, the U.S. Environmental Protection Agency (EPA) has approved TMDLs for the following: organic enrichment/low dissolved oxygen. TMDLs for other constituents remain under planning or development.

Section 401 requires every applicant for a federal permit or license for any activity that may result in a discharge to a water body to obtain a water quality certification that the proposed activity will comply with applicable water quality standards.

Section 402 regulates point- and nonpoint-source discharges to surface waters through the National Pollutant Discharge Elimination System (NPDES) program. In California, the State Water Resources Control Board (SWRCB) oversees the NPDES program, which is administered by the Regional Water Quality Control Boards (RWQCBs). The NPDES program provides for both general permits (those that cover a number of similar or related activities) and individual permits.

Section 404 of the Clean Water Act establishes a program to regulate the discharge of dredged and fill material into waters of the U.S., including some wetlands. Activities in waters of the U.S. that are regulated under this program include fills for development, water resource projects (e.g., dams and levees), infrastructure development (e.g., highways and airports), and conversion of wetlands to uplands for farming and forestry. Under Section 404(b)(1) of the Act, the Least Environmentally Damaging Practicable Alternative (LEDPA) must be identified from among those alternatives considered in detail in the EIS/EIR. If a federal agency is a partner in the implementation of a project, then the Proposed Action/Project must be recognized as the LEDPA. A 404(b)(1) evaluation will be included with the Final EIS/EIR pursuant to the Act to provide required information on the potential effects of the proposed action/project regarding water quality and rationale in support of identifying the LEDPA. This Draft EIS/EIR will be reviewed by concerned public and stakeholders with the opportunity to provide comments on the alternatives and documentation before making determinations of the Proposed Action/Project, LEDPA, environmentally preferred alternative, and environmentally superior alternative in the Final EIS/EIR.

Construction of the proposed project, including construction of the proposed intake facilities, pipelines, expanded reservoir, appurtenant facilities, and other associated facilities, would be subject to regulation under Sections 401, 402, and/or 404 of the Clean Water Act.

Rivers and Harbors Act

The U.S. Army Corps of Engineers (USACE) regulates the construction of any structure or work within navigable waters under Sections 9 and 10 of the Rivers and Harbors Act. The USACE regulates the construction of wharves, breakwaters, and jetties; bank protection and stabilization projects; permanent mooring structures, vessels, and marinas; intake and outfall pipes; canals; boat ramps; aids to navigation; and other modifications affecting the course, location, condition, and capacity of navigable waters. The USACE jurisdiction under the Rivers and Harbors Act is limited to "navigable waters," or waters subject to the ebb and flow of the tide shoreward to the mean high water mark that may be used for interstate or foreign commerce.

The USACE must consider the following criteria when evaluating projects within navigable waters: (1) the public and private need for the project; (2) reasonable alternative locations and methods; and (3) the beneficial and detrimental effects on the public and private uses to which the area is suited. The Rivers and Harbors Act would be applicable to the new Delta Intake and Pump Station.

Central Valley Project Improvement Act

The Central Valley Project Improvement Act (1992) amended the previous authorizations of the Central Valley Project (CVP) to include fish and wildlife protection, restoration, and mitigation as project purposes having equal priority with irrigation and domestic uses, and fish and wildlife enhancement as a project purpose equal in priority to power generation. It is described in Section 2.3.1.

The CVP Improvement Act is relevant to all aspects of the project alternatives that would result in diversion of CVP water from the Delta, or use of CVP water to enhance fish and wildlife.

Safe Drinking Water Act

The Safe Drinking Water Act was established to protect the quality of waters actually or potentially designated for drinking use, whether from aboveground or underground sources. Contaminants of concern in a domestic water supply are those that either pose a health threat or in some way alter the aesthetic acceptability of the water. Primary and secondary maximum contaminant levels (MCLs) are established for numerous constituents of concern including turbidity, total dissolved solids (TDS), chloride (Cl), fluoride, nitrate, priority pollutant metals and organic compounds, selenium, bromate, trihalomethane and haloacetic acid precursors, radioactive compounds, and gross radioactivity. All domestic water suppliers must follow the requirements established by this Act and its associated amendments.

Surface Water Treatment Rule

The Federal Surface Water Treatment Rule is implemented by the California Surface Water Treatment Rule, which satisfies three specific requirements of the Safe Drinking Water Act by: (1) establishing criteria for determining when filtration is required for surface waters; (2) defining minimum levels of disinfection for surface waters; and (3) addressing *Cryptosporidium spp., Giardia lamblia, Legionella spp., E. Coli,* viruses, turbidity, and heterotrophic plate count by setting a treatment technique. A treatment technique is set in lieu of an MCL for a contaminant when it is not technologically or economically feasible to measure that contaminant. The Surface Water Treatment Rule applies to all drinking water supply activities in California; its implementation is overseen by the California Department of Health Services (DHS).

Stage 1 and Stage 2 Disinfectants and Disinfection Byproducts Rule and Long-Term 1 and Long-Term 2 Enhanced Surface Water Treatment Rule

The Stage 1 Disinfectants and Disinfection Byproducts Rule established maximum residual disinfectant level goals and maximum residual disinfectant levels for chlorine, chloramines, and chlorine dioxide. It also establishes MCL goals and MCLs for trihalomethanes, five haloacetic acids, chlorite, and bromate. The primary purpose of the Long-Term 1 Enhanced Surface Water Treatment Rule is to improve microbial control, especially for *Cryptosporidium*.

Water systems that use surface water and conventional filtration treatment are required to remove specified percentages of organic materials, measured as total organic carbon (TOC), which may react with disinfectants to form disinfection byproducts (DBPs). Removal is to be achieved through a treatment technique (e.g., enhanced coagulation or enhanced softening), unless the system meets alternative criteria.

The U.S. EPA adopted the Stage 2 Microbial and Disinfection Byproducts Rules in January 2006. The Rules include both the Stage 2 Disinfectants and Disinfection Byproducts Rule and Long-Term 2 Enhanced Surface Water Treatment Rule. These rules include revised and new requirements, such as water systems having to meet DBP MCLs at each monitoring site in the distribution system, rather than averaging multiple sites. The rules also contain a risk-targeting approach to better identify monitoring sites where customers are exposed to high levels of DBPs. The rules include new requirements for treatment efficacy and *Cryptosporidium* inactivation/removal, as well as new standards for DBPs, disinfectants, and potential contaminants.

The overall goal of this group of regulations is to balance the risks from microbial pathogens with those from carcinogenic DBPs. All domestic water suppliers must follow the requirements of these rules, which are overseen by DHS.

Coordinated Operations Agreement

The Coordinated Operations Agreement (COA), signed in 1986, is an agreement between the State of California (represented by the Department of Water Resources [DWR]) and the federal government (represented by the U.S. Department of the Interior, Bureau of Reclamation, Mid-Pacific Region [Reclamation]). The purpose of the COA is to coordinate the operations of the CVP and the State Water Project (SWP). The COA defines each project's responsibility to protect other beneficial uses of water, and defines the sharing of excess water between the projects.

The procedure for sharing responsibility for demands and for sharing excesses of water is defined under two conditions: balanced water conditions and excess water conditions. Balanced water conditions occur when upstream releases plus unregulated flows equal the water supply needed to meet in-basin uses plus CVP and SWP Delta diversions, which include withdrawals under CVP and SWP water right permits at the Jones (formerly Tracy) Pumping Plant, the Banks Pumping Plant, the Contra Costa Canal Pumping Plant #1, and the North Bay Aqueduct. Excess water conditions occur when upstream releases plus unregulated flows exceed the water supply needed to meet in-basin uses plus SWP and CVP Delta diversion.

The COA stipulates that the CVP and SWP will coordinate responsibility for meeting Sacramento Valley in-basin use and for sharing any unstored water for export. When stored water is needed for in-basin use then the CVP agrees to provide 75 percent of the water necessary to meet the standard while the SWP provides the remaining 25 percent. If unstored water is available for export, then the CVP is entitled to use 55 percent of the excess available water and the SWP is entitled to the remaining 45 percent. Any water that is not used by one project is available for use by the other project, or it flows out of the Delta as surplus. These rules were established to account for meeting SWRCB Decision 1485. Subsequent changes to the Water Quality Control Plan have resulted in modifications to these rules by mutual agreement between Reclamation and DWR.

Operations Criteria and Plan Biological Opinions

The CVP and SWP Operations Criteria and Plan (OCAP) describes the long-term coordinated water operations of the state and federal water projects. On December 15, 2008, USFWS issued a Biological Opinion (USFWS OCAP BO) for delta smelt and its critical habitat governing the coordinated operations of the CVP and SWP. On June 4, 2009, NMFS issued a Biological Opinion (NMFS OCAP BO) for listed anadromous fishes and marine mammal species and their critical habitats governing the long-term operations of the CVP and SWP. The Old and Middle River (OMR) flow restrictions on exports and other operational conditions established by the new OCAP BOs modify SWP and CVP operations compared to the prior operations of the CVP and SWP.

State

Porter-Cologne Water Quality Control Act

Under the Porter-Cologne Water Quality Control Act, water quality objectives are limits or levels of water quality constituents or characteristics established for the purpose of protecting beneficial uses. The Act requires the RWQCBs to establish water quality objectives while acknowledging that water quality may be changed to some degree without unreasonably affecting beneficial uses. Designated beneficial uses, together with the corresponding water quality objectives, also constitute water quality standards under the federal Clean Water Act. Therefore, the water quality objectives form the regulatory references for meeting state and federal requirements for water quality control.

A change in water quality is only allowed if the change is consistent with the maximum beneficial use of the waters of the state, would not unreasonably affect the present or anticipated beneficial uses, and would not result in water quality lower than that specified in applicable water quality control plans (CVRWQCB, 1998). All aspects of the project alternatives would be subject to the Porter-Cologne Water Quality Control Act.

State Water Rights

California's system of water rights is referred to as a "dual system" in which both the riparian doctrine and the prior appropriation doctrine apply. Riparian rights result from the ownership of land bordering a surface water source (a stream, lake, or pond). These rights normally are senior in priority to most appropriative rights, and riparian landowners may use natural flows directly for beneficial purposes on riparian lands without a permit from the SWRCB.

Appropriative rights are acquired by diverting surface water and applying it to a beneficial use. Before 1914, appropriative rights could be obtained by simply diverting and using the water, posting a notice of appropriation at the point of diversion, and recording a copy of the notice with the county recorder. Since 1914, the acquisition of an appropriative right also requires a permit from the SWRCB.

The SWRCB is responsible for overseeing the water rights and water quality functions of the state. The SWRCB has jurisdiction to issue permits and licenses for appropriation from surface and underground streams. The California courts have jurisdiction over the use of percolating ground water, riparian use of surface waters, and the appropriative use of surface waters from diversions begun before 1914.

SWRCB Water Rights Decisions, Water Quality Control Plans and Water Quality Objectives

The Porter-Cologne Water Quality Control Act provides for the development and periodic review of water quality control plans (WQCP) that designate beneficial uses of California's major rivers and groundwater basins and establish narrative and numerical water quality objectives for those waters. Many of the permit terms and conditions contained in the WQCP for the Sacramento-San Joaquin Delta and Suisun Marsh and in water rights decisions implementing the WQCP have substantial influence on Delta operations, flows, water quality and ecosystem functions. The SWRCB adopts the Delta WQCP to establish standards to protect beneficial uses in the Delta.

Beneficial uses represent the services and qualities of a water body (i.e., the reasons why the water body is considered valuable), while water quality objectives represent the standards necessary to protect and support those beneficial uses. Beneficial uses are defined in Water Code section 13050(f) as including, but not limited to, domestic, municipal, agricultural, and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and the preservation and enhancement of fish, wildlife, and other aquatic resources or preserves.

The SWRCB Water Rights Division has primary regulatory authority over water supplies and issues permits for water rights specifying amounts, conditions, and construction timetables for diversion and storage facilities. Water rights decisions implement the objectives adopted in the Delta WQCP and reflect water availability, recognizing prior rights and flows needed to preserve instream uses, such as water quality and fish habitat, and whether the diversion is in the public interest.

1995 Water Quality Control Plan and D-1641. The current WQCP in effect in the Delta is the 1995 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (1995 WQCP) (SWRCB, 1995). The 1995 WQCP identifies beneficial uses in the Delta to be protected, water quality objectives for the reasonable protection of beneficial uses, and a program of implementation for achieving the water quality objectives.

The 1995 WQCP was developed as a result of the December 15, 1994 Bay-Delta Accord, which committed the CVP and SWP to new Delta habitat objectives. The new objectives were adopted by amendment through a water rights decision (D1641) for CVP and SWP operations. One key feature of the 1995 WQCP was the estuarine habitat objectives ("X2") for Suisun Bay and the western Delta. The X2 standard refers to the position at which 2 parts per thousand salinity occurs in the Delta estuary, and is designed to improve shallow water fish habitat in the spring of each year. The X2 standard requires specific daily or 14-day salinity, or 3-day averaged outflow requirements to be met for a certain number of days each month from February through June. Other elements of the 1995 WQCP include export-to-inflow ratios intended to reduce entrainment of fish at the export pumps, Delta Cross Channel gate closures, minimum Delta outflow requirements, and San Joaquin River salinity and flow standards.

Basin plans adopted by RWQCBs are primarily implemented through the NPDES permitting system and issuance of waste discharge requirements to regulate waste discharges so that water quality objectives are met. Basin plans provide the technical basis for determining waste discharge requirements and taking regulatory enforcement actions if deemed necessary. A basin plan has been adopted for the Sacramento and San Joaquin River Basin (Region 5; CVRWQCB, 1998).

The Region 5 RWQCB has set water quality objectives for the surface waters in the Delta for the following substances and parameters: ammonia, bacteria, biostimulatory substances, chemical constituents, color, dissolved oxygen, floating material, oil and grease, pH, radioactivity, salinity, sediment, settleable material, suspended material, taste and odor, temperature, toxicity, and turbidity. In addition, Region 5 has adopted standards for pesticides. Specific objectives for concentrations of chemical constituents are also applied to bodies of water based on their designated beneficial uses (CVRWQCB, 1998; SWRCB, 1995).

Water quality objectives applicable to all groundwater have been set for bacteria, chemical constituents, radioactivity, taste, and odors, and in Region 5, have been set for toxicity (CVRWQCB, 1998; SWRCB, 1995).

Central Valley Regional Water Quality Control Board Drinking Water Policy

The CVRWQCB is in the process of a multi-year effort to develop a drinking water policy for surface waters in the Central Valley. Existing policies and plans lack water quality objectives for several known drinking water constituents of concern, including DBP precursors and pathogens, and also lack implementation strategies to provide effective source water protection. The CVRWQCB adopted Resolution No. R5-2004-0091 in July 2004, which supports the development of this policy. The new policy will culminate in the incorporation of new requirements into a Basin Plan amendment in 2009. The CVRWQCB Drinking Water Policy will apply to Delta waters and any activities, such as discharges, that affect Delta water quality.

Streambed Alteration Agreement Program

Under Sections 1600–1616 of the California Fish and Game Code, any person, business, state or local government agency, or public utility that proposes an activity that would (1) substantially divert or obstruct the natural flow, (2) substantially change use of any material from the bed, channel, or bank of any river, stream, or lake, or (3) deposit or dispose of debris, waste, or other material containing crumbled, flaked, or ground pavement where it can pass into any river, stream, or lake, is required to notify the California Department of Fish and Game (CDFG).

After such notification, the Streambed Alteration Agreement requires that the notifying entity and CDFG identify potential impacts of construction and mitigation measures required to minimize and avoid impacts. All portions of the project alternatives that would alter a waterway, including the new Delta intake, pipelines in areas of stream crossings, and the reservoir expansion, would be subject to the Streambed Alteration Agreement Program.

State Reclamation Board Approval

Any project encroaching into rivers, waterways, and floodways within and adjacent to federal- and state-authorized flood control projects or within designated floodways must receive approval from the state Reclamation Board. Under California Water Code sections 8534, 8608, and 8710–8723, the Reclamation Board is required to enforce, within its jurisdiction, on behalf of the State of California, appropriate standards for the construction, maintenance, and protection of adopted flood control plans that will best protect the public from floods.

The Reclamation Board's jurisdiction encompasses the entire Central Valley, including all tributaries and distributaries of the Sacramento and San Joaquin Rivers and Tulare and Buena Vista Basins. The Reclamation Board exercises jurisdiction over the levee section, the waterside area between project levees, a 10-foot-wide strip adjacent to the landward levee toe, the area within 30 feet of the top to the banks with no levees, and within designated floodways adopted by the Board. Construction of the new Delta intake and pump station would be subject to state Reclamation Board approval.

Los Vaqueros Project Water Right (Permit No. 20749)

SWRCB Decision 1629 (D1629) gives the terms and conditions governing Contra Costa Water District's (CCWD's) diversions to storage in Los Vaqueros Reservoir under Permit No. 20749. D1629 provides that CCWD may divert water under Permit No. 20749 from Old River to Los Vaqueros Reservoir from November through June during excess conditions in the Delta, as defined in the SWP/CVP COA, when those diversions will not adversely impact the operations of the SWP and CVP; CCWD may also divert water under its CVP water supply contract to storage in Los Vaqueros Reservoir. D1629 specifies the maximum diversion rates and annual diversion to storage by CCWD to Los Vaqueros Reservoir.

CCWD's operations are governed in part by the following three biological documents:

- 1993 National Marine Fisheries Service Biological Opinion for winter-run chinook salmon,
- 1993 U.S. Fish and Wildlife Service (USFWS) Biological Opinion for Delta smelt, and
- ~~1994 Memorandum of Understanding between CDFG and CCWD regarding the Los Vaqueros Project,~~ and
- 2009 CDFG California Endangered Species Act Incidental Take Permit for CCWD Maintenance and Operation of the Los Vaqueros Project and Alternative Intake Project.

The biological documents specify the following:

- **No-Fill Period** – CCWD will avoid filling Los Vaqueros Reservoir for 75 days each spring. The default no-fill period is March 15th through May 31st. This condition is also included in D1629. An additional zero to fifteen days of no-fill requirement may apply at the end of February, depending on Los Vaqueros Reservoir storage on February 1: 15 days of no fill are applied if storage in Los Vaqueros Reservoir is at or above 90 thousand acre-feet (TAF) on February 1, 10 days are applied if storage is at or above 80 TAF, and 5 days are applied if storage is at or above 70 TAF. If storage in Los Vaqueros Reservoir is below 70 TAF on February 1, the no fill requirement is not applied in February. The timing of the default periods can be modified at the request of the fisheries agencies.

- **No-Diversion Period** – CCWD will avoid Delta diversions for 30 days each spring, concurrent with part of the no-fill period. The default no-diversion period is the month of April. This condition is also included in D1629. The timing of the default periods can be modified at the request of the fisheries agencies.

- **Emergency Storage** – The no-fill and no-diversion restrictions are in effect only when Los Vaqueros Reservoir is above emergency storage levels. Emergency storage is defined as 70 TAF in below-normal, above-normal, and wet years, and 44 TAF in dry and critical years. This condition is also included in D1629.

- **X2 Restrictions** – Los Vaqueros Reservoir may be filled when X2 is west of Chipps Island in February through May, and Collinsville in January, June through August, and December. X2 restrictions on filling in December only exist when adult delta smelt are present at the Old River intake. In 2005, CDFG and USFWS granted a temporary ~~waiver on the July and August~~ modification to CCWD's X2 restrictions, adding two additional compliance methods and waiving the July and August X2 restrictions~~, allowing 5 years to evaluate~~to bring~~ing~~ CCWD's operating restrictions in line with D1641.

In reviewing Delta operations as modified by the OCAP BOs described above, CCWD, Reclamation and DWR staff have developed proposed modifications to the default no fill and no diversion timing that improve coordination of water operations in the Delta while maintaining water supply and water quality for CCWD and for the CVP and SWP. These proposed modifications are described in Section 4.2.2 below.

Mallard Slough Water Right

CCWD has a license and a permit for diversions at Mallard Slough for up to 26,780 AF per year. However, Mallard Slough diversions are unreliable during most of the year as a result of high salinity from seawater intrusion in the San Joaquin River at the point of diversion. Over the last 10 years, diversions by CCWD from Mallard Slough have averaged less than 3 TAF per year. Diversions from Mallard Slough substitute for other diversions, principally CVP supplies from Rock Slough.

CVP Contract

On May 10, 2005, CCWD entered into a 40-year renewal of its contract with Reclamation for the delivery of up to 195,000 AF per year (Reclamation, 2005, Contract No. I75r3401A-LTR1, executed May 10, 2005). This water would be for municipal and industrial (M&I) uses and may be diverted at the Rock Slough, Old River, and Alternative Intake Project (AIP) intakes during any time of year, though diversions under this CVP contract are also limited by the no-fill and no-diversion periods described above.

Water Rights and Water Service Contracts

Each alternative may require changes to existing water right permits and licenses, which would be accomplished through change petitions to the SWRCB. Changes in water service contracts may also be required.

In addition to its long-term contract with Reclamation, CCWD has separate water rights for the Los Vaqueros Reservoir. CCWD's separate Los Vaqueros water rights are subject to permit terms and conditions to ensure they do not adversely affect the CVP and SWP operations under the water rights held by Reclamation and DWR, respectively. Under all these water system operations, the use of the collective water rights of the project participants would be coordinated to operate the existing and new facilities in a manner designed to accomplish the project objectives without adversely affecting SVP or SWP operations. This would be achieved through agreements among the parties and permit changes as necessary.

California Department of Health Services Drinking Water Regulations

DHS serves as the primary responsible agency for drinking water regulations. DHS must adopt drinking water quality standards at least as stringent as federal standards, and may also regulate contaminants to more stringent standards than U.S. EPA, or develop additional standards. DHS regulations cover over 150 contaminants, including microorganisms, particulates, inorganics, natural organics, synthetic organics, radionuclides, and DBPs. The specific regulations promulgated by DHS, in coordination with the U.S. EPA, are summarized in **Table 4.2-1**.

TABLE 4.2-1
FEDERAL AND STATE DRINKING WATER REGULATIONS

Regulation	Promulgation Year	Contaminants Regulated
National Interim Primary Drinking Water Regulations	1975–1981	Inorganics, Organics, Physical, Radioactivity, Bacteriological
National Secondary Drinking Water Regulations	1979	Inorganics, Color, Corrosivity, Odor, Foaming Agents
Phase I Standards	1987	VOCs
Phase II Standards	1991	VOCs, SOCs, IOCs
Phase V Standards	1992	VOCs, SOCs, IOCs
Surface Water Treatment Rule	1989	Microbiological and Turbidity
Total Coliform Rule	1989	Microbiological
Lead and Copper Rule	1991 / 2003	Lead, Copper
Drinking Water Source Assessment and Protection Program	1996	Source Water Protection
Information Collection Rule	1996	Microbiological and Disinfectants / DBPs
Stage 1 Disinfectants/Disinfection Byproducts Rule	1998	Disinfectants / DBPs, Precursors
Interim Enhanced Surface Water Treatment Rule	1998	Microbiological, Turbidity
Unregulated Contaminant Monitoring Rule	1999	Organics, Microbiological
Radionuclides Rule	2000	Radionuclides
Arsenic Rule	2001	Arsenic
Filter Backwash Rule	2002	Microbiological, Turbidity
Drinking Water Candidate Contaminant List	2003	Chemical, Microbiological
Stage 2 Microbiological and Disinfection Byproducts Rules	2006	Microbiological and Disinfectants / DBPs
Secondary Maximum Contaminant Levels	2006	Metals, Color, Foaming Agents, MTBE, Odor, Thiobencarb, Turbidity, TDS, and Anions
Primary MCL for Perchlorate	2007	Perchlorate
Interim Enhanced Surface Water Treatment Rule	2008	Microbiological and Turbidity

DBP = Disinfection by-product
IOC = Inorganic Compound
MCL = Maximum Contaminant Level
MTBE = methyl tertiary-butyl ether
SOC = Synthetic Organic Compound
TDS = Total Dissolved Solid(s)
VOC = Volatile Organic Compound

Local

Contra Costa County General Plan

The Contra Costa County General Plan provides several goals and policies related to water service and water resources. Specifically, the general plan includes the following provisions: assurance of potable water availability to residents (7-F); development of locally controlled water supplies to meet growth (7-G); conservation of water resources (7-H); flood control and flooding prevention (7-O-7-R); assurance of adequate long-term supply of water for domestic purposes as well as fishing, agricultural, and industrial uses (8-T); maintenance of ecology and hydrology of streams, creeks, and other natural waterways (8-U); and enhancement of opportunities for public accessibility and recreational use (9-43, 9-47). These goals and policies are shown in Appendix E-2.

Alameda County East County Area Plan

The Alameda County East County Area Plan also includes water-related goals and policies. These goals and policies include ensuring the mitigation of impacts on water quality caused by development near agricultural lands (76); protection of watershed land from the effects of development (110); the expansion of public facilities (218); the provision of an adequate, reliable, and safe water supply (253-254). Specific goals and policies are listed in Appendix E-1.

Sacramento River Basinwide and Regional Water Management Plans

In the mid-1990s, the Sacramento River Settlement Contractors, who held water rights higher in priority than the CVP water rights, initiated discussions with Reclamation for CVP contract renewals and prepared the *Sacramento River Basinwide Water Management Plan*. Finalized in 2004, this Plan identifies potential water management improvements, including subbasin-level management actions and system improvement/water use efficiency projects.

This planning process involved regional cooperation among the Sacramento River Settlement Contractors, other CVP contractors, government agencies, and stakeholders. The Sacramento Valley Water Management Agreement (described below) was prepared as a result of these coordination efforts. The Sacramento River Settlement Contractors and Reclamation are currently cooperating to finalize a regional water management plan that will encourage further regional and subbasin coordination, including meeting the CALFED-targeted benefits and establishing quantifiable objectives associated with numerous projects.

Sacramento Valley Water Management Agreement and Integrated Regional Water Management Plan

In addition to the planning efforts undertaken by CVP contractors and Reclamation as described above, a broader multi-agency process is underway.

In July 1998, the SWRCB conducted a water-rights hearing to consider how to implement the 1995 WQCP (described above). As a result of the hearing, responsibility for implementing the 1995 WQCP objectives was allocated to water-right holders, since they were affecting Delta inflows, diversions, and exports.

More than 40 water suppliers in the Sacramento Valley negotiated and entered into the Sacramento Valley Water Management Agreement with Reclamation, DWR, USFWS, CDFG, and the State Water Contractors. Signed in 2002, the agreement describes the need for a cooperative regional approach to improve local, regional, and statewide water supply reliability and quality, while providing supplies to help implement water quality standards in the Delta. Its proposed implementation will offer relief to water-short areas of the Sacramento Valley, provide additional water supplies for the Delta, and support water transfers to CVP and SWP users. CCWD was a signatory to the initial agreement, as a separate party.

The *Sacramento Valley Integrated Regional Water Management Plan* (IRWMP) was released in December 2006. The IRWMP objectives are to improve the economic health of the region; improve regional water supply reliability for local water users, the region, and California; improve flood protection and floodplain management; improve and enhance water quality; and protect and enhance the ecosystem. The Sacramento Valley Water Management Agreement and the IRWMP are relevant to the Los Vaqueros project because they have implications for Delta hydrology and water quality.

Environmental Setting

Surface Water Hydrology

Surface water hydrology within the Sacramento–San Joaquin Delta, the Sacramento River, and the San Joaquin River is discussed below. For this discussion, a diversion is defined as a withdrawal of water from the water body in question; an export is defined as water that is diverted and removed from the Delta area by the CVP or SWP for south-of-Delta use; and Delta outflow is water that flows out of the Delta to the San Francisco Bay and Pacific Ocean.

Sacramento River

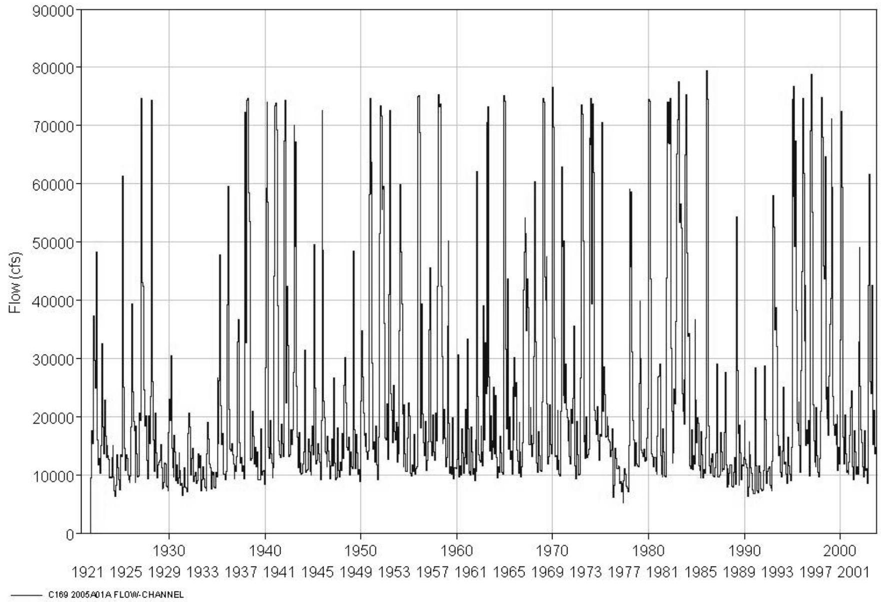
Flows within the Sacramento River are highly regulated and are influenced by the following factors: runoff from precipitation and snowmelt; natural variation; upstream water storage facilities; water diversions for agricultural, municipal, and industrial purposes; agricultural and municipal discharges; and a flood damage reduction system that includes levees, floodplains (the Yolo, Sutter, and Colusa bypasses), and weirs. These features contribute to observed flows within the Sacramento River.

Sacramento River flows vary substantially on a seasonal and year-to-year basis. Seasonally, flows in the river may vary as a result of runoff from local tributaries and releases from the major water storage reservoirs, as well as diversions by agricultural, municipal, and other users. Interannually, river flows vary according to precipitation, the volume of carryover storage in reservoirs, and releases to downstream water users.

The Sacramento River enters the Delta (as defined by California Water Code Section 12220) at Freeport, where the average annual flow is about 16 million acre-feet (MAF). **Figure 4.2-1** presents the average monthly flows of the Sacramento River at Freeport for the period of record. Additional Sacramento River flow enters the Yolo Bypass upstream of Freeport, then rejoins the river and flows into the Delta downstream of Freeport.

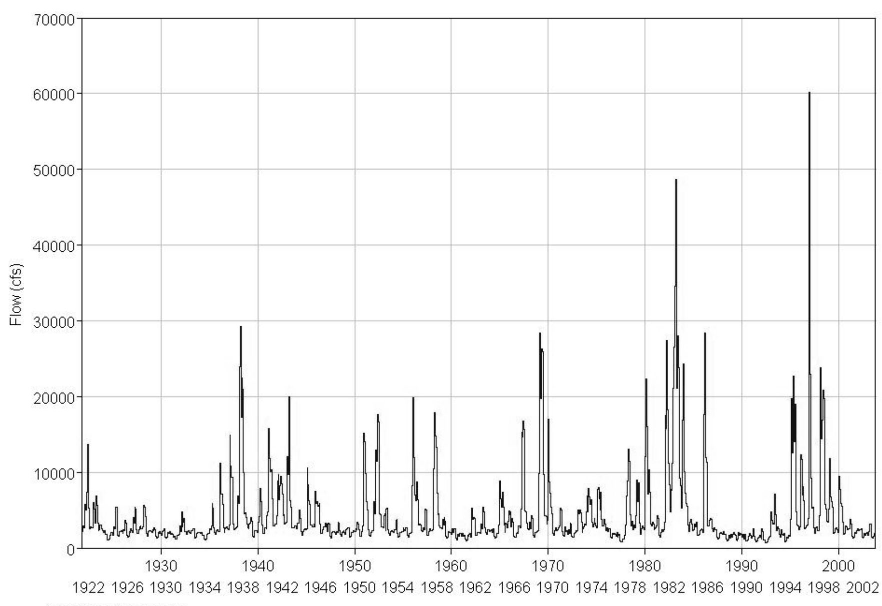
San Joaquin River

Flows within the San Joaquin River are highly regulated and influenced by the following factors: runoff from precipitation and snowmelt; natural variation; upstream water storage facilities; water diversions for agricultural, municipal, and industrial purposes; agricultural and municipal discharges; and a flood damage reduction system. These features contribute to observed flows within the San Joaquin River. The average annual flow of the San Joaquin River as it enters the Delta at Vernalis is about 2.6 MAF, or 3,600 cubic feet per second (cfs). **Figure 4.2-2** presents the average monthly flows of the San Joaquin River at Vernalis for the period of record.



Los Vaqueros Reservoir Expansion Project. 201110

Figure 4.2-1
Existing Average Monthly
Sacramento River Flow at Freeport



Los Vaqueros Reservoir Expansion Project. 201110

Figure 4.2-2
Existing Average Monthly
San Joaquin Flow at Vernalis

Typically, during summer months, flows within the lower San Joaquin River are composed primarily of agricultural and wildlife refuge return flows and municipal discharges. Portions of the middle/lower San Joaquin River below Friant Dam typically run dry during the dry season, resulting in a temporary hydrologic disconnect between the lower and upper watersheds.

Sacramento–San Joaquin Delta

The Sacramento-San Joaquin Delta, to the east of San Francisco Bay, represents the point of discharge for the Sacramento-San Joaquin River system. Water flows out of the Delta, into San Francisco Bay, and through the Golden Gate to the Pacific Ocean, creating an extensive estuary where salty ocean water and fresh river water commingle. In sum, water from over 40 percent of the state's land area is discharged into the Delta.

The Delta supports several beneficial uses, including water supply to local and south of Delta municipalities and agricultural uses, ecological support for fisheries including wetlands and important habitat, in-Delta agriculture, flood management, water quality management, and a major conveyance for transporting fresh water from northern to southern portions of the state (Delta Vision, 2007; DWR, 2008). However, many water projects, including export pumps for the SWP and CVP, diversions for Delta-area and Bay-area municipalities, and regional agricultural users, also divert Delta waters, and thereby influence Delta hydrology and water quality.

Figure 4.2-3 shows a map of the Delta, including features relevant to the following discussion of Delta hydrology and water quality.

Delta Hydrology and Hydrodynamics

The primary factors that affect Delta hydrology are: (1) twice-daily tidal cycles, which result in inflow and outflow through the Delta and San Francisco Bay, (2) freshwater inflow from the Sacramento and San Joaquin Rivers, and (3) water management activities, including SWP and CVP reservoir storage and releases, as well as water exports from the south Delta. Additionally, winds and salinity/freshwater mixing generate a number of secondary currents. While these currents are generally of low velocity, they are significant in terms of transporting contaminants and mixing different sources of water.

Tidal Cycles. Twice-daily tides push water back and forth between San Francisco Bay and the Delta. Over each tidal cycle, ebb flows draw water downstream from the Delta towards San Francisco Bay, while flood tides push bay water upstream and into the lower portions of the Delta. The average peak tidal flow is about 350,000 cfs at Chipps Island (the interface between the Delta and Suisun Bay). Because daily tidal inflows are about equal to daily tidal outflows, the tidal cycle can be described as having a sloshing or mixing effect within the Delta. Tidal flows are far larger than any other flows in the Delta. For example, the current combined export capacity from the south Delta is about 15,000 cfs, and estimated average monthly net Delta outflow is about 32,000 cfs in winter and about 6,000 cfs in summer (CALFED, 2000).

Delta Inflow. Inflows of freshwater to the Delta are derived primarily from the Sacramento and San Joaquin Rivers, although some additional inflow is provided by the Mokelumne, Calaveras, and Cosumnes Rivers along the eastern Delta. Sacramento River flows, including those routed

SOURCE: ESRI, 2006; and ESA, 2008

Figure 4.2-3
Sacramento-San Joaquin Delta Overview

through the Yolo Bypass, account for an annual average of about 80 percent of total Delta inflow. The San Joaquin River provides about an additional 15 percent, while flows from eastside tributaries account for the remainder; about 5 percent (DPC, 2000; DWR 2008).

An average of about 21 MAF of fresh water reaches the Delta every year from a combination of these freshwater inflow sources. However, interannual variation in flow can be substantial: in 1977, a year of extraordinary drought, Delta inflow totaled only 5.9 MAF, while in 1983, an exceptionally wet year, Delta flow reached about 70 MAF. Delta inflow in dry and critically dry years averages about 12 MAF annually.

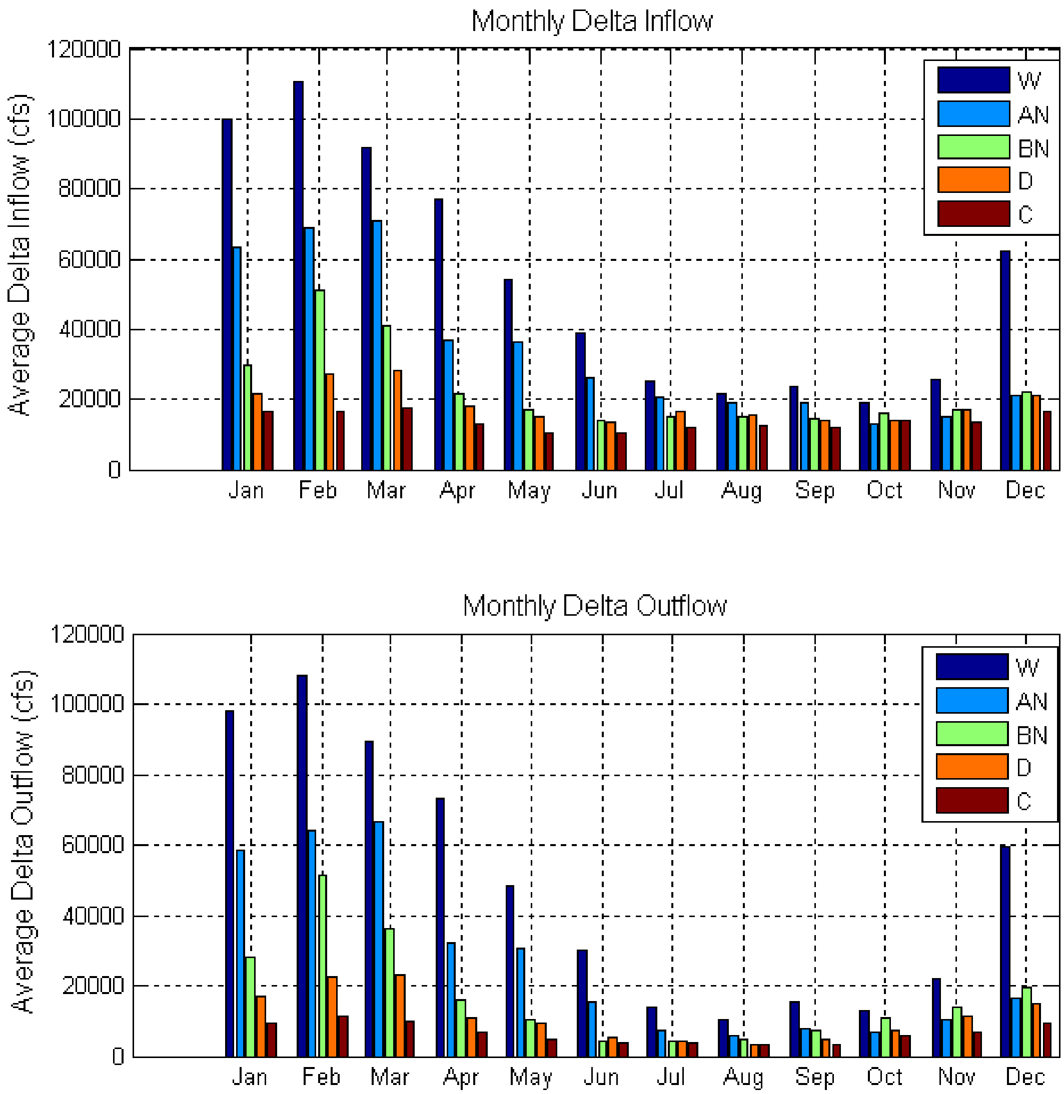
In combination with an extended period of drought, historic upstream diversions reduced inflow to a point in the 1920's that salinity intrusion in the Delta became a problem (Means, 1928), necessitating construction of reservoirs to help manage water supplies and salinity.

Delta Outflow. The water that flows into the Delta may be diverted by water users within the Delta area, exported by CVP and SWP pumps, or left to flow out through San Francisco Bay and into the Pacific Ocean. Flows into the Delta may also be augmented by local precipitation and runoff, local drainage and seepage, and flows from local wastewater treatment plants. Delta outflow is the net flow of water from the Delta into San Francisco Bay.

Figure 4.2-4 provides a comparison of average monthly Delta inflow and outflow for wet, above normal, below normal, dry, and critical water years, according to Sacramento Valley hydrology. Delta inflow and outflow exceedance curves are shown in **Figure 4.2-5**. As indicated, Delta outflow is influenced by diversions, and is therefore noticeably less than inflow during most periods. However, during peak flow conditions exceeding 100,000 cfs, diversions from the Delta represent a much smaller percentage of total Delta inflow, and Delta inflow is much closer in rate to Delta outflow.

Together, local diversions and water exports in the Delta account for an average of about 35 to 40 percent of total Delta inflow (CALFED, 2000), with the remaining 60 to 65 percent flowing out of the Delta to the Pacific Ocean. The total diversions and exports from the Delta include use by in-Delta agricultural users (about 10 percent of average inflow), the CVP and SWP pumping facilities (about 25 to 30 percent of average inflow), and CCWD diversions (less than 1 percent of average inflow). An additional 20 percent of average Delta inflow provides minimum outflow for salinity control and to meet outflow requirements for protecting fishery resources, and the remaining approximately 40 to 45 percent of average Delta inflow provides Delta outflow to the Pacific Ocean beyond that needed to meet salinity standards.

Water Management Activities. The CVP and SWP are the largest users and exporters of Delta water. Water is exported via pumping and aqueduct facilities at Clifton Court Forebay, the Jones Pumping Plant, and the North Bay Aqueduct. Local agencies, including CCWD, municipalities, private entities, and agricultural users also operate their own diversion programs and infrastructure, independent of the CVP and SWP. Examples include the approximately 1,800 agricultural diversions within the Delta, and diversion projects such as the Freeport Regional Water Authority Project (under construction) and the proposed Stockton Delta Water Supply Project (Stockton



Los Vaqueros Reservoir Expansion Project. 201110

Figure 4.2-4
Delta Inflow and Outflow by Water Year Type

DWSP). Surface water infrastructure associated with the CVP, SWP, and local diversions is discussed in greater detail below.

Water management activities, especially export pumping, can affect the direction of flow in Delta channels. Under natural conditions, net flow of Delta waters is westward from the San Joaquin and Sacramento Rivers, across the Delta and towards San Francisco Bay. However, under certain tidal, river inflow, and south Delta export pumping conditions, net reverse flows may occur over a tidal cycle in specific western Delta so that the net flow direction in those channels is eastward. QWEST is a parameter that represents the estimated net westward flow of the San Joaquin River at Jersey Point that is used as a measure of net reverse flow conditions (exclusive of tides) within certain Delta channels.

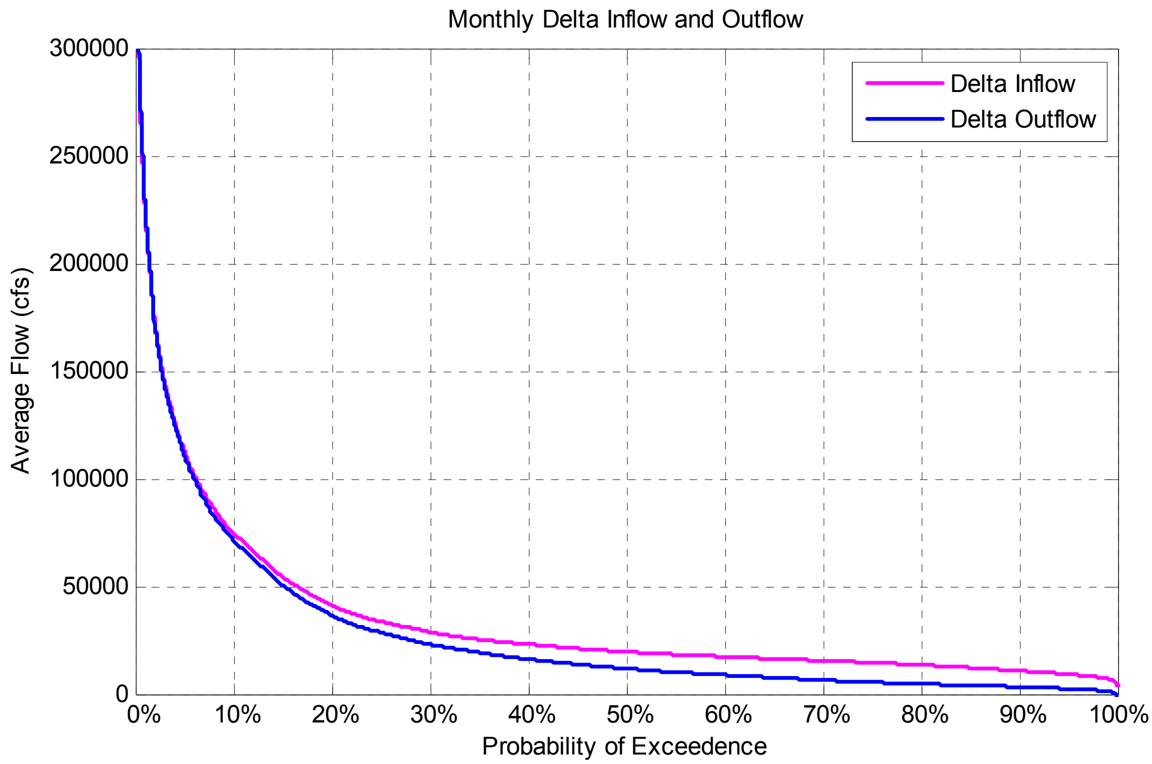


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Figure 4.2-5
Delta Inflow and Outflow Exceedance Curves

As QWEST decreases, reverse flows in some Delta channels increase. CVP and SWP export pumping can also cause reverse flows in the southward direction down Old and Middle Rivers and other central and south Delta channels. Figure 4.2-3 shows the locations of the San Joaquin River, Jersey Point, and other features of the Delta.

Surface Water Infrastructure

The surface water infrastructure along the Sacramento and San Joaquin Rivers, in the Delta, and south of the Delta, supports storage, conveyance, and export of water throughout much of California. Operation of this infrastructure, which includes reservoirs, diversions, and conveyances, substantially affects Delta hydrology.

Central Valley Project Facilities

The CVP, which is administered by Reclamation, stores and transports water from the Delta for irrigation use in the San Joaquin Valley, and for municipal use in CCWD's service area and elsewhere. In total, the CVP is composed of some 20 reservoirs with a combined storage capacity of over 11 MAF, 11 power plants, and over 500 miles of canals and aqueducts. The CVP serves multiple purposes, including flood control; navigation; water supply for irrigation and domestic uses; fish and wildlife protection, restoration, and enhancement; and power generation. The following text provides a description of the major components of the CVP, as relevant to the project alternatives.

Trinity River Diversion (North of Delta). The Trinity River Diversion includes Trinity Dam and facilities to transfer water from the Trinity River basin to the Sacramento River basin. Water is conveyed from Trinity Dam, which has a capacity of about 2.4 MAF, via the Clear Creek Tunnel, to Keswick Dam on the Sacramento River below Shasta Dam. Trinity Reservoir is operated for water storage and flood control, consistent with the DWR Division of Safety of Dams guidance. The outflow from Trinity Reservoir also provides water to meet temperature objectives for special-status species in the Trinity and upper Sacramento Rivers.

Shasta Reservoir (North of Delta). Shasta Reservoir, which provides up to about 4.5 MAF of water storage capacity, is on the upper Sacramento River, about 5 miles north of the city of Redding. The watershed that is drained into Shasta Reservoir encompasses about 6,600 square miles of land. Inflows to the reservoir vary both annually and seasonally, with inflows typically peaking in March during the springtime snowmelt. After the spring snowmelt has ended, typical June through October flow into the reservoir is less than 5,000 cfs. About 1.3 MAF of storage space is reserved for flood control, which is managed by the USACE.

Releases from Shasta Reservoir and Keswick Reservoir (which is just downstream of Shasta Reservoir) are managed to meet minimum fish flows and temperature requirements, flood control requirements, salinity control, and water supply demands of CVP contractors (Reclamation and DWR, 2003).

Folsom Reservoir (North of Delta). Folsom Reservoir has a maximum capacity of about 1 MAF, and is on the American River about 15 miles northeast of Sacramento, near the city of Folsom. The dam is managed to provide flood control, recreation, power, water supply, Delta water quality protection, and minimum fish protection flows in the American River and Delta.

New Melones Reservoir (East of Delta). The New Melones Reservoir is on the Stanislaus River and is the fifth largest reservoir in California, with a capacity of 2.4 MAF. The reservoir provides flood control for the lower Stanislaus River and San Joaquin Delta, irrigation and municipal water supplies, peak use period hydrologic production, recreation, and fish and wildlife enhancement. New Melones Reservoir is also used to provide salinity control at Vernalis and interior Delta water quality compliance locations. The New Melones Reservoir is overseen and operated by Reclamation.

Jones Pumping Plant (Delta Area). The Jones Pumping Plant is the CVP's primary diversion facility in the south Delta, and has a capacity of 4,600 cfs. The Jones Pumping Plant provides water to the Delta-Mendota Canal, which supplies water for storage in the San Luis Reservoir and for use within the San Joaquin Valley. On average, the Jones Pumping Plant exports about 3,350 thousand acre-feet (TAF) of water per year.

Delta Cross Channel Gates (Delta Area). The Delta Cross Channel (DCC) gates are a gated diversion channel in the Sacramento River near Walnut Grove. Flows into the channel from the Sacramento River are controlled by two 60-foot by 30-foot radial gates. When the gates are open, water flows from the Sacramento River into the cross channel and then into the Mokelumne River to the lower San Joaquin River. The gates are operated to move Sacramento River water into the Delta interior to improve water quality and improve circulation of water towards the export pumps.

Contra Costa Canal (Delta Area). The Contra Costa Canal has its origin on Rock Slough, and consists of a 4-mile earth-lined intake canal (currently being converted to a pipeline to improve water quality and reduce flood risks), four pump stations with a capacity of 350 cfs, and a 44-mile concrete-lined canal. The canal was constructed and is owned by Reclamation, and is operated and maintained by CCWD. The canal is used to serve water to CCWD's customers.

San Luis Reservoir (South of Delta). San Luis Reservoir is a shared facility between the CVP and the SWP. It is near Los Banos, and has a storage capacity of about 2 MAF. This pumped-storage reservoir provides seasonal storage of water exported from the Delta, including 966 TAF of CVP storage. Water is conveyed from San Luis Reservoir into federal and state aqueducts serving the San Joaquin Valley and other agricultural and municipal areas south of the Delta. Deliveries from San Luis Reservoir also flow west through Pacheco Pumping Plant and Conduit to the San Felipe Division of the CVP, which includes the SCVWD and San Benito Water District. Water in San Luis Reservoir is managed to meet water supply demands of SWP and CVP contractors.

State Water Project Facilities

The SWP, which is operated and maintained by DWR, stores and transports water for agricultural and M&I use within the Feather River area, the San Francisco Bay Area, the San Joaquin Valley, southern California, and the central California coast. In total, the SWP is composed of 32 reservoirs and storage facilities, 17 pumping plants, eight hydroelectric power plants, and over 660 miles of aqueducts and pipelines. The SWP serves over two-thirds of California's population, including about 600,000 acres of farmland. The SWP serves multiple purposes including providing water supply to contracting agencies, flood control, recreation, fish and wildlife enhancements, power generation, and salinity control within the Delta. The following text provides a description of the major SWP components, as relevant to the project alternatives.

Oroville Reservoir (North of Delta). The Oroville Reservoir, which has a maximum water storage capacity of about 3.5 MAF, is the primary SWP storage reservoir. It is on the Feather River near the city of Oroville and the Thermalito Forebay and Afterbay. Inflow to the reservoir is strongly influenced by snowmelt and rainfall runoff during the winter and spring, and results primarily from base flows (i.e., flows in a river or stream that occur in the absence of any recent rainfall) during the summer and autumn. Monthly flows from January through June are typically greater than 2,000 cfs, while summer flows are typically at least 1,000 cfs. A minimum release of at least 600 cfs is maintained during all months to provide adequate flows and water quality to meet fish requirements (Reclamation and DWR, 2003).

Releases from Oroville Reservoir and Thermalito Afterbay are managed to meet minimum fish flows and temperature requirements, flood control requirements, navigation control point requirements, Delta water quality requirements, and water supply demands of SWP contractors.

Banks Pumping Plant (Delta Area). The SWP Banks Pumping Plant supplies water for the South Bay Aqueduct and the California Aqueduct, and has an installed capacity of 10,300 cfs. However, under current operational constraints, inflow to Clifton Court, which is the forebay to the Banks plant, is often limited to a maximum of 6,680 cfs. The 6,680 cfs limitation is removed from December 15th through March 15th, when exports may be increased by 33 percent of San Joaquin River inflow to the Delta, as long as San Joaquin River inflow is at least 1000 cfs. In addition, a temporary permit was issued to pump an additional 500 cfs at Banks Pumping Plant from July 1 through September 30 of each year to provide water for Environmental Water Account purposes.

Barker Slough Intake for the North Bay Aqueduct (Delta Area). In addition to the pumps at Clifton Court, the SWP also pumps water from Barker Slough into the North Bay Aqueduct for use within the Bay region. The Barker Slough Pumping Plant, just upstream of the confluence of Barker Slough and Lindsey Slough, pumps water into a 27-mile underground pipeline that connects to the North Bay Aqueduct. The pumping plant and North Bay Aqueduct supply SWP water to parts of Solano and Napa Counties north of San Francisco Bay (CALFED, 2000).

San Luis Reservoir (South of Delta). San Luis Reservoir is a shared facility between the CVP and the SWP. It is near Los Banos, and has a storage capacity of about 2 MAF. This pumped-storage reservoir provides seasonal storage of water exported from the Delta, including 1,062 TAF of SWP storage. Water is conveyed from San Luis Reservoir into federal and state aqueducts serving the San Joaquin Valley and other agricultural and municipal areas south of the Delta. Water in San Luis Reservoir is managed to meet water supply demands of SWP and CVP contractors.

Other Facilities

CCWD Diversion Intakes. CCWD owns and operates three screened intakes; these are the Mallard Slough Intake (39 cfs), Old River Intake and Pump Station (250 cfs), and the AIP on Victoria Canal (250 cfs), which is currently under construction. Reclamation owns and CCWD operates the Contra Costa Canal with its intake on Rock Slough (350 cfs), described above. Together, the current average annual diversion from all of CCWD's intakes combined is about 125 TAF.

Delta Agricultural Diversions. The Delta includes about 540,000 acres of agricultural land which, during the summer irrigation season, is supplied by surface water from the Delta. To satisfy these surface water demands, agricultural users operate their own diversions at over 1,800 locations and divert at a combined net rate (diversions less drainage returned to the Delta) estimated at over 4,000 cfs, for a total of about 1.5 MAF of water consumed annually. This diversion rate is relatively close in magnitude to summer Delta exports of either the Banks Pumping Plant or the Jones Pumping Plant. Water diverted by Delta agricultural users may be used for irrigation, or to leach accumulated salts from fields. Agricultural tailwater, including tailwater resulting from leaching of accumulated salts, is collected by systems of canals within the Delta islands, and pumped back into Delta waterways. A portion of the water diverted from Delta waterways for agricultural use is thereby returned to Delta waterways; consequently, actual diversions exceed the net water consumed by as much as 50 percent or more. However, agricultural island discharge water typically has elevated concentrations of salts and organic carbon.

Joint Water Project Operations for Hydrology, Water Quality, and Ecosystems

Operation of the CVP and SWP is coordinated according to their respective water right permits, and a series of other governing laws, regulations, and agreements that have been developed to ensure compliance with specific hydrology, water quality, and ecosystem requirements while meeting the water supply contract obligations. CVP and SWP operations are adjusted to meet Delta flow and water quality standards by increasing releases of stored water in project reservoirs, or altering export pumping, DCC gate positions, and other Delta facility operations.

Water Rights Decision-1641 and Order WR 2001-05 contain the current water right requirements for Reclamation and DWR to implement the WQCP flow and water quality objectives. The COA (described above) defines how Reclamation and DWR share their joint responsibility to meet Delta water quality standards and meet the water demands of senior water right holders.

Depending on specific conditions of the fisheries populations and presence in the Delta each year, CVP/SWP exports can be restricted on a seasonal basis pursuant to biological opinions issued by the National Marine Fisheries Service and USFWS. The assumptions used in the analysis for governing CCWD, CVP, and SWP operations are discussed in more detail in Section 4.2.2~~3.1.2~~. Related operational considerations that have been incorporated into the analysis for the Los Vaqueros Reservoir Expansion Project are discussed below.

Surface Water Quality

The following text provides a description of relevant and applicable surface water quality constituents, and then describes the existing surface water quality conditions within the Delta and the Sacramento and San Joaquin Rivers.

Water Quality Constituents

The following water quality constituents are found within the Delta and San Joaquin and Sacramento Rivers, and contribute to existing water quality conditions within the Sacramento-San Joaquin River-Delta system. The constituents listed below represent only a few of all the constituents of concern for drinking water that are present in the Sacramento-San Joaquin River-Delta system, and were selected because of their relevance to the project alternatives and availability of comprehensive data. Salinity in particular is the constituent most likely to be affected by shifts in the timing and location of pumping in the Delta, and is also the constituent for which the most monitoring data and calibrated Delta modeling tools are available.

Salinity

Salinity refers to the concentration of salts or ions present in water, including sodium, magnesium, calcium, phosphates, nitrates, potassium, Cl, bromide, and sulphate. Salinity measures commonly used for Delta waters include TDS and Cl concentrations, both measured in milligrams per liter (mg/L).

Salinity is both an aesthetic (taste) and a health issue for drinking water quality. High salinity adversely affects drinking water taste, landscape irrigation, and industrial and manufacturing processes. Salinity is particularly problematic because it cannot be removed via conventional drinking water treatment processes, and the EPA has implemented a secondary (i.e., recommends but does not require compliance) maximum contaminant level for TDS of 500 mg/L. Additionally, CCWD has established a water quality delivery objective for Cl, a constituent of salinity, of 65 mg/L. Health impacts of bromide, another constituent of salinity, are discussed below.

Organic Carbon

Organic carbon is composed of naturally occurring organic matter from plants and animals. Two forms of organic carbon occur in surface waters: (1) dissolved organic carbon (DOC), which is organic carbon that cannot be removed from water by a 0.45-micron filter; and (2) total organic carbon (TOC), which is a measure of all the organic carbon in the water, including DOC and organic carbon from particulate matter such as plant residues.

Organic carbon is a DBP precursor that causes problems during the drinking water treatment process. Organic carbon reacts with chlorine during the disinfection process to form trihalomethanes, haloacetic acids, and other toxic compounds. As a result, CCWD and many other agencies that rely on the Delta for water supply have changed to ozone disinfection. High levels of organic carbon in Delta water require increased ozone dosages during the disinfection process at CCWD's two water treatment plants. This can, in turn, potentially result in increased formation of bromate in treated water. Drinking water regulations specify a required level of reduction for organic carbon based on source water concentrations.

Sacramento–San Joaquin Delta

The Delta, which is an estuarine environment, contains a mix of fresh water and saltwater. In general, downstream areas of the Delta contain saltier water, while upstream areas contain fresher water. The location at which Delta waters become saline is largely dependent on the rate of net outflows from the Delta, which is determined primarily by inflows, local diversions, and exports. High flows push saltwater towards the San Francisco Bay, while lower outflow rates allow saltwater to intrude upstream farther into the Delta.

The release of water from storage in Lakes Shasta, Folsom, and Oroville has controlled saltwater intrusion into the Delta during summer and fall months. Flows from the eastside streams and the San Joaquin River system also contribute to controlling saltwater intrusion. In general, peak winter and spring flows have been reduced by upstream storage and diversions, and summer and fall flows have been augmented. During very wet years, reservoirs are unable to control runoff, and salinity in the northern portions of San Francisco Bay is reduced to freshwater concentrations (CALFED, 2000).

Delta flows and water quality are specifically controlled or influenced by the following factors:

- Inflow of fresh water from tributary rivers, as influenced by upstream reservoirs, diversions, and other infrastructure and management activities
- In-Delta diversions for export and local use, including CCWD, CVP and SWP pumping
- Upstream agricultural return flows

- Upstream and in-Delta wastewater treatment plant discharges
- In-Delta agricultural discharges resulting in elevated concentrations of total organic carbon and salts, which result from contact with peat-rich Delta soils and evaporative concentration, respectively
- Discharges from Delta agricultural islands may also have elevated concentrations of nutrients, suspended solids, organic carbon, boron, and pesticides
- Tidal action that forces high-salinity seawater, including bromide associated with seawater, from Suisun and San Francisco Bays into the lower Delta
- Heavy metals, including cadmium, copper, mercury, and zinc, which continue to enter the Delta. Sources of these metals include runoff from abandoned mine sites, tailing deposits, downstream sediments where metals have been deposited over the past 150 years, urban runoff, and industrial and municipal wastewater.

The factors that most influence Delta water quality can differ by location. The north Delta tends to have better water quality in terms of salinity, in large part a result of low salinity water inflow from the Sacramento River. The quality of water in the west Delta is strongly influenced by tidal exchange with San Francisco Bay. During low-flow periods, seawater intrusion results in increased salinity. In the south Delta, water quality tends to be poorer because of the combination of low inflows of lower quality water from the San Joaquin River, agricultural return flows that are pumped from Delta islands into Delta channels, and the effects of seawater intrusion from San Francisco Bay.

Table 4.2-2 identifies current mean concentrations of selected constituents at various locations in the Delta. These and other water quality parameters relevant to Delta water quality are described in the following paragraphs. For reference, a map of the Delta is presented as Figure4.2-3. Review of these water quality data indicates that higher levels of the constituents related to salinity tend to occur toward the southern and western portions of the Delta.

TABLE 4.2-2
WATER QUALITY FOR SELECTED STATIONS IN THE DELTA

Location	Mean TDS (mg/L)	Mean EC (µS/cm)	Mean Chloride (mg/L)	Mean Bromide (mg/L)	Mean DOC (mg/L)
Sacramento River at Greene’s Landing	100	160	6.8	0.018	2.5
North Bay Aqueduct at Barker Slough	192	332	26	0.015	5.3
Clifton Court Forebay	286	476	77	0.269	4.0
Jones Pumping Plant	258	482	81	0.269	3.7
CCWD Intake at Rock Slough	305	553	109	0.455	3.4
San Joaquin River at Vernalis	459	749	102	0.313	3.9

The sampling period varies, depending on the location and constituent, but generally is between 1990 and 1998.

TDS = total dissolved solids
EC = electrical conductivity
DOC = dissolved organic carbon
mg/L = milligrams per liter
µS/cm = micro Siemens per centimeter

SOURCE: CALFED, 2000.

Delta Salinity

Salinity (defined above) varies across the Delta, and results from a combination of mineral loads from river inflows, saline water intrusion from the San Francisco Bay, and agricultural tailwater and wastewater treatment plant outfalls within the Delta. Table 4.2-2 shows that mean TDS concentrations are highest in the west Delta and in south Delta channels that receive water from the San Joaquin River (CALFED, 2000).

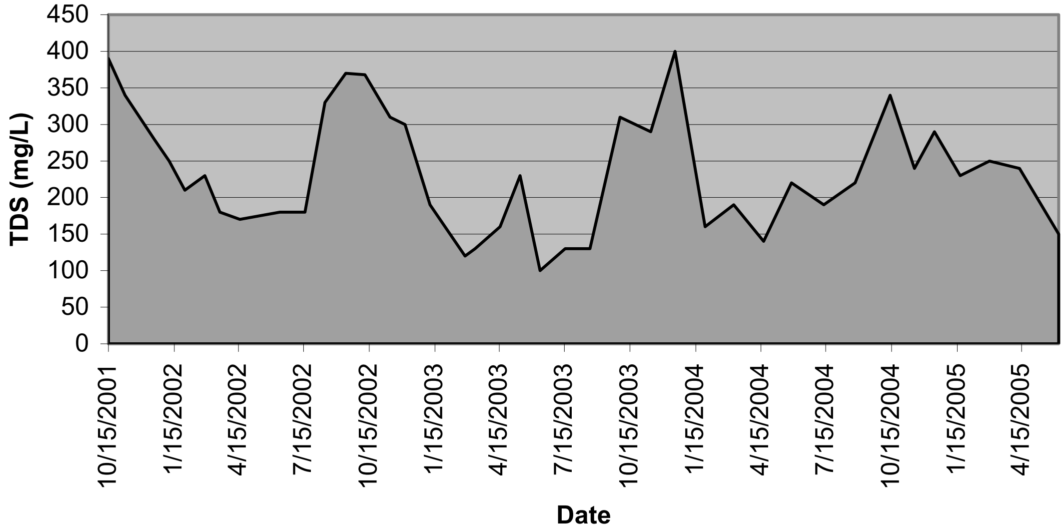
Saline water intrusion from the San Francisco Bay primarily affects the western Delta. Daily tidal cycles force saline water into and out of the Delta, with the extent of intrusion determined by tidal height, freshwater inflow from the Sacramento, San Joaquin, and east-side rivers, the rate of pumping at Delta water intakes, and the operation of various flow control structures (e.g., Delta Cross-Channel Gates and Suisun Marsh Salinity Control System; DWR, 2001).

In addition to varying geographically within the Delta, salinity varies seasonally depending on the quantity and quality of freshwater inflows and water operations. During winter and early spring, flows through the Delta are usually above the minimum levels required to control salinity. During the summer and autumn, salinity in the Delta may increase because of decreased inflows or discharges from agricultural runoff. Additionally, decreased inflow during the late summer can lower Delta outflow and, combined with high exports, result in increased net reverse flow and increased saltwater intrusion into the Delta.

The Sacramento and San Joaquin Rivers contribute about 61 percent and 33 percent, respectively, to tributary inflow salinity loads within the Delta. Sacramento River salt concentration is relatively low, but because of its large volumetric contribution, the river contributes the majority of the salt load supplied by tributary inflow to the Delta (DWR, 2001). Flow from the San Joaquin River is lower than flow from the Sacramento River, but the salt concentrations in San Joaquin River water average about seven times those of the Sacramento River. Return flows to the Delta from agricultural islands also contribute salt to Delta waterways.

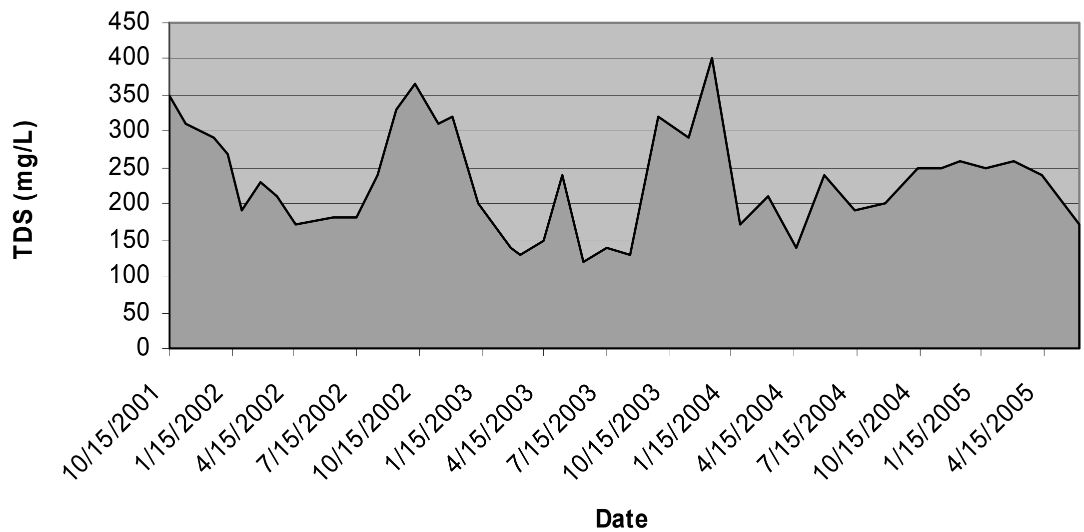
CVP and SWP exports and pumping can influence the direction of flow at various locations throughout the Delta, and thereby have the potential to affect Delta salinity. Operation of the Banks and Jones Pumping Plants draws high-quality Sacramento River water across the Delta and restricts the low-quality area to the southeast corner (CALFED, 2000; SWRCB, 1997). Each portion of the Delta is dominated by different hydraulic variables, and salinity therefore varies within different sections of the Delta.

Figure 4.2-6, **Figure 4.2-7**, and **Figure 4.2-8** illustrate the seasonal variation in salinity. Salinity generally shows a consistent increase in concentration from about August through December; salinity during these months is much higher than during the other parts of the year. The increase in concentration is still evident at the Middle River sample location near Highway 4, but the overall concentration levels are lower than at the other two testing sample locations. The salinity at Middle River, which is east of the two other stations, is typically lower than the salinity at the two Old River sampling locations in the summer and fall. This is consistent with the southern and western portions of the Delta being saltier than the northern and eastern portions. Salinity control and monitoring is the responsibility of the CVP and SWP, and is regulated by the SWRCB. Salinity is monitored



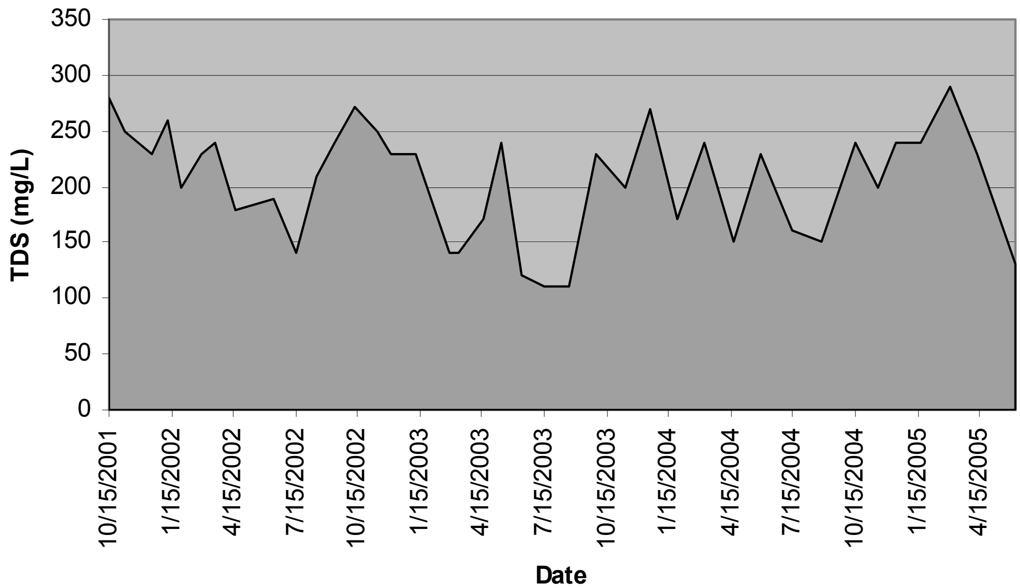
Los Vaqueros Reservoir Expansion Project. 201110

Figure 4.2-6
Regional Survey Grab Sample Data
Station #14 – Old River at CCWD Intake



Los Vaqueros Reservoir Expansion Project. 201110

Figure 4.2-7
Station #15 – Confluence of Old River and
Victoria Canal at Widows Island



Los Vaqueros Reservoir Expansion Project. 201110

Figure 4.2-8
Station #18 – Middle River at Highway 4 Bridge

because water diverted and exported from the Delta is used for a variety of municipal, industrial, and agricultural uses (CALFED, 2000; SWRCB, 1997). Salinity control in the Delta is necessary because the Delta is influenced by the ocean, and because Delta water channels are at or below sea level. Unless forced back by a continuous seaward flow of fresh water, seawater will advance into the Delta and degrade water quality. Salinity varies geographically and seasonally within the Delta and varies depending on water-year type (CALFED, 2000; SWRCB, 1997).

Bromide

Bromide is an important component of salinity because it reacts with natural organic compounds in the water to form DBPs such as trihalomethanes, haloacetic acids (HAAs), and bromate during disinfection of drinking water. Four types of trihalomethane compounds are regulated in drinking water: chloroform, bromodichloromethane, dibromochloro-methane, and bromoform, as well as total HAAs. CCWD established a source water quality goal of 50 micrograms per liter (μg/L) for bromide on the basis of a 1998 study by the California Urban Water Agencies.

The primary source of bromide in the Delta is saltwater intrusion. Other sources include drainage returns in the San Joaquin River and the Delta, and connate water beneath some Delta islands. The bromide in river and agricultural irrigation sources primarily comes from seawater intrusion into applied water delivered from the Delta. As shown in Table 4.2-2, TDS, electrical conductivity, bromide, and Cl data indicate that seawater intrusion is highest in the western and southern portions of the Delta, where the direct effects of recirculated bromide from the San Joaquin River are evident (DWR, 2001).

Overall, bromide patterns in the Delta are similar to salinity patterns in the Delta (DWR, 2001). Like salinity, bromide concentrations are highest in the west and south Delta channels affected by the San Joaquin River (DWR, 2001). Like salinity, bromide concentrations are higher in dry years than in wet years, and bromide concentrations are higher during low Delta outflows as compared to medium or high flows (DWR, 2001).

Figure 4.2-9, **Figure 4.2-10**, and **Figure 4.2-11** illustrate the bromide concentrations at various locations in the Delta. As was seen in the charts for salinity, the bromide concentration shows an increase between August and December. The levels are much higher during these months than during the rest of the year. Bromide concentrations in Delta waters tend to be strongly correlated with Cl concentration.

X2

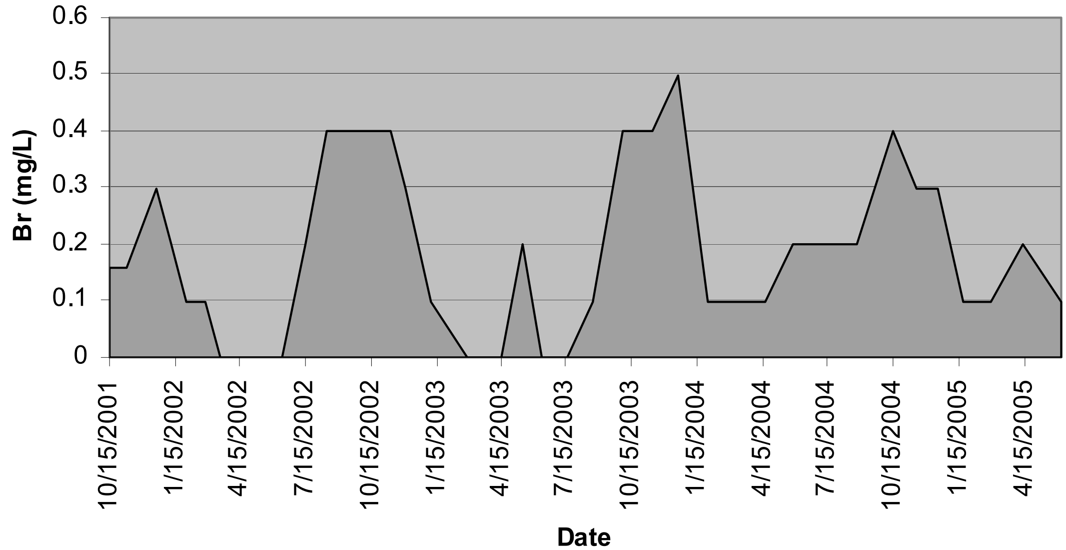
Delta outflow, along with tidal action, is one of the primary factors controlling water quality in the Delta. While tidal action pushes saline water into and out of the Delta, Delta outflow provides an ongoing barrier against saline water intrusion. The standards governing X2 (the distance in kilometers from the Golden Gate of 2 parts per thousand (ppt) salinity within the Delta) are a tool used to regulate and manage salinity within the Delta and modeling results are available in Appendix C4. When Delta outflow is low, seawater can intrude farther into the Delta, increasing the value of X2 and salinity / bromide concentrations at drinking water intakes. When Delta outflow is high, seawater is driven back towards San Francisco Bay, decreasing the values of X2 and salinity / bromide concentrations at drinking water intakes.

The position of X2 is managed through reservoir releases and, in some instances, curtailment of Delta pumping. The length of time that X2 must be positioned at set locations in the Delta each month is determined by a formula that considers the previous month’s inflow to the Delta from the Sacramento and San Joaquin Rivers. The February through June period is regulated by the X2 standard, to provide protection to Delta fisheries.

X2 is currently used as a key indicator in managing Delta conditions. It is correlated with a variety of biological indicators and is related to the magnitude of fresh water flowing downstream through the Delta, and saltwater moving upstream within the lower portion of the Delta. The *Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta* (Basin Plan) defines requirements for maintaining X2 at Port Chicago, Chipps Island, and Collinsville (SWRCB, 1995).

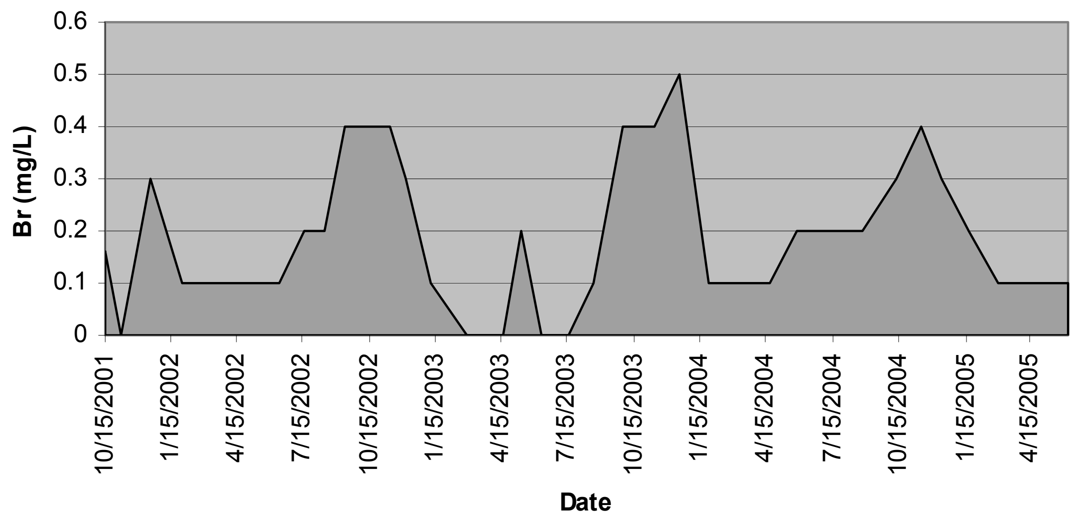
Organic Carbon

Like salinity and bromide concentrations, organic carbon concentrations in the Delta vary both geographically and seasonally. Like salinity and bromide, organic carbon concentrations are higher in the west and south Delta than in locations nearer to the Sacramento River (Table 4.2-2). However, unlike salinity and bromide, organic carbon concentrations are typically lower in the summer and higher during the wetter, winter months. Organic carbon is important because of its role in the formation of DBPs, specifically trihalomethanes. Only a portion of organic carbon is responsible for DBP formation. Studies conducted by the California Department of Water Resources (DWR,



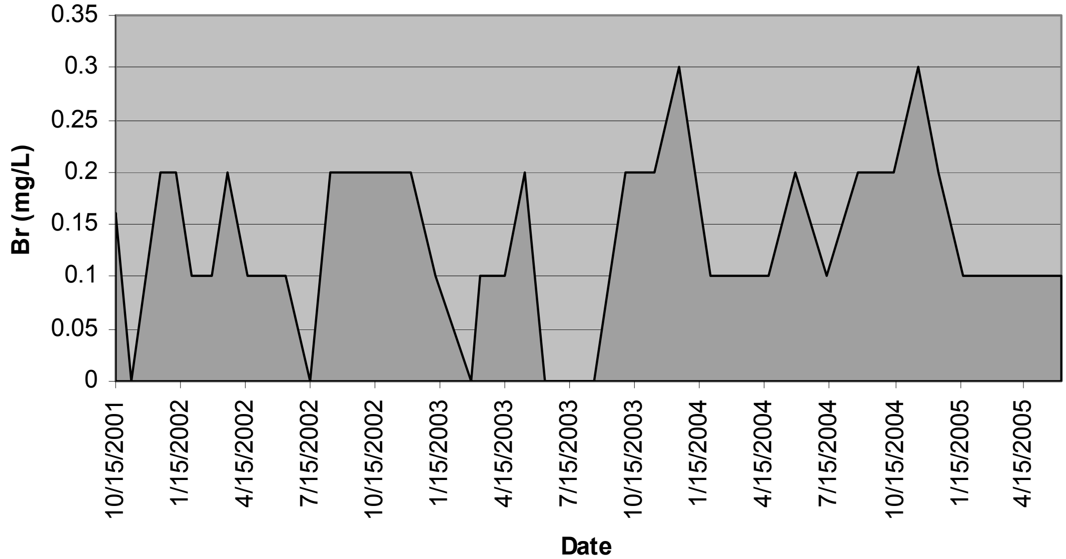
Los Vaqueros Reservoir Expansion Project. 201110

Figure 4.2-9
Regional Survey Grab Sample Data -
Station #14 – Old River at CCWD Intake



Los Vaqueros Reservoir Expansion Project. 201110

Figure 4.2-10
Station #15 – Confluence of Old River and
Victoria Canal at Widows Island



Los Vaqueros Reservoir Expansion Project. 201110

Figure 4.2-11
Station #18 – Middle River at Highway 4 Bridge

2001) suggest that Delta island drainage contributes 38 to 52 percent of the DBP-forming carbon in the Delta during the winter, and 40 to 45 percent in the summer during the irrigation season.

The Sacramento and San Joaquin Rivers and drainage return flows from in-Delta islands are important sources of DOC and TOC to the Delta (CALFED, 2000). Of the organic carbon loading contributed by tributary inflow, the Sacramento River contributes an estimated 71 percent of the total carbon load to the Delta (DWR, 2001). The Sacramento River is a major contributor of organic carbon because about three-quarters of the total Delta inflow comes from the Sacramento River (DWR, 2001). The San Joaquin River contributes about 20 percent of the TOC load attributed to tributary inflow (DWR, 2001).

Sacramento and San Joaquin Rivers

As shown in Table 4.2-2, concentrations of many water quality constituents, including TDS, bromide, and organic carbon, are typically higher in Delta exports than in Sacramento River inflow. Water quality in the Sacramento River upstream of the Delta is generally good and acceptable for agricultural and municipal/industrial (M&I) uses although the Colusa Drain and a major wastewater discharge near Freeport degrade the Sacramento River water quality as it enters the Delta.

Salinity along the lower San Joaquin River, near its point of entry into the Delta, is relatively high in comparison to salinity in the Sacramento River. During the irrigation season, daily electrical conductivity (EC) values at Vernalis are generally less than 750 microSiemens per centimeter (µS/cm), and are usually less than 1,000 µS/cm during the remainder of the year. Salt concentrations in the San Joaquin River downstream of Vernalis increase because of agricultural activities discharges from the Stockton wastewater treatment plant.

4.2.2 Environmental Consequences

Analysis of Project Alternatives

Potential effects of the project alternatives on the Delta and upstream areas were assessed with the aid of computer models developed by DWR and Reclamation, as updated for this project by CCWD and the consultant team for the project. Water supply, water management, and water quality conditions were modeled and analyzed for a 2005 (existing) level of development and 2030 (future) level of development. The 2005 level of development reflects the level of water supply demand in 2005, patterns of land use in 2005, and the water-related facilities assumed to be in place under existing conditions. The 2030 level of development reflects the projected level of water supply demand in 2030, projected patterns of land use in 2030, and the additional water-related facilities assumed to be in place by 2030. Conditions without any of the project alternatives were modeled under both 2005 and 2030 levels of development. For the 2005 modeling, those conditions are labeled "Existing Condition." For the 2030 modeling, those conditions are labeled "Future Without Project."

Conditions with each of the project alternatives were also modeled under both 2005 and 2030 levels of development (Alternative 3 was not simulated in this model analysis). This modeling methodology allows comparisons to be made between the Existing Condition and each of the project alternatives under the 2005 level of development, and between the Future Without Project and each of the project alternatives under the 2030 level of development. This is a standard modeling approach for water-related projects. The following discussion provides a description of the models used for this purpose. Additional detailed information on the models, model assumptions, and the modeling process can be found in Appendix C-3.

Hydrology, Water Operations, Hydrodynamics, and Water Quality Models

Potential effects of the project alternatives on Delta flows, Sacramento and San Joaquin River instream flows, SWP and CVP reservoir releases, and reservoir storage levels were evaluated using DWR/Reclamation's hydrology and water operations model, California Simulation Model II (CalSim II). Model output from the CalSim II analysis was then used as input to DWR's hydrodynamic/water quality model of the Delta (Delta Simulation Model, Version 2 [DSM2]). The CalSim II and DSM2 models represent the industry standard analytical tools for predicting changes in Delta conditions and CVP and SWP operations. A discussion of background information and key elements, assumptions, and limitations of CalSim II and DSM2 is provided below.

As discussed in Sections 3.1.2 and 3.4.1 (Vol. 1), operational restrictions imposed on the SWP and CVP to protect fishery resources are an important part of the background conditions in the Delta. However, considerable uncertainty exists regarding both what the regulations will be and how they will be implemented from year to year.

~~To capture the range of operations likely with fishery restrictions, both current and future, and the resulting SWP and CVP operations, two scenarios were simulated. The "moderate fishery restriction" scenario represents the least restrictive array of requirements that are reasonably to be expected under current and future regulatory conditions, while the "severe fishery restriction" scenario captures the most restrictive requirements reasonably to be expected.~~

Analyses using both the moderate and severe fishery restrictions assumptions were used to bracket the range of background conditions that are likely to occur in any year, and to evaluate the environmental effects of the project alternatives under this range of conditions. The assumptions used to estimate these restrictions are described in Appendix C3 (Vol. 4).

Water supply and management model results are provided in Appendix C4. Water quality and hydrodynamic model results are provided in Appendix C5 (Vol. 4).

CalSim II: Key Elements and Background Information

CalSim II is considered the best available tool for modeling operations of the CVP and SWP and is the system-wide hydrologic and operations model used by Reclamation and DWR to conduct planning and impact analyses for the Sacramento River, San Joaquin River, and Delta. CalSim II is also the only peer-reviewed model available to analyze the impacts of the project on the water resources of the Delta and the upstream watershed. CalSim II was developed to determine the reliability of water deliveries to CVP and SWP contractors. The model is now regularly used for water resources studies in the Delta, including water-right studies prepared for the SWRCB and CEQA and NEPA documents to estimate potential changes in surface water resources.

Land use, water infrastructure, water supply contracts, and regulatory requirements are held constant over the period of simulation, representing a fixed level of water demands and operational parameters in CalSim II. DWR and Reclamation have developed land-use-based estimates of water demands associated with current and anticipated future land uses in the Central Valley.

The historical flow record from October 1921 to September 2003, adjusted for the influence of land use changes and upstream flow regulation, is used to represent the possible range of water supply conditions at a given level of development. This 82-year historical period provides a sufficient variety of hydrological conditions (e.g., droughts and wet-year periods of varying magnitude and length) to evaluate the potential consequences of a project that would change water operations in the Delta.

The analyses performed for the Draft EIS/EIR for this project are based on CalSim II studies for 2005 and 2030 levels of development prepared as part of the Common Assumptions effort for the ongoing CALFED surface storage projects.[1] The Common Assumptions 2030 level of development

[1] Common Assumptions has not yet developed a standard constraint equation for Old and Middle River Flows under either the Wanger Ruling or the 2008 OCAP. Currently, more than one equation is being evaluated by the Common Assumptions effort. To evaluate moderate and severe Delta fishery restrictions in CalSim II, a method first implemented by the Bay-Delta Conservation Plan modeling team was used which averages three equations to determine net flows in Old and Middle rivers (See Appendices C-2 and C-3). Each equation includes pumping at the SWP Banks and CVP Jones pumping facilities, and the portion of pumping at Los Vaqueros intakes that had been shifted from SWP and CVP facilities for the South Bay water agencies (Alternative 1 and Alternative 2). The portion of pumping at the Los Vaqueros intakes to meet CCWD demand and other project benefits (including Delta Supply Restoration in Alternative 1 and Dedicated Storage for Environmental Water in Alternative 2), either through direct diversion or diversion to storage, is not included in the equations used in the CalSim II model to constrain modeled net flow in Old and Middle rivers. The impact analysis performed using the DSM2 Delta hydrodynamics model calculates flows in Old and Middle rivers based upon all simulated boundary flows and diversions, including all diversions at the Los Vaqueros intakes (See Section 4.3.2, Subsection titled, Old and Middle Rivers, page 4.3-87).

scenarios include future water supply facilities and operations that are considered reasonably likely to be implemented, as described in Section 4.1.2 (Vol. 1). To ensure that model analysis of the Los Vaqueros Reservoir Expansion Project more precisely captures any effects of the project alternatives resulting from the operation of the CVP and SWP under the OCAP BOs, the analyses performed for this Final EIS/EIR are updated using CalSim II studies developed in August 2009 for the 2005 and 2030 levels of development. These studies modified the Common Assumptions studies to include modeling assumptions that capture the export restrictions based on Old and Middle River flow and the other regulations on state and federal water project operations imposed by the OCAP BOs.

A review of the methodology, software, and application of CalSim II was conducted in 2003 (Close et al., 2003). The main limitations of CalSim II that are relevant to its application for this EIS/EIR are as follows:

Monthly time step. Since CalSim II uses a monthly time step, it does not represent daily variations that may occur in the rivers under actual flow and weather conditions. The hydrodynamic and water quality modeling conducted using DSM2 uses a 15-minute time step, but uses the CalSim II average monthly inflows to the Delta as boundary conditions. Water quality results from DSM2 are averaged over a month to provide input salinity to CalSim II that drives simulated Los Vaqueros Reservoir operations. Changes in salinity on a monthly time step can be substantial and may not accurately capture operational decisions that change over the time scale of days or weeks. This is a recognized limitation of the model, and is addressed through careful interpretation of model results that include large changes between subsequent months.

Threshold Sensitivity in CalSim II. CalSim II simulates operational rules to guide reservoir and pumping operations and decisions. Some of these rules specify threshold values that, when exceeded, trigger a different operation. This can result in simulated operations with changes greater than might be expected in practice, because in practice operator judgment plays a role in interpreting and implementing operational rules.

Similarly, some regulatory requirements specify thresholds that trigger different standards, which cannot be simulated with accuracy in a monthly time-step model. For example, the X2 requirement at Port Chicago applies only in months when the average EC at Port Chicago during the 14 days just before the first day of the month is less than or equal to 2.64 millimhos per centimeter (mmhos/cm).

Use of these threshold values in CalSim II, coupled with a monthly time step, can result in responses to small changes that might be larger than expected in practice for any given month, but generally average out over several months. Changes in simulated CVP and SWP operations between an Existing or Future Without Project scenario and a project alternative are carefully investigated to determine whether such changes would reasonably be caused by the project alternative or are an artifact of the approximations used in the model.

CalSim II is recognized as a valuable tool when used in a comparative analysis, such as for this EIS/EIR. Results from a single simulation may not necessarily correspond to actual system operations for a specific month or year, but are representative of general water supply conditions.

Model results are best interpreted using various statistical measures such as long-term and year-type average, and probability of exceedance. In this form, the model results adequately estimate the potential impacts of the project alternatives, notwithstanding the limitations of CalSim II previously discussed.

DSM2: Key Elements and Background Information

DSM2 is a one-dimensional numerical model developed by DWR for simulation of tidal hydraulics, water quality, and particle tracking in the Delta. This model is the standard tool used by DWR and Reclamation for analyzing potential impacts of the project alternatives on water conditions in the Delta. The DSM2 model was used in conjunction with CalSim II to evaluate the potential impacts of the project alternatives on Delta channel flow, water level, and water quality. Appendix C3 provides the input assumptions and other criteria used for the DSM2 modeling analysis. A brief summary is provided below.

The DSM2 analysis used monthly simulated boundary flows from the CalSim II analysis described above. Changes in simulated Delta tidal flows, stage, and water quality, in comparison to Existing and Future Without Project conditions, were determined for the 16-year period from 1976 to 1991. This period includes the 2-year drought from 1976 to 1977, as well as the 6-year drought, from 1987 to 1992. This shorter period of simulation, rather than the 82 year CalSim II analysis period, has been standard practice for DSM2 modeling studies.

A recognized issue in using CalSim II inputs to DSM2 is that the estimation of Delta water quality is approached differently by the two models. This sometimes leads to a condition in which the CalSim II model estimates the amount of outflow required to avoid causing a Delta water quality violation, but the subsequent DSM2 estimate of Delta salinity shows that the standard might be exceeded. This mismatch between the models is generally small, but still occurs. Due to this known mismatch, interpretation of DSM2 results that are based on CalSim II inputs for analysis of compliance with Delta water quality standard compliance is best done in a comparative fashion between two model studies.

Most water quality impacts were analyzed using DSM2 outputs for electrical conductivity, either directly or as converted to Cl concentrations. Changes in X2 location were assessed from the CalSim II output.

Operations and Benefits Provided by Project Alternatives

To perform the analysis of the Los Vaqueros Reservoir Expansion Project, the CalSim II model described was modified to include Los Vaqueros Reservoir, the existing intakes, and the new Delta intake and pump station. This allowed estimation of Los Vaqueros Reservoir operations in conjunction with the state and federal water facilities represented within the CalSim II model. Details on the inclusion of Los Vaqueros Reservoir operations within the CalSim II model are presented in Appendix C.

The terms of the USFWS and NMFS OCAP BOs require changes to the prior operation of the CVP and SWP in the Delta. To ensure that the modeling analysis of the Los Vaqueros Reservoir

Expansion Project more precisely captures any effects of the project alternatives resulting from the operation of the CVP and SWP under the OCAP BOs, the analyses performed for this Final EIS/EIR have been updated using CalSim II studies completed in August 2009 that incorporate the requirements of the OCAP BOs.

The modeling analysis for the Draft EIS/EIR included restrictions on CVP and SWP exports from the Delta that were based on terms in the December 2007 court order in *NRDC vs. Kempthorne*, as modified to include further OMR flow requirements anticipated to be required for protection of longfin smelt. Due to uncertainty about future implementation of OMR flow restrictions at the time the Draft EIS/EIR analysis was performed, a bracketed approach was used in that analysis in which the best available information was used to predict the likely high and low bounds for OMR flow restrictions (moderate and severe restrictions). The analysis performed for the Final EIS/EIR incorporates updated modeling of CVP and SWP operations under the USFWS and NMFS OCAP BOs, which both include restrictions on OMR flows. Diversions at the CCWD Old River and AIP Intakes are included in the calculation of OMR net flow within the CalSim II model. The bracketed approach was not used in the CalSim II modeling. Remaining uncertainty regarding the implementation of OMR flow restrictions, which are adaptively managed based on real-time Delta water quality and fishery monitoring, is addressed in the Final EIS/EIR analysis through the use of multi-year model simulations, which capture a range of operations and potential effects.

The studies include modeling assumptions that capture the export restrictions based on OMR flow. Operational assumptions have been updated for Alternatives 1 and 2 of the Los Vaqueros Reservoir Expansion Project so that increased diversions for Delta Supply Restoration or Dedicated Storage of Environmental Water are not made for those project alternatives when the new OMR flow regulations are controlling CVP and SWP exports from the Delta. Operations for Delta Supply Restoration and additional Dedicated Storage for Environmental Water are not included in Alternative 4; therefore, this updated assumption did not affect the analysis of Alternative 4.

CCWD, Reclamation and DWR have reviewed Delta water supply operations in light of the recently issued OCAP BOs, comments on the Draft EIS/EIR, and the Special Delta Term included in D1629, and have developed a proposed set of operations for CCWD that will avoid potential conflicts, improve overall coordination of Delta water operations, while maintaining fishery protection, water supply and water quality for CCWD, CVP and SWP. The proposed operations represent changes to the default timing of the no fill and no diversion periods described in the biological permits that govern the operations of Los Vaqueros Reservoir (1993 USFWS and NMFS Biological Opinions and 2009 CDFG Incidental Take Permit). These changes in timing would be allowable under the existing permits, with approval from the permit-issuing agencies. The proposed operations may be refined during Endangered Species Act consultation with NMFS, USFWS and/or CDFG. The proposed operations that are included in this updated modeling analysis are:

- The 75 to 90 day no fill period for Los Vaqueros Reservoir is implemented in half or all of February and all of March and June, and the 30-day CCWD no diversion period is implemented in March. This reduces the potential influence of filling Los Vaqueros Reservoir when OMR flow restrictions govern Delta operations, and will protect aquatic resources while maintaining water right priorities. These operations are implemented within the CalSim II model used in the updated analysis for the project alternatives. The model simulations for Existing Conditions and Future Without Project used the current default timing for no fill and no diversion periods, which implements the no fill requirement variably in February, and from March 15 through May 31, and implements the no diversion period in April.

- During periods when OMR flow restrictions occur, the screened Rock Slough Intake (described in Section 3.1.3 of the Final EIS/EIR, Vol. 4, Section 3.1, Master Response 1: Project Purpose and Description,) is used to the maximum extent possible for direct diversions to CCWD customers while maintaining the chloride delivery goal. This also protects aquatic resources while avoiding adverse effects on water supply and quality. This operation is implemented in the updated CalSim II modeling performed for the Final EIS/EIR for simulations of Alternatives 1, 2, and 4 under both 2005 and 2030 level of development. In the modeling of this operation, it is assumed that between December and June, all direct diversions to CCWD would be made from Rock Slough Intake when the chloride concentration at that location is below the CCWD delivery goal of 65 mg/L. If the chloride concentration at the Rock Slough Intake is above 65 mg/L during the December through June period, diversions are made from other CCWD intakes to blend the Rock Slough Intake salinity to 65 mg/L, if possible based on the salinity at the other CCWD intakes.

- Releases from Los Vaqueros Reservoir are minimized from September through November, while still maintaining the chloride delivery goal for CCWD customers. Los Vaqueros Reservoir is also filled during this period when water quality allows. This improves fishery protection and avoids water supply or quality impacts. This operation is included in the CalSim II modeling performed for the Final EIS/EIR by using the CCWD intake with lowest salinity for diversions to CCWD customers in the September through November period, and by allowing the reservoir to be filled when salinity at one or more intakes is below 65 mg/L.

- When diversions from the Freeport Intake are available to CCWD pursuant to the agreement with EBMUD for shared use of this intake, these diversions were used to fill Los Vaqueros Reservoir whenever other Delta water quality and CCWD operational conditions allow. This minimizes the potential effects of filling Los Vaqueros Reservoir on OMR flow to maintain fishery protections while avoiding water quality and supply impacts. This operation was incorporated in the modeling performed for the Final EIS/EIR by instructing the model to fill Los Vaqueros Reservoir with diversions of 3.2 TAF from the Freeport Intake, under the terms of the agreement with EBMUD, at the first opportunity in each CVP contract year when Rock Slough Intake water quality is below the CCWD delivery goal of 65 mg/L chloride, as this condition allows CCWD customer demand to be met from Rock Slough Intake while the reservoir is filled from the Freeport Intake.

The modified CCWD operations described above are used for the analysis of alternatives in the updated modeling presented in this section. The modifications are assumed to occur in Alternatives 1, 2, and 4 under both 2005 and 2030 levels of development. (Alternative 3 was not re-evaluated because even with these changes it cannot avoid significant impacts.) The modifications to the timing of no fill and no diversion periods were not used for the existing or future Without Project Conditions because such modifications are not currently in place, and would not be sought absent approval of the project or one of the alternatives. The operation of the Rock Slough Fish Screen is assumed to occur in Alternatives 1, 2, and 4. The Rock Slough Fish Screen is not assumed to be operated in the existing Without Project Conditions, but is assumed to be operated in the future Without Project Conditions. This is because the Rock Slough fish screen is not currently in place and was not approved at the time environmental review commenced, but will be constructed regardless of whether the project is approved. However, the Rock Slough Intake is not preferentially used in the Future Without Project conditions. Instead, intake selection for direct diversions to CCWD customers is assumed to be made based on best available water quality in the simulation of Future Without Project conditions.

As described in Chapter 3 (Vol. 1), the alternatives were designed to provide various levels of water supplies for environmental water management and water supply reliability, while improving delivered drinking water quality. The project alternatives were modeled using the tools described previously in this section to determine the benefits they would provide and to assess the impacts of providing those benefits. The physical and operational characteristics of each alternative are described in detail in Chapter 3 (Vol. 1).

Table 4.2-3 presents the annual average of the total diversions that would be taken at Rock Slough, Old River, AIP, and, under Alternatives 1 and 2, the new Delta intake facilities. These diversions would be either directly delivered or stored. Diversions to storage would be later released (e.g. releases to South Bay water agencies or wildlife refuges). These releases are not included in Table 4.2-3 but are discussed as part of the project benefits. The diversions are grouped by the initial destination of the water that is pumped. For a further breakdown of the water use (for instance, by CCWD water right, month, and water year type), see Appendix C4 (Vol. 4).

TABLE 4.2-3 (REVISED)*
ANNUAL AVERAGE DELTA DIVERSIONS AT ROCK SLOUGH, OLD RIVER, VICTORIA CANAL, AND NEW DELTA INTAKE FACILITIES, BY WATER USE (TAF/YR)

	Long-Term Average			1987-1992 Drought Average			1976-1977 Drought Average		
	Direct Delivery to CCWD	Direct Delivery to Others	Diversion to LV Storage	Direct Delivery to CCWD	Direct Delivery to Others	Diversion to LV Storage	Direct Delivery to CCWD	Direct Delivery to Others	Diversion to LV Storage
2005 Level of Development									
Existing Condition	102	0	23	118	0	13	111	0	0
Alternative 1	103	147	32	121	67	7	102	86	0
Alternative 2	103	146	31	121	65	7	102	86	0
Alternative 4	100	0	26	116	0	6	82	0	0
2030 Level of Development									
Future Without Project	139	0	25	159	0	12	150	0	0
Alternative 1	139	137	35	159	53	8	137	74	2
Alternative 2	139	137	35	159	54	8	137	74	2
Alternative 4	136	0	29	155	0	7	118	0	2

* Modeling results presented in this table have been updated based on analysis for the Final EIS/EIR.

CCWD = Contra Costa Water District
LV = Los Vaqueros
TAF = thousand acre-foot (feet)
YR = year

As shown in Table 4.2-3, direct deliveries to CCWD under each of the project alternatives would decrease during droughts compared to the Existing and Future Without Project conditions, because of the use of CCWD's share of the increased storage capacity in Los Vaqueros Reservoir. ~~Direct deliveries to CCWD under Alternative 3 would decrease during all conditions because the reservoir is operated to provide additional environmental water management benefits as described in Chapter 3.~~ Annual average diversions to storage would be greater for ~~all alternatives~~ Alternatives 1 and 2 compared to the Existing and Future Without Project conditions because a larger demand for water deliveries from the reservoir that includes customers at South Bay water agencies is assumed for ~~the larger reservoir provides more available storage space~~these alternatives. The additional stored water would then be available for release to project participants, providing environmental water management, water supply reliability, and water quality benefits as described in the following subsections. In Alternative 4, annual average diversions to storage are not greater than in the Existing and Future Without Project conditions, other than small increases to make up for increased evaporation from the larger reservoir surface area.

Project Benefits Analysis

The evaluation of benefits described in this report is intended to provide information for potential project participants and to provide a basis for evaluating potential environmental impacts. All of the project alternatives share two primary objectives: to use an expanded Los Vaqueros Reservoir to develop water supplies for environmental water management, and to increase water supply reliability for Bay Area water providers. The facilities considered and the manner in which the alternatives are operated determine to what extent the primary objectives are achieved. All of the project alternatives also share a secondary objective: to use an expanded Los Vaqueros Reservoir to improve the quality of water deliveries to municipal and industrial customers in the San Francisco Bay Area, without impairing the project's ability to meet the environmental and water supply reliability objectives. (See Chapter 1 (Vol. 1) for a discussion of project purpose and need and objectives.) The extent of the benefits achieved in each of these areas will depend on several factors, including future Delta conveyance and habitat improvements, Delta operations requirements, and the project's precise environmental water management actions as further developed in project permits and agreements with project partners.

Some of the project benefits estimated in the Final EIS/EIR analysis have decreased relative to the benefits estimates provided in the Draft EIS/EIR analysis. These changes occur primarily because of the model updates in the Final EIS/EIR. Diversions for Delta Supply Restoration and Dedicated Storage for Environmental Water are limited by OMR flow requirements in the Final EIS/EIR modeling, which reduces the estimated benefit for each of these categories by limiting these operations relative to what was assumed in the Draft EIS/EIR analysis. Environmental Water Management associated with shifting diversions to CCWD intakes with positive barrier fish screens are based on CVP and SWP contract allocation values in the CalSim II model, which have decreased relative to the Draft EIS/EIR analysis with the inclusion of the OCAP BO terms in the CalSim II model used for the Final EIS/EIR analysis. The Environmental Water Management deliveries to South Bay water agency customers are also diminished during the CCWD no diversion periods by the OMR flow limits placed on filling Los Vaqueros Reservoir for South Bay water agency supply in the Final EIS/EIR analysis. CCWD operations are modified in the Final EIS/EIR analysis to better coordinate fishery protection operations with CVP and SWP, as described above, but the CCWD water supply reliability benefits of the project alternatives are not substantially affected by these modifications. Incidental water quality benefits to customers of South Bay water agencies are expected to decrease along with the amount of water potentially delivered from Los Vaqueros Reservoir to those agencies. Incidental water quality benefits to CCWD customers are expected to occur along with the water supply reliability benefit to CCWD in the project alternatives.

Environmental Water Management

Benefits are determined by the facilities and operations for each project alternative. The modeling results show that improvements in environmental water management are similar for a given project alternative across levels of development and fishery restrictions. Appendix C4 (Vol. 4) provides detailed model results for water supply and management.

The project alternatives result in varying degrees of improvement in environmental water management depending on the water system operations implemented. Under Alternative 1, most of the improvement in environmental water management would be provided through Improved Fish Screening (see Section 3.1.2 and 3.4.2 in Vol. 1). **Table 4.2-4** shows the amount of water that would be diverted through the Los Vaqueros Reservoir system positive-barrier fish screens and delivered to the South Bay water agencies to replace water that would otherwise have been diverted at the existing SWP and CVP export pumps. CVP and SWP Delta export pumping would be reduced to correspond with the use of the Los Vaqueros Reservoir pumping system for the South Bay water agencies. Shifting this water diversion to the more effectively screened Los Vaqueros Reservoir system intakes would have fewer impacts to fish than the same amount of water diverted from either the SWP or CVP export facilities.

As analyzed in this EIS/EIR, this export pumping reduction takes place at the same time as the shift to Los Vaqueros Reservoir system intakes, but DWR, Reclamation and the state and federal fisheries agencies could optimize the timing of the reduction to further benefit fish. For example, the SWP and CVP Delta export pumps could be operated at minimal levels ~~in April to improve salmon migration or to allow delta smelt larvae to move out of the South Delta, or they could be operated at minimal levels in February to allow longfin smelt larvae to move out of the South Delta~~at critical periods for the Delta fisheries, to allow fish passage through or out of the south Delta. Initial estimates indicate that such operation could yield about 100 to 150 TAF of water per year to use in this manner. In either case, using the Los Vaqueros Reservoir system to deliver water to South Bay water agencies would result in improvement in environmental water management. Alternative 1 would also provide improvement in environmental water management through the No-Diversion Period and Multiple Delta Intake Locations (see Section 3.1.2 and 3.4.2 in Vol. 1).

In Alternative 2, most of the improvement in environmental water management would be provided through Improved Fish Screening, as described above, and Dedicated Storage for Environmental Water (see Section 3.1.2 and 3.4.2 in Vol. 1). **Table 4.2-5** shows the amount of water that would be diverted through the Los Vaqueros Reservoir system positive-barrier fish screens and delivered

TABLE 4.2-4 (REVISED)*
ALTERNATIVE 1 SUMMARY OF BENEFITS

Operations	Benefits					
	2005 Level of Development			2030 Level of Development		
		6-Year Drought[1]			6-Year Drought	
	Long-term Avg[2]	Annual Avg	Total	Long-term Avg	Annual Avg	Total
Environmental Water Management[3]	151 TAF/yr	68 TAF/yr	410 TAF	141 TAF/yr	55 TAF/yr	328 TAF
South Bay Water Agencies Water Supply Reliability	5 TAF/yr	7 TAF/yr	43 TAF	6 TAF/yr	10 TAF/yr	58 TAF
CCWD Water Supply Reliability[4]	NA	3 TAF/yr	20 TAF	NA	3 TAF/yr	20 TAF
Emergency Water Storage[5]	106 TAF	64 TAF	NA	107 TAF	67 TAF	NA
Additional Real-time Operating Benefits	Multiple intake locations to further avoid fish impacts; increased water supply reliability by reducing regulatory pumping restrictions Timing of pumping reductions at SWP/CVP Delta export facilities to further benefit fish					
South Bay Water Agencies Water Quality	Incidental taste & odor improvements, Incidental salinity improvements					
CCWD Water Quality	Incidental improvement in CCWD‘s ability to meet its delivered water quality goal					

* Modeling results presented in this table have been updated based on analysis for the Final EIS/EIR.

1 6-year drought values based on hydrology of 1987-1992 drought
2 Long-term average values shown based on 82-year simulation
3 Environmental Water Management in Alternative 1 includes screened intakes, a 30-day No-Diversion period, multiple intake locations, and possible optimization of export reduction timing to benefit Delta fish
4 Assumes 20 TAF additional storage for CCWD
5 Average amount of water available in the reservoir for a single-year emergency

to the South Bay water agencies, plus the amount of water that would be provided for environmental water supplies for Delta fishery protection, San Joaquin Valley refuges, instream flows or other environmental purposes. For purposes of modeling, this water is assumed to be transferred to San Luis Reservoir where it would be available for delivery to Central Valley wildlife refuges. Alternative 2 would also provide improvement in environmental water management through the No-Diversion Period and Multiple Delta Intake Locations (see Section 3.1.2 and 3.4.3 in Vol. 1).

~~In the case of Alternative 3, most of the improvement in environmental water management would be provided through both the No-Diversion Period and Dedicated Environmental Water Storage (see Section 3.1.2 and 3.4.2). Under this alternative, CCWD could temporarily stop pumping from the Delta and instead draw from the stored Los Vaqueros Reservoir supplies to serve its customers during periods that would allow Reclamation to retain cold water stored in upstream reservoirs. The water stored upstream of the Delta in CVP reservoirs that had been reserved for delivery to CCWD could be reallocated for environmental purposes. These purposes could include cold water releases to support salmon spawning or pulse flow releases to support salmon migration in addition to water for wildlife refuges or other environmental purposes. The CVP water supply foregone by CCWD in this manner could also be conveyed through the Delta by existing export facilities for~~

TABLE 4.2-5 (REVISED)*
ALTERNATIVE 2 SUMMARY OF BENEFITS

	Benefits					
	2005 Level of Development			2030 Level of Development		
		6-Year Drought[1]			6-Year Drought	
Operations	**Long-term Avg[2]**	**Annual Avg**	**Total**	**Long-term Avg**	**Annual Avg**	**Total**
Environmental Water Management[3]	155 TAF/yr	69 TAF/yr	413 TAF	146 TAF/yr	54 TAF/yr	322 TAF
CCWD Water Supply Reliability[4]	NA	3 TAF/yr	20 TAF	NA	3 TAF/yr	20 TAF
Emergency Water Storage[5]	100 TAF	58 TAF	NA	101 TAF	58 TAF	NA
Additional Real-time Operating Benefits	Multiple intake locations to further avoid fish impacts; increased water supply reliability by reducing regulatory pumping restrictions Timing of pumping reductions at SWP/CVP Delta export facilities to further benefit fish					
South Bay Water Agencies Water Quality	Incidental taste & odor improvements, Incidental salinity improvements					
CCWD Water Quality	Incidental improvement in CCWD ‘s ability to meet its delivered water quality goal					

* Modeling results presented in this table have been updated based on analysis for the Final EIS/EIR.

1 6-year drought values based on hydrology of 1987-1992 drought
2 Long-term average values shown based on 82-year simulation
3 Environmental Water Management in Alternative 2 includes screened intakes, a 30-day No-Diversion period, multiple intake locations, dedicated storage for environmental water, and possible optimization of export reduction timing to benefit Delta fish
4 Assumes 20 TAF additional storage for CCWD
5 Average amount of water available in the reservoir for a single-year emergency

~~environmental purposes south of the Delta. **Table 4.2-6** shows the amount by which CCWD would decrease its diversions, the amount stored upstream for environmental purposes, and the amount conveyed through the Delta for San Joaquin Valley Refuge use. Alternative 3 would also provide improvement in environmental water management through Multiple Delta Intake Locations (see Section 3.1.2 and 3.4.4).~~

The improvement in environmental water management under Alternative 4 would be smaller than under the other alternatives. Most of the benefit would be provided through the No-Diversion Period operations (see Section 3.1.2 and 3.4.2 in Vol. 1). When the reservoir is above emergency levels, the no-fill and no-diversion periods described ~~in Section 3.4.5~~above would apply. During extended dry conditions, the existing reservoir can fall below emergency levels, which results in exemptions from the no-fill and no-diversion periods so that it can be refilled up to emergency levels. The additional storage constructed under Alternative 4 would increase the number of years in which CCWD would implement the no-fill and no-diversion periods. The quantity presented in **Table 4.2-7** represents the reduction in diversions required to maintain the expanded reservoir at or above emergency levels. Alternative 4 would also provide improvement in environmental water management through Multiple Delta Intake Locations (see Section 3.1.2 and 3.4.5 in Vol. 1).

TABLE 4.2-6
ALTERNATIVE 3 SUMMARY OF BENEFITS

Operations	Benefits											
	Moderate Fishery Restrictions						Severe Fishery Restrictions					
	2005 Level of Development			2030 Level of Development			2005 Level of Development			2030 Level of Development		
		6-Year Drought[1]			6-Year Drought			6-Year Drought			6-Year Drought	
	Long-term Avg[2]	Annual Avg	Total	Long-term Avg	Annual Avg	Total	Long-term Avg	Annual Avg	Total	Long-term Avg	Annual Avg	Total
Environmental Water Management[3]	15 TAF/yr	45 TAF/yr	275 TAF	20 TAF/yr	65 TAF/yr	385 TAF	10 TAF/yr	55 TAF/yr	340 TAF	10 TAF/yr	45 TAF/yr	275 TAF
CCWD Water Supply Reliability[4]	NA	3 TAF/yr	20 TAF	NA	3 TAF/yr	20 TAF	NA	3 TAF/yr	20 TAF	NA	3 TAF/yr	20 TAF
Emergency Water Storage[5]	245 TAF	180 TAF	NA	235 TAF	130 TAF	NA	235 TAF	130 TAF	NA	220 TAF	105 TAF	NA
CCWD Water Quality	Incidental improvement in CCWD 's ability to meet its delivered water quality goal											

1 6-year drought values based on hydrology of 1987-1992 drought
2 Long-term average values shown based on 82-year simulation
3 Environmental Water Management in Alternative 3 includes screened intakes, a 30-day No-Diversion period, and dedicated storage for environmental water
4 Assumes 20 TAF additional storage for CCWD
5 Average amount of water available in the reservoir for a single-year emergency

**TABLE 4.2-7 (REVISED)*
ALTERNATIVE 4 SUMMARY OF BENEFITS**

Operations	Benefits					
	2005 Level of Development			2030 Level of Development		
	Long-term Avg[2]	6-Year Drought[1] Annual Avg	6-Year Drought[1] Total	Long-term Avg	6-Year Drought Annual Avg	6-Year Drought Total
Environmental Water Management[3]	NA	2 TAF/yr	14 TAF/yr	NA	3 TAF/yr	20 TAF/yr
Water Supply Reliability[4]	NA	10 TAF/yr	60 TAF	NA	10 TAF/yr	60 TAF
Emergency Water Storage[5]	117 TAF	69 TAF	NA	116 TAF	69 TAF	NA
CCWD Water Quality[6]	5%			6%		

* Modeling results presented in this table have been updated based on analysis for the Final EIS/EIR.

1 6-year drought values based on hydrology of 1987-1992 drought
2 Long-term average values shown based on 82-year simulation
3 Environmental Water Management in Alternative 4 includes screened intakes and a 30-day No-Diversion period
4 Assumes 60 TAF additional storage for CCWD and any other participating Bay Area water agencies
5 Average amount of water available in the reservoir for a single-year emergency
6 Improvement in amount of time CCWD water quality goal met

Water Supply Reliability

Water supply reliability benefits are determined by the facilities and operations for each project. The modeling results show that these benefits are similar for a given project alternative across levels of development and fishery restrictions. Appendix C4 (Vol. 4) provides detailed model results of water supply and management.

Under Alternative 1, the water supply reliability benefit would be provided through Delta supply restoration, dry-year storage, and increased emergency water storage (see Section 3.1.2 in Vol. 1). With Delta supply restoration, direct diversions, and stored water supplies would be used to partially restore delivery reductions to the South Bay water agencies that have occurred and are expected to continue to occur due to regulatory restrictions at the SWP and CVP Delta export pumps. Dry-year storage would increase the amount of water available in dry years to South Bay water agencies and CCWD, reducing the need to purchase supplemental dry year supplies, activate dry-year exchange programs, or institute drought management measures. For South Bay water agencies, the combination of Delta supply restoration and dry-year storage is measured by the quantity of water available to participating agencies above that which would be available in the absence of the project.

For CCWD, dry-year storage is measured by the additional amount of water that could be available to CCWD at the beginning of a multi-year drought above that which would be available in the absence of the project. Emergency storage is measured by the amount of water that would be available to the Bay Area during shortages caused by natural disasters or other emergencies. Table 4.2-4 presents the Delta supply restoration, dry-year storage, and emergency water storage for Alternative 1.

Under Alternatives 2, 3 and 4, the water supply reliability benefit would be provided through dry-year storage and increased emergency water storage (see Section 3.1.2 in Vol. 1). Dry-year storage in each of these alternatives would increase the amount of water available in dry years to CCWD. Emergency storage would increase the amount of water that would be available to the Bay region during shortages caused by natural disasters or other emergencies.

Tables 4.2-5 and 4.2-7 presents the dry-year storage and emergency water storage under Alternatives 2, 3 and 4.

Table 4.2-6 has not been updated for the Final EIS/EIR. Alternative 3 was found to have significant and unavoidable fisheries impacts in modeling analysis performed for the Draft EIS/EIR, as explained in Section 4.3 of that document. This alternative was not included in the updated modeling analysis performed for the Final EIS/EIR because it would not be environmentally superior to the other alternatives.

Water Quality Improvements

All alternatives would meet the secondary project objective of improving the quality of water deliveries to municipal and industrial customers in the San Francisco Bay Area, without impairing the project's ability to meet the environmental and water supply reliability objectives. The water quality improvements would primarily benefit CCWD customers, as measured by the delivered salinity levels. For all of the alternatives, the expanded storage would provide additional dry year supply for CCWD, which would also provide an inherent water quality improvement for CCWD in dry years, when this type of benefit is most needed.

The long-term average improvement in delivered water quality for CCWD would be small in Alternatives 1, and 2, and 3; these benefits have not been quantified. The benefit to CCWD delivered water quality would be relatively larger in Alternative 4, and is shown in Table 4.2-7. Alternatives 1 and 2 also are expected to result in minor improvements in the quality of water delivered to South Bay water agencies by providing low salinity water from the Los Vaqueros Reservoir to the South Bay water agencies during dry periods. This would reduce deliveries of Delta water to the South Bay water agencies through Clifton Court Forebay during such dry periods, where salinity would be relatively high, and where warm, shallow, slow-moving water often results in algae growth and a resulting increase in organic carbon content and taste and odor issues. These minor improvements are noted, but not quantified.

Methodology for Impact Assessment

The changes in Delta operations identified in the previous section have been analyzed to determine whether they would change water supplies for other water users, Delta water quality, or Delta water levels. An impact analysis was conducted to assess whether changes under each project alternative would cause a significant adverse impact. Impacts are classified as no impact, less than significant impact, less than significant with mitigation, significant and unavoidable, or beneficial.

The parameter values used to determine potential impacts have been obtained from the hydrologic modeling analysis described in the previous section.

The assessment relies on a comparative analysis of operational and resulting environmental conditions between Existing and Future Without Project conditions and each of the project alternatives. Such comparisons were performed for both the 2005 level of development and the 2030 level of development ~~and for moderate and severe fishery restrictions (described in the previous section and Chapter 3)~~. Water supply and management model results are provided in Appendix C4 (Vol. 4). Water quality and hydrodynamic model results are provided in Appendix C5 (Vol. 4).

Significance Criteria

The following thresholds for determining significance of the project impacts are based on the environmental checklist in Appendix G of the California Environmental Quality Act Guidelines, thresholds that have been developed by state and federal agencies for other Delta water projects, and the judgment of the lead agencies and the EIS/EIR preparers. The following thresholds also encompass factors taken into account under National Environmental Policy Act to determine the significance of an action in terms of its context and the intensity of its effects. An alternative was determined to result in a significant effect on water supply, water quality, or water level if it would do any of the following:

- Result in substantial adverse effects on operations or decreases in water deliveries for water users including the SWP, CVP, and Delta agricultural diverters, or significant changes in carryover storage, or timing or rate of river flows
- Violate existing water quality standards
- Result in substantial water quality changes that would adversely affect beneficial uses
- Reduce surface water elevations in the Delta to a level that would not support existing land uses or planned land uses for which permits have been granted or to a level that would restrict water transfers at the SWP and/or CVP export facilities due to conflicts with in-Delta diversions

Impact Summary

Table 4.2-8 provides a summary of the impact analysis for issues related to water supply, water quality, and water levels based on actions outlined in Chapter 3.

Impact Analysis

No Project/No Action Alternative

Under the No Project/ No Action Alternative, no new facilities would be constructed, and CCWD would continue operating the existing Los Vaqueros Reservoir and other facilities to deliver the highest quality water available subject to regulatory and physical constraints. This alternative would not change operations of the Los Vaqueros Reservoir system or the CVP or SWP in a way

TABLE 4.2-8 (REVISED)*
SUMMARY OF IMPACTS – WATER SUPPLY, WATER QUALITY, AND WATER LEVEL

Impact	Project Alternatives			
	Alternative 1	Alternative 2	~~Alternative 3~~	Alternative 4
4.2.1: The project alternatives would not adversely alter deliveries of water to other users.	LS	LS	~~LS~~	LS
4.2.2: The project alternatives would not result in significant adverse changes in Delta water quality causing the violation of a water quality standard.	LS	LS	~~LS~~	LS
4.2.3: The project alternatives would not result in changes to Delta water quality that would result in significant adverse effects on beneficial uses.	LS	LS	~~LS~~	LS
4.2.4: Diversions of Delta water under the project alternatives would not result in a significant reduction of Delta water levels.	LS	LS	~~LS~~	LS
4.2.5: The project alternatives would not result in a cumulatively considerable contribution to significant adverse cumulative effects on deliveries of water to other users, changes in Delta water quality, or change in Delta water levels.	LS	LS	~~LS~~	LS

* Results presented in this table have been updated based on analysis for the Final EIS/EIR.

SU = Significant Unavoidable Impact
LSM = Less-than-Significant Impact with Mitigation
LS = Less-than-Significant Impact
NI = No Impact

that would have a direct or indirect effect on water supply, water quality, or water levels for other Delta water users, and would not considerably contribute to any adverse cumulative water resource effects.

Delta water supply reliability for the South Bay water agencies is currently limited by recent actions taken in the Delta to protect fish. This condition would continue in the Existing and Future Without Project Conditions. Water supply reliability for CCWD and other Bay Area water agencies would not be improved and additional emergency storage for CCWD and other Bay Area water agencies would not be increased. No additional supplies for improved environmental water management would be provided, and no additional water would be diverted through positive-barrier fish screens<u>, with the exception of the Rock Slough Fish Screen currently under construction</u>.

Impact 4.2.1: The project alternatives would not adversely alter deliveries of water to other users. (Less Than Significant Impact)

Each of the alternatives would alter the quantity, location, and timing of water diversions from the Delta to varying degrees. The following analysis addresses the potential for these changes to affect deliveries of water to other users. The effects of the alternatives on water deliveries to CVP and SWP customers may be evaluated directly by comparing the model estimates of these deliveries in the Existing and Future Without Project conditions to the corresponding estimates under each of the project alternatives. Other parameters, including reservoir carry-over storage and river flows into the Delta, are used to support the evaluation of effects on CVP and SWP water users, and also to evaluate potential effects on other water users, including other in-Delta diverters.

Effects on Delta water deliveries were analyzed by assessing changes in CVP and SWP exports from the Delta, changes in carry-over storage in CVP and SWP reservoirs, changes in Sacramento and San Joaquin River flows into the Delta, and changes in net Delta outflow. **Table 4.2-9** shows long-term averages of the parameters used to evaluate the effects of each of the project alternatives. Additionally, the changes were analyzed by the five water year types used in hydrologic planning in California, based on Sacramento Valley hydrology: wet, above normal, below normal, dry, and critical. This analysis by water year type assessed whether changes caused by the project alternatives were more pronounced during certain hydrologic conditions. The results of each of these analyses are discussed in the following paragraphs. See Appendix C4 and Appendix C4 (Vol. 4) for additional presentation of modeled deliveries, storage, and Delta flows.

TABLE 4.2-9 (REVISED)*
SUMMARY OF CHANGES USED TO EVALUATE WATER DELIVERY TO OTHER USERS (all years)

		Annual CVP Exports[1,3] [TAF]	Annual SWP Exports[2,3] [TAF]	CVP and SWP Carry-over Storage[4] [TAF]	Sacramento River Flow at Hood [TAF]	San Joaquin River Flow at Vernalis [TAF]	Net Delta Outflow [TAF]
2005 Level of Development							
Existing Condition		2,191	2,625	7,471	16,121	3,073	15,865
Percent Change from Existing Condition	Alt. 1	0.2%	0.2%	0.1%	0.0%	0.0%	-0.1%
	Alt. 2	0.2%	0.2%	0.2%	0.0%	0.0%	-0.1%
	Alt. 4	0.2%	0.3%	0.1%	0.0%	0.0%	-0.1%
2030 Level of Development							
Future Without Project		2,193	2,634	7,420	16,130	3,191	15,976
Percent Change from Future Without Project	Alt. 1	0.1%	0.0%	0.1%	0.0%	0.0%	-0.1%
	Alt. 2	0.1%	0.0%	0.1%	0.0%	0.0%	-0.1%
	Alt. 4	0.2%	0.1%	0.0%	0.0%	0.0%	-0.1%

* Modeling results presented in this table have been updated based on analysis for the Final EIS/EIR.

1 CVP exports include agricultural, refuge, municipal, and industrial deliveries.
2 Table A, Article 56 and Article 21 components of SWP exports are shown.
3 CVP and SWP exports include water pumped at Jones and Banks pumping plants and water delivered to the South Bay water agencies in lieu of Jones and Banks pumping. Delta supply restoration deliveries to South Bay water agencies in Alternative 1 are not included.
4 CVP and SWP carry-over storage includes storage in Shasta, Trinity, Oroville, Folsom and San Luis reservoirs.

% = percent
Alt. = Alternative
CVP = Central Valley Project
SWP = State Water Project
TAF = thousand-acre foot (feet)

Annual CVP and SWP Deliveries

The CVP pumps water from the Delta for delivery to customers in the Bay Area and San Joaquin Valley. The SWP also pumps water from the Delta, for delivery to customers in the Bay Area, San Joaquin Valley, central coast, and southern California. By design, the project alternatives should not affect these deliveries. In Alternatives 1 and 2, SWP deliveries to the South Bay water agencies are made through the Los Vaqueros Reservoir system facilities. In all alternatives, increased filling of Los Vaqueros Reservoir occurs primarily during surplus conditions when there is good water quality in the South Delta.

2005 Level of Development. CVP and SWP deliveries under each project alternative are compared to the Existing Condition. Typically deliveries increased slightly under the 2005 level of development. CVP and SWP deliveries do not change appreciably under any of the alternatives~~ or fishery restrictions~~.

Table 4.2-9 presents the long-term average for CVP and SWP exports from the Delta. The long-term average shows that CVP exports increase slightly or remain the same for ~~all~~ project ~~a~~Alternatives 1, 2, and 4 ~~and both fishery restrictions~~ compared to the Existing Condition. SWP exports vary slightly more but decrease no more than 0.1 percent for ~~all~~ project ~~alternatives~~ Alternatives 1, 2, and 4~~ and both levels of fishery restriction~~.

Table 4.2-10 presents the wet year averages. **Table 4.2-11** presents the above normal year averages. **Table 4.2-12** presents the below normal averages. **Table 4.2-13** presents the dry year averages. **Table 4.2-14** presents the critical year averages. During critical years CVP and SWP exports increase compared to the Existing Condition. Decreases in CVP and SWP deliveries were less than 1 percent from the Existing Condition in all water year types and would not be expected to result in a significant effect on deliveries.

2030 Level of Development. CVP and SWP exports under each project alternative are compared to the Future Without Project. CVP and SWP exports do not change appreciably under any of the alternatives~~ or fishery restrictions~~.

Table 4.2-9 presents the long-term average for CVP and SWP exports. The long-term average shows that decreases in CVP or SWP exports are no more than 0.~~2~~ 1 percent for ~~all project alternatives~~ Alternatives 1, 2, and 4~~ and both fishery restrictions~~.

Table 4.2-10 presents the wet year averages. Table 4.2-11 presents the above normal year averages. Table 4.2-12 presents the below normal averages. Table 4.2-13 presents the dry year averages. Table 4.2-14 presents the critical year averages. Decreases in CVP and SWP deliveries were less than 1 percent from the Future Without Project condition in all water year types and would not be expected to result in a significant effect on deliveries.

CVP and SWP Carry-over Storage

The stored water remaining in reservoirs at the end of the water year in September is referred to as carry-over storage. In general, this quantity is representative of stored water that will be available for use in the following year. Decreases in carry-over storage in CVP and SWP reservoirs could mean that less water is available for delivery to CVP and SWP customers in following years. The total carry-over storage available to the CVP and SWP is a useful measure for evaluating the potential effects of the project alternatives on water supply. Total carry-over storage in Shasta, Trinity, Oroville, Folsom and San Luis reservoirs was used for this analysis.

TABLE 4.2-10 (REVISED)*
WET YEAR ANNUAL AVERAGES OF CHANGES USED TO EVALUATE WATER DELIVERY TO OTHER USERS

		Annual CVP Exports[1,3] [TAF]	Annual SWP Exports[2,3] [TAF]	CVP and SWP Carry-over Storage[4] [TAF]	Sacramento River Flow at Hood [TAF]	San Joaquin River Flow at Vernalis [TAF]	Net Delta Outflow [TAF]
2005 Level of Development							
Existing Condition		2,511	3,329	9,721	24,127	5,350	28,933
Percent Change from Existing Condition	Alt. 1	0.2%	0.3%	0.1%	0.0%	0.0%	-0.1%
	Alt. 2	0.2%	0.3%	0.1%	0.0%	0.0%	-0.2%
	Alt. 4	0.3%	0.4%	0.1%	0.0%	0.0%	-0.1%
2030 Level of Development							
Future Without Project		2,550	3,347	9,613	24,120	5,490	28,973
Percent Change from Future Without Project	Alt. 1	0.0%	0.1%	0.1%	0.0%	0.0%	-0.1%
	Alt. 2	0.0%	0.1%	0.1%	0.0%	0.0%	-0.1%
	Alt. 4	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%

* Modeling results presented in this table have been updated based on analysis for the Final EIS/EIR.
1 CVP exports include agricultural, refuge, municipal and industrial deliveries.
2 Table A, Article 56 and Article 21 components of SWP exports are shown.
3 CVP and SWP exports include water pumped at Jones and Banks pumping plants and water delivered to the South Bay water agencies in lieu of Jones and Banks pumping. Delta supply restoration deliveries to South Bay water agencies in Alternative 1 are not included.
4 CVP and SWP carry-over storage includes storage in Shasta, Trinity, Oroville, Folsom and San Luis reservoirs.

Alt. = alternative
CVP = Central Valley Project
SWP = State Water Project
TAF = thousand acre-feet

TABLE 4.2-11 (REVISED)*
ABOVE NORMAL YEAR ANNUAL AVERAGES OF CHANGES USED TO EVALUATE WATER DELIVERY TO OTHER USERS

		Annual CVP Exports[1,3] [TAF]	Annual SWP Exports[2,3] [TAF]	CVP and SWP Carry-over Storage[4] [TAF]	Sacramento River Flow at Hood [TAF]	San Joaquin River Flow at Vernalis [TAF]	Net Delta Outflow [TAF]
2005 Level of Development							
Existing Condition		2,262	2,864	8,411	18,600	2,892	17,484
Percent Change from Existing Condition	Alt. 1	0.4%	0.3%	0.1%	0.0%	0.0%	-0.1%
	Alt. 2	0.5%	0.4%	0.2%	0.0%	0.0%	-0.1%
	Alt. 4	0.3%	0.4%	0.1%	0.0%	0.0%	-0.1%
2030 Level of Development							
Future Without Project		2,302	2,853	8,267	18,639	3,044	17,628
Percent Change from Future Without Project	Alt. 1	0.2%	0.2%	0.0%	0.0%	0.0%	0.0%
	Alt. 2	0.3%	0.3%	0.0%	0.0%	0.0%	-0.1%
	Alt. 4	0.2%	0.1%	0.0%	0.0%	0.0%	-0.1%

* Modeling results presented in this table have been updated based on analysis for the Final EIS/EIR.
1 CVP exports include agricultural, refuge, municipal and industrial deliveries.
2 Table A, Article 56 and Article 21 components of SWP exports are shown.
3 CVP and SWP exports include water pumped at Jones and Banks pumping plants and water delivered to the South Bay water agencies in lieu of Jones and Banks pumping. Delta supply restoration deliveries to South Bay water agencies in Alternative 1 are not included.
4 CVP and SWP carry-over storage includes storage in Shasta, Trinity, Oroville, Folsom and San Luis reservoirs.

Alt. = alternative
CVP = Central Valley Project
SWP = State Water Project
TAF = thousand acre-feet

TABLE 4.2-12 (REVISED)*
BELOW NORMALYEAR ANNUAL AVERAGES OF CHANGES USED TO EVALUATE WATER DELIVERY TO OTHER USERS

		Annual CVP Exports[1,3] [TAF]	Annual SWP Exports[2,3] [TAF]	CVP and SWP Carry-over Storage[4] [TAF]	Sacramento River Flow at Hood [TAF]	San Joaquin River Flow at Vernalis [TAF]	Net Delta Outflow [TAF]
2005 Level of Development							
Existing Condition		2,211	2,648	7,345	12,942	2,416	10,198
Percent Change from Existing Condition	Alt. 1	0.3%	0.1%	0.3%	0.0%	0.0%	-0.1%
	Alt. 2	0.3%	0.1%	0.3%	0.0%	0.0%	-0.2%
	Alt. 4	0.3%	0.5%	0.3%	0.0%	0.0%	-0.2%
2030 Level of Development							
Future Without Project		2,242	2,653	7,339	12,959	2,547	10,318
Percent Change from Future Without Project	Alt. 1	0.0%	0.3%	0.1%	0.0%	0.0%	-0.2%
	Alt. 2	0.0%	-0.1%	0.1%	0.0%	0.0%	-0.1%
	Alt. 4	0.1%	0.5%	0.0%	0.0%	0.0%	-0.2%

* Modeling results presented in this table have been updated based on analysis for the Final EIS/EIR.
1 CVP exports include agricultural, refuge, municipal and industrial deliveries.
2 Table A, Article 56 and Article 21 components of SWP exports are shown.
3 CVP and SWP exports include water pumped at Jones and Banks pumping plants and water delivered to the South Bay water agencies in lieu of Jones and Banks pumping. Delta supply restoration deliveries to South Bay water agencies in Alternative 1 are not included.
4 CVP and SWP carry-over storage includes storage in Shasta, Trinity, Oroville, Folsom and San Luis reservoirs.

Alt. = alternative
CVP = Central Valley Project
SWP = State Water Project
TAF = thousand acre-feet

TABLE 4.2-13 (REVISED)*
DRY YEAR ANNUAL AVERAGES OF CHANGES USED TO EVALUATE WATER DELIVERY TO OTHER USERS

		Annual CVP Exports[1,3] [TAF]	Annual SWP Exports[2,3] [TAF]	CVP and SWP Carry-over Storage[4] [TAF]	Sacramento River Flow at Hood [TAF]	San Joaquin River Flow at Vernalis [TAF]	Net Delta Outflow [TAF]
2005 Level of Development							
Existing Condition		2,058	2,228	6,082	10,826	1,652	7,490
Percent Change from Existing Condition	Alt. 1	0.4%	0.0%	0.1%	0.0%	0.0%	0.0%
	Alt. 2	0.4%	0.0%	0.1%	0.0%	0.0%	-0.1%
	Alt. 4	0.0%	0.1%	0.1%	-0.1%	0.0%	-0.1%
2030 Level of Development							
Future Without Project		2,013	2,198	6,059	10,798	1,757	7,664
Percent Change from Future Without Project	Alt. 1	0.2%	-0.4%	0.0%	0.0%	0.0%	0.1%
	Alt. 2	0.2%	-0.4%	0.0%	0.0%	0.0%	0.1%
	Alt. 4	0.4%	-0.1%	0.0%	0.1%	0.0%	0.0%

* Modeling results presented in this table have been updated based on analysis for the Final EIS/EIR.
1 CVP exports include agricultural, refuge, municipal and industrial deliveries.
2 Table A, Article 56 and Article 21 components of SWP exports are shown.
3 CVP and SWP exports include water pumped at Jones and Banks pumping plants and water delivered to the South Bay water agencies in lieu of Jones and Banks pumping. Delta supply restoration deliveries to South Bay water agencies in Alternative 1 are not included.
4 CVP and SWP carry-over storage includes storage in Shasta, Trinity, Oroville, Folsom and San Luis reservoirs.

Alt. = alternative
CVP = Central Valley Project
SWP = State Water Project
TAF = thousand acre-feet

TABLE 4.2-14 (REVISED)*
CRITICAL YEAR ANNUAL AVERAGES OF CHANGES USED TO EVALUATE WATER DELIVERY TO OTHER USERS

		Annual CVP Exports[1,3] [TAF]	Annual SWP Exports[2,3] [TAF]	CVP and SWP Carry-over Storage[4] [TAF]	Sacramento River Flow at Hood [TAF]	San Joaquin River Flow at Vernalis [TAF]	Net Delta Outflow [TAF]
2005 Level of Development							
Existing Condition		1,601	1,429	3,887	7,945	1,216	5,108
Percent Change from Existing Condition	Alt. 1	-0.1%	0.1%	0.1%	0.0%	0.0%	0.0%
	Alt. 2	-0.8%	0.1%	0.5%	-0.2%	0.0%	-0.1%
	Alt. 4	-0.3%	0.3%	0.2%	-0.2%	0.0%	-0.1%
2030 Level of Development							
Future Without Project		1,520	1,503	3,956	8,003	1,258	5,235
Percent Change from Future Without Project	Alt. 1	0.1%	0.1%	0.2%	-0.1%	0.0%	-0.1%
	Alt. 2	0.1%	0.1%	0.2%	-0.1%	0.0%	-0.1%
	Alt. 4	0.3%	0.2%	0.3%	-0.1%	0.0%	-0.1%

* Modeling results presented in this table have been updated based on analysis for the Final EIS/EIR.
1 CVP exports include agricultural, refuge, municipal and industrial deliveries.
2 Table A, Article 56 and Article 21 components of SWP exports are shown.
3 CVP and SWP exports include water pumped at Jones and Banks pumping plants and water delivered to the South Bay water agencies in lieu of Jones and Banks pumping. Delta supply restoration deliveries to South Bay water agencies in Alternative 1 are not included.
4 CVP and SWP carry-over storage includes storage in Shasta, Trinity, Oroville, Folsom and San Luis reservoirs.

Alt. = alternative
CVP = Central Valley Project
SWP = State Water Project
TAF = thousand acre-feet

2005 Level of Development. Carry-over storage under each project alternative was compared to the Existing Condition. The analysis shows that CVP and SWP carry-over storage under both levels of development would be essentially the same under the Existing Conditions compared to each of the project alternatives.

Table 4.2-9 presents the long-term average for carry-over storage. The long-term average shows that changes in carry-over storage are no more than 0.~~1~~2 percent for ~~all~~ project ~~alternatives~~ Alternatives 1, 2, and 4 ~~and both fishery restrictions~~. Table 4.2-10 presents the wet year averages. Table 4.2-11 presents the above normal year averages. Table 4.2-12 presents the below normal averages. Table 4.2-13 presents the dry year averages. Table 4.2-14 presents the critical year averages. Decreases in carry-over storage would be no more than ~~1~~0.4 percent from the Existing Condition in all water year types and would not be expected to result in a significant effect on deliveries.

2030 Level of Development. Carry-over storage under each project alternative was compared to the Future Without Project. The analysis shows that CVP and SWP carry-over storage under both levels of development would be essentially the same under the Future Without Project condition compared to each of the project alternatives.

Table 4.2-9 presents the long-term average for carry-over storage. The long-term average shows that decreases in carry-over storage would be no more than 0.3 percent for ~~all project a~~Alternatives 1, 2, and 4 ~~and both fishery restrictions~~. Table 4.2-10 presents the wet year averages. Table 4.2-11 presents the above normal year averages. Table 4.2-12 presents the below normal averages. Table 4.2-13 presents the dry year averages. Table 4.2-14 presents the critical year averages. Decreases in carry-over storage would be no more than ~~1~~0.4 percent from the Future Without Project condition by water year type and would not be expected to result in a significant effect on deliveries.

Sacramento and San Joaquin River Flow

Sacramento River flow at Hood represents the largest source of water that enters the Delta. At this location, flow in the Sacramento River can include water released from Trinity, Shasta, Oroville, and Folsom reservoirs for delivery to CVP or SWP customers in or south of the Delta, or for environmental purposes. In the dry season of each year, and especially during dry years, the flow in the Sacramento River at Hood is largely controlled by releases from these reservoirs. At such times, the releases are often made by CVP and SWP operators to ensure compliance with Delta salinity or flow standards. Changes in Sacramento River flow at this location could indicate changes in Delta conditions, and could affect reservoir carry-over storage, which could then affect water supply for Delta water users, including CVP and SWP customers south of the Delta.

San Joaquin River flow at Vernalis represents another source of water that enters the Delta. At this location, flow in the San Joaquin River can include water released from CVP reservoirs to meet salinity control standards in the south Delta. Changes in San Joaquin River flow at Vernalis could indicate changed conditions in the Delta, which could affect reservoir carry-over storage, and thus affect deliveries to other water users.

2005 Level of Development. Sacramento and San Joaquin inflows under each project alternative were compared to the Existing Condition. The analysis shows that Sacramento and San Joaquin inflow would not change appreciably under any alternative compared to the Existing Conditions. Table 4.2-9 presents the long-term average of change in Sacramento and San Joaquin inflow. The long-term average shows no changes in inflow.

Table 4.2-10 presents the wet year averages. Table 4.2-11 presents the above normal year averages. Table 4.2-12 presents the below normal averages. Table 4.2-13 presents the dry year averages.

Table 4.2-14 presents the critical year averages. During critical years, Sacramento inflow would decrease slightly, by less than 1 percent. San Joaquin inflow would remain the same during critical years. Decreases in Sacramento and San Joaquin inflow would be less than 1 percent from the Existing Condition for all water year types and would not be expected to result in a significant effect on deliveries.

2030 Level of Development. Sacramento and San Joaquin inflow under each project alternative was compared to the Future Without Project. The analysis shows that Sacramento and San Joaquin inflow would not change appreciably under any alternative compared to the Future Without Project. Table 4.2-9 presents the long-term average of change in Sacramento and San Joaquin inflow. The long-term average shows no changes in inflow.

Table 4.2-10 presents the wet year averages. Table 4.2-11 presents the above normal year averages. Table 4.2-12 presents the below normal year averages. Table 4.2-13 presents the dry year averages.

Table 4.2-14 presents the critical year averages. During critical years, Sacramento inflow would decrease slightly, by less than 1 percent. San Joaquin inflow would remain the same during critical years. Decreases in Sacramento and San Joaquin inflow would be less than 1 percent from the Future Without Project condition for all water year types and would not be expected to result in a significant effect on deliveries.

Net Delta Outflow

Net Delta outflow is an indicator of general Delta conditions. It represents the water that flows from the Delta into the San Francisco Bay. Relatively high net Delta outflow generally results in surplus Delta water supply and good Delta water quality. When Delta outflow is low, surplus water is generally not available in the Delta, and salt intrusion into the Delta from San Francisco Bay can occur. The Los Vaqueros Reservoir Expansion Project is designed to fill primarily with surplus Delta water, as part of the design to avoid impacts to other water users. This can reduce net Delta outflow at times when surplus Delta water supply is available, but would not affect water supply for other users.

2005 Level of Development. Net Delta outflow under each project alternative was compared to the Existing Condition. Table 4.2-9 presents the long-term average of change in net Delta outflow.

Table 4.2-10 presents the wet year averages. Table 4.2-11 presents the above normal year averages. Table 4.2-12 presents the below normal year averages. Table 4.2-13 presents the dry year averages.

Table 4.2-14 presents the critical year averages. The analysis shows that net Delta outflow would decrease by less than 1 percent under ~~all a~~Alternatives 1, 2, and 4 ~~1, 2 and 4 relative to the Existing Condition~~ for all water year types. ~~The decrease in net Delta outflow under Alternative 3 during critical years, assuming moderate fishery restrictions, would be 1.6 percent. These decreases would not be expected to significantly impact deliveries. They are discussed further below.~~

2030 Level of Development. Net Delta outflow under each project alternative was compared to the Future Without Project. Table 4.2-9 presents the long-term average of change in net Delta outflow.

Table 4.2-10 presents the wet year averages. Table 4.2-11 presents the above normal year averages. Table 4.2-12 presents the below normal year averages. Table 4.2-13 presents the dry year averages. Table 4.2-14 presents the critical year averages. The analysis shows that net Delta outflow would decrease by less than 1 percent under project Alternatives 1, 2, and 4 for all water year types.

~~Table 4.2-14 presents the critical year averages. The analysis shows that net Delta outflow would decrease by less than 1 percent under Alternatives 1, 2 and 4 relative to the Future Without Project condition for all water year types. Decrease in net Delta outflow under Alternative 3 during critical years assuming severe fishery restrictions would be 1.1 percent.~~

The small decrease in net Delta outflow represents additional diversions made by these project alternatives in times of surplus flow, when water supply for other Delta water users would not be affected. Because the project alternatives were not shown to adversely impact the direct measures of water supply for other users, including CVP and SWP exports, and because the Los Vaqueros Reservoir Expansion Project alternatives are designed to primarily use surplus Delta water, these small changes in net Delta outflow would not affect water supply for other users.

Alternatives 1 ~~through~~, 2 and 4

Alternatives 1 ~~through~~, 2 and 4 would result in no significant changes that would adversely affect deliveries to other water users. They would result in small changes in total Delta diversions, largely in periods with surplus flows, resulting in a more reliable water supply for the South Bay agencies, and no discernible changes in SWP and CVP water supply deliveries to other customers of those projects. They ~~It~~ would not affect water supplies of other water users. Average Delta outflow changes would be less than significant in both magnitude and timing, decreasing by less than one half of 1 percent from the Existing and Future Without Project conditions. Changes to upstream flows and reservoir carryover storage would be less than significant and the water supplies of other water users would not be significantly impacted.

The analysis performed for the Draft EIS/EIR found no significant changes that would adversely affect the deliveries to other water users. When compared to the analysis performed for the Draft EIS/EIR, the conclusion presented above for the updated modeling analysis regarding potential impacts of Alternatives 1, 2 and 4 on deliveries to of other water users has not changed.

Mitigation: None required.

Impact 4.2.2: The project alternatives would not result in significant adverse changes in Delta water quality causing the violation of a water quality standard. (Less Than Significant Impact)

Delta water quality standards are established by the SWRCB in the 1995 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary, which is discussed above in Section 4.2.1. These Delta water quality standards govern salinity at Rock Slough, Emmaton, Jersey Point, Brandt Bridge, Old River near Middle River, and Old River near Tracy Bridge, as shown in **Table 4.2-15**.

TABLE 4.2-15
SUMMARY OF SELECTED WATER QUALITY STANDARDS IN THE DELTA

Compliance Location	Description	Value
Rock Slough	Maximum mean daily Cl	250 mg/L
Sacramento River at Emmaton	14-day running average of mean EC during the spring and summer months depending on water year type	0.45-2.78 mmhos/cm depending on water year type and time of year
San Joaquin River at Jersey Point	14-day running average of mean EC during the spring and summer months depending on water year type	0.45 -2.20 mmhos/cm depending on water year type and time of year
San Joaquin River at Brandt Bridge	Maximum 30-day running average of mean daily EC	Apr – Aug: 0.7 mmhos/cm Sep – Mar: 1.0 mmhos/cm
Old River near Middle River	Maximum 30-day running average of mean daily EC	Apr – Aug: 0.7 mmhos/cm Sep – Mar: 1.0 mmhos/cm
Old River at Tracy Bridge	Maximum 30-day running average of mean daily EC	Apr – Aug: 0.7 mmhos/cm Sep – Mar: 1.0 mmhos/cm

Cl = chloride
cm = centimeter
EC = electrical conductivity
mg/L = milligram(s) per liter
mmhos/cm = millimhos per centimeter

Salinity at the standards compliance locations was simulated using the DSM2 model throughout the Delta for the Existing and Future Without Project conditions and each of the project alternatives, as described in the preceding subsection titled Hydrology, Water Operations,

Hydrodynamics, and Water Quality Models. Appendix C5 presents complete model results of Delta water quality changes for each alternative.

Potential standards violations were found in all model runs, including the Existing Condition and Future Without Project runs. The apparent violations in the model results are referred to as "potential violations" because they occur in the model but would not occur in actual operations. The Delta is operated to meet water quality standards and would continue being operated to meet standards if the Los Vaqueros Reservoir Expansion Project is built.

The apparent standards violations under the Existing and Future Without Project conditions are caused solely by modeling inadequacies which are discussed in more detail below and in the modeling section above. Apparent violations in the project alternatives modeling could also be caused by model inadequacies, like in the Existing and Future Without Project conditions, or could reflect the impacts of project alternative operations.

For some standards (Rock Slough, Emmaton, and Jersey Point), potential standards violations in the alternatives model results are caused solely by a mismatch between the CalSim II operations model and the DSM2 Delta hydrodynamics and mixing model, and are not caused by project operations. CalSim II defines flows into and out of the Delta such that these standards are met. A CalSim II – DSM2 mismatch occurs when the flows calculated by CalSim II are fed into the DSM2 hydrodynamics and mixing model and the salinity calculated by DSM2 does not meet the standards, as explained above in the Monthly Time Step description and in the DSM2 description. Modeled standards violations caused by DSM2- CalSim II mismatches occur because CalSim's monthly time step is not well suited to handling daily or 14-day standards, or running average standards that span more than 1 month. Furthermore, CalSim II uses empirical approximations for estimating Delta salinities that may not match the physically-based salinity calculations done in DSM2.

For other standards (San Joaquin River at Brandt Bridge, Old River near Middle River, and Old River at Tracy Road Bridge), potential standards violations in the model results for project alternatives could also be caused by CalSim II – DSM2 mismatches. However, CalSim II does not operate the SWP and CVP to meet these standards so it is also possible that potential violations at these sites in the model results reflect the impacts of project alternative operations.

A statistical analysis (chi-squared test) was performed to compare the occurrence of potential violations in the Existing and Future Without Project conditions and in each of the project alternatives. This analysis shows that the potential violations do not occur more often in any of the project alternatives than they do in the Existing and Future Without Project conditions. This finding supports the conclusion that the apparent violations of the Rock Slough, Emmaton, and Jersey Point standards in the model results are modeling artifacts, and suggests that apparent violations of the San Joaquin River at Brandt Bridge, Old River near Middle River, and Old River at Tracy Road Bridge are also modeling artifacts. Violations that are modeling artifacts would be expected to occur about as often in the Existing and Future Without Project conditions model runs as they do in the project alternatives runs, while potential violations caused by project operations would result in statistically significant increases in the number of violations under the alternatives as compared with the Existing and Future Without Project conditions.

The numbers of potential water quality standards violations in the Existing and Future Without Project conditions model runs were compared to the numbers of potential violations in the project alternatives model runs. The statistical analysis provides a means to determine (within certain limits of precision or confidence) whether the number of violations modeled under the alternatives was significantly different from the number modeled under the Existing and Future Without Project conditions. ("Significant" in this sense is a quantitative designation with a specific mathematical meaning based on the type of test used and the precision or confidence limits used.)

If no statistically significant difference occurred in the numbers of potential violations at a compliance location, then the potential violations found in the alternatives runs were attributed to modeling artifacts and it was determined that the project alternative would not be expected to cause standards violations. If a statistically significant difference occurred, then project alternative operations could potentially cause standards violations. See Appendix C6 (Vol. 4) for complete details of the statistical analysis.

The analysis showed that none of the alternatives had a statistically significant increase in the frequency of potential standards violations at any of the stations compared to the Existing and Future Without Project conditions. This means that the changes in the frequency of potential standards violations are likely to be the result of modeling artifacts, and that changes to operations under the alternatives do not produce statistically significant differences from the Existing and Future Without Project conditions, with respect to Delta water quality standards. The alternatives would have less than significant impacts on compliance with water quality standards in the Delta.

Table 4.2-16 presents the number of days of standards violations in the Existing and Future Without Project conditions, and the changes in the number of days that standards could be violated under the project alternatives. The following paragraphs discuss the data and results for 2005 and 2030 levels of development.

TABLE 4.2-16
FREQUENCY OF POTENTIAL STANDARDS VIOLATIONS

		Rock Slough [days]	Sacramento River at Emmaton [days]	San Joaquin River at Jersey Pt [days]	San Joaquin at Brandt Bridge [days]	Old River near Middle River [days]	Old River at Tracy [days]
2005 Level of Development							
Existing Condition		294	203	369	175	171	258
Change from Existing Condition	Alt. 1	-24	-2	1	0	0	-3
	Alt. 2	-25	-5	0	0	0	-3
	Alt. 4	-29	-2	-3	0	0	2
2030 Level of Development							
Future Without Project		272	149	358	94	93	150
Change from Existing Condition	Alt. 1	-18	0	4	0	0	0
	Alt. 2	-18	0	4	0	0	0
	Alt. 4	-42	0	-3	0	0	1

2005 Level of Development. Comparison of potential standards violations shows that the numbers of potential violations under all project alternatives would be about equal to the number of potential violations under the Existing Condition. Statistical analysis confirms that no statistically significant changes exist in the numbers of potential violations, which supports the conclusion that the alternatives would have less than significant impacts on compliance with water quality standards in the Delta.

2030 Level of Development. Comparison of potential standards violations shows that the numbers of potential violations under ~~all~~ project ~~alternatives~~ Alternatives 1, 2, and 4 would be about equal to the number of potential violations under the Future Without Project condition. Statistical analysis confirms that there are no ~~the only~~ statistically significant changes in the numbers of potential standards ~~violations are improvements in compliance with the Rock Slough standard in Alternatives 1, 2, and 3 under the moderate fishery restrictions and in Alternative 3 under severe fishery restrictions~~. These results support the conclusion that the alternatives would have less than significant impacts on compliance with water quality standards in the Delta.

Alternative 1

Compared to the Existing and Future Without Project conditions, the operation of Alternative 1 would not result in significant adverse changes in Delta water quality standards compliance. ~~The only significant difference between Alternative 1 and the Existing of Future Without Project conditions in standards compliance were found at Rock Slough, where there would be a reduced likelihood of water quality standard violations under the 2030 level of development. (See Table 4.2-16.)~~ No statistically significant differences in the number of potential standards violations were found at any other water quality stations under any of the modeling scenarios. Alternative 1 would have less than significant impacts on compliance with water quality standards in the Delta.

Alternative 2

The operation of Alternative 2 as compared with both Existing and Future Without Project conditions would have results nearly identical to Alternative 1. ~~There would be improvements in standards compliance at Rock Slough under the moderate fishery restrictions and 2030 level of development. (See Table 4.2-16)~~ No statistically significant differences were found at any other stations. Alternative 2 would have less than significant impacts on compliance with water quality standards in the Delta.

~~*Alternative 3*~~

~~Under Alternative 3, water quality improvements were also found at Rock Slough under both moderate and severe fishery restrictions. (See Table 4.2-16.) No significant differences in numbers of potential standards violations were found at any other stations. Alternative 3 would have less than significant impacts on compliance with water quality standards in the Delta.~~

Alternative 4

No significant differences appeared in the numbers of standards violations found at any standard compliance stations. Alternative 4 would have less than significant impacts on compliance with water quality standards in the Delta. (See Table 4.2-16.)

The analysis performed for the Draft EIS/EIR found no significant changes that would adversely affect Delta water quality standard compliance. When compared to the analysis performed for the Draft EIS/EIR, the conclusion presented above for the updated modeling analysis regarding potential impacts of Alternatives 1, 2 and 4 on Delta water quality standard compliance has not changed.

Mitigation: None required.

Impact 4.2.3: The project alternatives would not result in changes to Delta water quality that would result in significant adverse effects on beneficial uses. (Less Than Significant Impact)

Changes in timing and location of diversions have the potential to affect water quality conditions in the Delta so as to adversely affect beneficial uses. To assess these effects, estimated Delta salinity concentrations were compared between each project alternative and the Existing or Future Without Project conditions under the 2005 and 2030 levels of development. Potential beneficial use impacts were assessed at current and proposed drinking water intakes by examining both long-term average changes in salinity and sizable short-term changes in salinity. The intakes include Jones Pumping Plant, Clifton Court Forebay, Barker Slough at the North Bay Aqueduct intake, Cache Slough at the City of Vallejo Intake, and the proposed City of Stockton Delta Intake. A complete analysis of water quality changes is provided in Appendix C5 (Vol. 4).

Long-term Changes in Salinity

Table 4.2-17 presents modeled long-term salinity for Existing and Future Without Project conditions and the modeled changes in salinity for each alternative. At some intakes under some alternatives the model shows no change in long-term average salinity, and at some intakes under some alternatives the model shows small changes in long-term average salinity. Some of these changes are increases and some are decreases, but all increases are less than ~~in only a single case does the magnitude of the change exceed~~ 0.5 percent~~. The exception at Barker Slough for Alternative 3 is discussed in more detail below.~~ The magnitude of changes as well as the fact that in some cases salinity improved slightly and in others it degraded by similar amounts would further indicate that the changes are on the whole not significant.

2005 Level of Development

Clifton Court Forebay. On average, small increases in salinity, less than 0.3 percent, were found at Clifton Court Forebay for project Alternatives 1, 2, and 4.~~Alternatives 1, 2, and 3 under both moderate and severe fishery restrictions. A small decrease in salinity occurred at Clifton Court Forebay for Alternative 4 under moderate fishery restrictions and no change occurred under severe fishery restrictions.~~

Jones Pumping Plant. Changes at Jones Pumping Plant were nearly identical to those at Clifton Court Forebay.

City of Stockton Delta Intake. At the City of Stockton Delta Intake small increases in salinity were found for ~~all of the alternatives~~ Alternatives 1, 2, and 4 ~~under both moderate and severe fishery restrictions~~.

Barker Slough North Bay Aqueduct. ~~All a~~Alternatives 1, 2, and 4 ~~except Alternative 3~~ showed ~~small decreases~~negligible changes in salinity at Barker Slough ~~under moderate fishery restrictions~~. ~~For Alternative 3 under moderate fishery restrictions a 1 percent increase in salinity occurred at~~

TABLE 4.2-17 (REVISED)*
SUMMARY OF LONG-TERM SALINITY CHANGES AT DELTA INTAKES

		Entrance to Clifton Court Forebay [μS/cm]	Jones Pumping Plant [μS/cm]	City of Stockton Delta Intake [μS/cm]	Barker Slough at North Bay Aqueduct Intake [μS/cm]	Cache Slough at City of Vallejo Intake [μS/cm]
2005 Level of Development						
Existing Condition		506	526	373	265	287
Percent Change from Existing Condition	Alt. 1	0.3%	0.3%	0.0%	0.0%	0.0%
	Alt. 2	0.3%	0.2%	0.0%	0.0%	0.0%
	Alt. 4	-0.2%	-0.1%	-0.2%	0.0%	-0.1%
2030 Level of Development						
Future Without Project		481	498	361	259	287
Percent Change from Existing Condition	Alt. 1	0.3%	0.2%	0.1%	0.0%	0.0%
	Alt. 2	0.3%	0.2%	0.1%	0.0%	0.0%
	Alt. 4	-0.1%	-0.1%	0.0%	0.1%	0.0%

* Modeling results presented in this table have been updated based on analysis for the Final EIS/EIR.

Alt. = alternative
μS/cm = microSiemens per centimeter

~~Barker Slough; the only instance of any change greater than 0.5 percent. Further investigation found that the 1 percent increase was influenced by an isolated event involving changes not related to the alternative under evaluation, and it was concluded that this estimated difference in Barker Slough water quality does not reflect an impact that would be caused by the Alternative 3 operations.~~

Cache Slough, City of Vallejo. ~~All of the a~~Alternatives 1, 2, and 4 showed ~~no change~~small decreases in the salinity at Cache Slough Vallejo Intake ~~under both moderate and severe fishery restrictions~~.

2030 Level of Development

Clifton Court Forebay. Alternatives 1 and 2 showed a small increase in salinity while Alternative 4 showed a small decrease. ~~All alternatives showed small decreases in salinity at Clifton Court Forebay under moderate fishery restrictions. Under severe restrictions, Alternatives 1, 2, and 3 showed small increases in salinity at Clifton Court Forebay and Alternative 4 showed a small decrease.~~

Jones Pumping Plant. The changes in salinity at Jones Pumping Plant were nearly identical to those at Clifton Court Forebay.

City of Stockton Delta Intake. At the City of Stockton Delta Intake, small decreases in salinity occurred in Alternatives 1, 2, and 4. ~~under moderate fishery restrictions for all alternatives. Under severe fishery restrictions, Alternative 1 showed no change, Alternative 2 showed a small decrease, Alternative 3 showed a small increase, and Alternative 4 showed a small decrease at the City of Stockton's intake.~~

Barker Slough North Bay Aqueduct. Alternatives 1, 2, and 4 showed negligible changes in salinity at Barker Slough. ~~Small increases in salinity occurred at Barker Slough for Alternatives 1, 2, and~~

~~3 under moderate fishery restrictions; Alternative 4 showed no change. Alternative 3 showed a small increase in salinity at Barker Slough under severe fishery restrictions and the other alternatives showed no change.~~

Cache Slough City of Vallejo. <u>Alternatives 1, 2, and 4 showed negligible changes in salinity at Cache Slough Vallejo Intake.</u> ~~Alternative 1 showed a small increase in salinity at Cache Slough under moderate fishery restrictions and the other alternatives showed no changes.~~

Short-term Changes in Salinity

Although the long-term average changes in salinity would be very small and would not significantly affect beneficial uses, changes in operations under the alternatives could impact beneficial uses if there were consistent but sizable changes in short-term salinity. Sizable short-term changes in salinity were analyzed at Jones Pumping Plant, Clifton Court Forebay, Barker Slough, Cache Slough, City of Stockton Delta Intake, and Antioch.

A sizable increase in salinity was defined as a monthly average salinity difference between a project alternative and the Existing or Future Without Project conditions that is greater than 5 percent and greater than 5 mg/ L Cl. A sizable decrease in salinity was defined as a monthly average salinity difference between a project alternative and the Existing or Future Without Project conditions that is less than -5 percent and less than -5 mg/L Cl.

Sizable salinity changes at the City of Antioch intake were defined separately because an operational threshold is established at that location, and effects on the beneficial use of water could be caused by changing the amount of time that Antioch's source water salinity is below that threshold. When Cl concentration is greater than 250 mg/L, the City of Antioch uses water from other sources. If the monthly average Cl concentration was modeled for the Existing or Future Without Project conditions as less than 250 mg/L, and operations under a project alternative increased the concentration to 250 mg/L Cl or more, the month was flagged as showing a sizable increase in salinity. Conversely, if the monthly average Cl concentration was modeled as greater than 250 mg/L under the Existing or Future Without Project conditions, and was lowered below 250 mg/L Cl under a project alternative, a sizable salinity decrease was indicated for that month.

Sizable changes in salinity modeled under a project alternative could be due to two factors:

- CalSim II threshold sensitivity, as explained in the preceding Threshold Sensitivity in CalSim II section. Sizable changes in salinity caused by CalSim II threshold sensitivity are modeling artifacts rather than genuine project impacts. CalSim II threshold sensitivity would be expected to result in about the same numbers of sizable salinity decreases and sizable salinity increases in the project alternatives modeling runs as in the Existing or Future Without Project conditions modeling runs.

- Effects of project alternative operations. Water quality standards violations that are caused by project alternative operations and are not modeling artifacts would lead to a statistically significant difference between the number of sizable increases in salinity and the number of sizable decreases in salinity in the project alternatives modeling runs, as compared to the Existing or Future Without Project conditions model runs.

A statistical analysis (one-tailed binomial test),was performed to determine whether sizable changes in salinity found in the project alternatives model runs were the result of project alternative operations. The analysis was based on comparing the numbers of sizable salinity increases to sizable decreases. If no statistically significant difference occurred in the numbers of increases compared to decreases, then the changes found in the project alternatives runs were attributed to threshold sensitivity. If a statistically significant difference occurred, then project alternative operations could cause impacts. See Appendix C6 (Vol. 4) for complete details of the statistical analysis.

~~In this analysis, none of the project alternatives had more statistically significant sizable salinity increases than decreases except for Barker Slough under Alternative 3 conditions. This difference is discussed in more detail below.~~ **Table 4.2-18** presents the numbers of sizable changes in salinity at the drinking water intakes. The data and results are discussed below for 2005 and 2030 levels of development.

2005 Level of Development. Under the 2005 level of development, the numbers of short-term sizable changes in salinity at existing and proposed drinking water intakes are generally low, and the numbers of sizable decreases in salinity are comparable to the numbers of sizable increases, as shown in Table 4.2-18. Statistical analysis confirms that no statistically significant difference exists between salinity decreases and increases under ~~any~~ project ~~alternative~~Alternatives 1, 2, and 4~~, with the single exception of Barker Slough in Alternative 3 under moderate fishery restrictions~~.

~~Further investigation found that the number of sizable salinity increases at Barker Slough under the aforementioned conditions was influenced by an event lasting several consecutive months where changes not related to Alternative 3 operations caused the changes in salinity. It was concluded that this estimated difference in Barker Slough water quality does not reflect an impact that would be caused by the Alternative 3 operations. The statistical analysis supports the conclusion that project alternative operations would not cause changes in short-term water quality that would adversely affect beneficial uses.~~ Project alternative operations would not cause changes in short-term water quality that would adversely affect beneficial uses.

2030 Level of Development. Under the 2030 level of development, the numbers of sizable short-term changes in salinity at existing and proposed drinking water intakes are generally low and the numbers of sizable decreases in salinity are comparable to the numbers of sizable increases, as shown in Table 4.2-18**.** Statistical analysis confirms that no statistically significant difference exists between salinity decreases and increases under any project alternative. Project alternative operations would not cause changes in short-term water quality that would adversely affect beneficial uses.

Alternative 1

Compared to the Existing and Future Without Project conditions, the operation of Alternative 1 would not result in significant long-term or short-term changes in Delta water quality that would adversely affect beneficial uses.

TABLE 4.2-18 (REVISED)*
FREQUENCY OF SIZABLE CHANGES IN SALINITY AT DRINKING WATER INTAKES

	Jones Pumping [months]		Clifton Court Forebay [months]		Barker Slough [months]		Cache Slough [months]		City of Stockton Delta Intake [months]		Antioch [months]	
	Sizable Salinity Increase	Sizable Salinity Decrease	Sizable Salinity Increase	Sizable Salinity Decrease	Sizable Salinity Increase	Sizable Salinity Decrease	Sizable Salinity Increase	Sizable Salinity Decrease	Sizable Salinity Increase	Sizable Salinity Decrease	Sizable Salinity Increase	Sizable Salinity Decrease
2005 Level of Development												
Existing Condition												
Alt. 1	0	0	0	0	0	0	0	0	0	0	2	4
Alt. 2	0	0	0	0	0	0	0	0	0	0	4	2
Alt. 4	1	2	3	5	0	0	0	1	2	3	2	7
2030 Level of Development												
Future Condition												
Alt. 1	0	0	0	1	0	0	0	0	0	0	1	0
Alt. 2	0	0	0	0	0	0	0	0	0	0	3	0
Alt. 4	0	1	0	2	0	0	0	0	0	1	2	0

* Modeling results presented in this table have been updated based on analysis for the Final EIS/EIR.

Alternative 2

Compared to the Existing and Future Without Project conditions, the operation of Alternative 2 would not result in significant long-term or short-term changes in Delta water quality that would adversely affect beneficial uses.

~~*Alternative 3*~~

~~Compared to the Existing and Future Without Project conditions, the operation of Alternative 3 would not result in significant long-term or short-term changes in Delta water quality that would adversely affect beneficial uses. The apparent change in Barker Slough water quality between the Existing Condition and the Alternative 3 scenario under the 2005 level of development with moderate fishery restrictions was not found to be caused by project operations. It was concluded that this estimated difference in Barker Slough water quality does not reflect an impact that would be caused by the Alternative 3 operations.~~

Alternative 4

Compared to the Existing and Future Without Project conditions, the operation of Alternative 4 would not result in significant long-term or short-term changes in Delta water quality that would adversely affect beneficial uses.

The analysis performed for the Draft EIS/EIR found no significant changes in Delta water quality that would adversely affect beneficial uses. When compared to the analysis performed for the Draft EIS/EIR, the conclusion presented above for the updated modeling analysis regarding potential impacts of Alternatives 1, 2 and 4 on changes in Delta water quality that would affect beneficial uses has not changed.

Mitigation: None required.

Impact 4.2.4: Diversions of Delta water under the project alternatives would not result in a significant reduction of Delta water levels. (Less Than Significant Impact)

Delta water users have a substantial interest in maintaining Delta water levels so that their siphons and pumps, installed at fixed elevations, can continue to divert water onto Delta islands for agricultural irrigation. To evaluate water level effects of the project alternatives, modeling results were examined for sites in the vicinity of the Los Vaqueros system intakes, and at the four monitoring locations identified in the CVP/SWP Joint Point of Diversions Water Level Response Plan.

Table 4.2-19 presents a summary of model results showing the changes in water level at lower-low tide during irrigation season. Delta agricultural irrigation users are primarily concerned with effects on the water level at lower-low tide because it represents the minimum water level they would experience. Irrigation season is assumed to be April through September. Complete model estimates of Delta water level changes are presented in Appendix C5 (Vol. 4).

TABLE 4.2-19 (REVISED)*
LARGEST WATER LEVEL DECREASE AT LOWER-LOW TIDE IN IRRIGATION SEASON (in feet)

		Doughty Cut above Grant Line Canal Barrier	Old River near Tracy Road Bridge	Middle River near Howard Road Bridge	East of Coney Island	Old River Intake	AIP Intake
2005 Level of Development							
Change from Existing Condition	Alt. 1	-0.03	-0.02	-0.02	-0.06	-0.06	-0.06
	Alt. 2	-0.03	-0.03	-0.03	-0.06	-0.06	-0.06
	Alt. 4	-0.04	-0.04	-0.02	-0.08	-0.04	-0.05
2030 Level of Development							
Change from Future Without Project	Alt. 1	-0.02	-0.02	-0.02	-0.05	-0.05	-0.05
	Alt. 2	-0.02	-0.02	-0.02	-0.06	-0.06	-0.06
	Alt. 4	-0.02	-0.02	-0.02	-0.01	-0.01	-0.02

* Modeling results presented in this table have been updated based on analysis for the Final EIS/EIR.

NOTES: Irrigation season is assumed to be April through September

AIP = Alternative Intake Project
Alt. = alternative

Table 4.2-20 presents the frequency at which water level decreases exceed 0.1 foot during the typical irrigation season. Water level changes of less than 0.1 foot would be difficult to measure, and are within the level of accuracy of the model tools used for this analysis.

2005 Level of Development. ~~Table 4.2-20 presents the frequency at which water-level decreases exceed 0.1 foot during the typical irrigation season. Water level changes of less than 0.1 foot would be difficult to measure, and are within the level of accuracy of the model tools used for this analysis.~~ As shown in **Table 4.2-19**, the maximum estimated decrease in water level at lower-low tide is less than 0.06 ~~0.1~~ foot (less than 1 inch~~es~~) ~~in nearly~~for ~~all of the project a~~Alternatives 1, 2, and 4 at the 2005 level of development.~~The only exceptions are Alternative 1 at the east of Coney Island location under moderate fishery restrictions, which has a maximum decrease of 0.11 foot (less than 1.5 inches), and Alternative 3 under moderate fishery restrictions, which had maximum water level decreases of greater than a tenth of a foot at all locations evaluated, the largest being 0.23 foot (less than 3 inches) at Old River near Tracy Road Bridge.~~

Table 4.2-20 presents the frequency at which water-level decreases exceed 0.1 foot during the typical irrigation season. Water level changes of less than 0.1 foot would be difficult to measure, and are within the level of accuracy of the model tools used for this analysis. Changes larger than 0.1 ft did not occur under any of the proposed alternatives.

~~Table 4.2-20 shows how often the maximum decrease in water level exceeds 0.1 foot. This condition occurs only once (which is less than 0.1 percent of the time) over the 16-year study period in Alternative 1 at the east of Coney Island location, and this condition did not occur at all at the other locations evaluated for this alternative. The water level decreased by more than 0.1 foot less than 1 percent of the time over the 16-year study period at the locations evaluated in Alternative 3 under~~

TABLE 4.2-20 (REVISED)*
PERCENT OF TIME WHEN MAXIMUM DECREASE IN WATER LEVEL EXCEEDS 0.1 FOOT

		Doughty Cut above Grant Line Canal Barrier	Old River near Tracy Road Bridge	Middle River near Howard Road Bridge	East of Coney Island	Old River Intake	AIP
2005 Level of Development							
Percent Change from Existing Condition	Alt. 1	0%	0%	0%	0%	0%	0%
	Alt. 2	0%	0%	0%	0%	0%	0%
	Alt. 4	0%	0%	0%	0%	0%	0%
2030 Level of Development							
Percent Change from Future Without Project	Alt. 1	0%	0%	0%	0%	0%	0%
	Alt. 2	0%	0%	0%	0%	0%	0%
	Alt. 4	0%	0%	0%	0%	0%	0%

* Modeling results presented in this table have been updated based on analysis for the Final EIS/EIR.

NOTES: Irrigation season is assumed to be April through September

% = percent
AIP = Alternative Intake Project
Alt. = alternative

~~moderate fishery restrictions. Water levels never decreased by more than 0.1 foot at the locations evaluated in Alternatives 2 and 4.~~

2030 Level of Development. ~~Table 4.2-20 shows the frequency at which water level decreases exceed 0.1 foot during the typical irrigation season. Water level changes below 0.1 foot would be difficult to measure, and are within the level of accuracy of the model tools used for this analysis.~~ As shown in Table 4.2-19, the maximum estimated decrease in water level at lower-low tide is less than 0.06 foot (less than 1inch~~es~~) at each of the locations evaluated in ~~all four project alternatives~~Alternatives1, 2, and 4. Table 4.2-20 shows how often the maximum decrease in water level would exceed 0.1 foot. As shown, this condition would not occur at the locations evaluated in the project alternatives.

Table 4.2-20 shows the frequency at which water level decreases exceed 0.1 foot during the typical irrigation season. None of the proposed alternatives would result in water level decreases exceeding 0.1 ft during the irrigation season compared to the future without project conditions.

The results of this comparison show that all of the project alternatives would have a less than significant impact on Delta water levels.

Alternative 1

Alternative 1 would result in small water level changes ~~so small that they would be difficult to measure~~. The largest change estimated at lower-low tide would be -0.06 ~~0.11~~ foot, which is less than 1.5 inches, and would occur infrequently ~~(once during an irrigation season in a 16-year study period)~~. A change in water level surface elevation of this magnitude and frequency would not affect the ability of local water users to divert water for their beneficial uses. Therefore, this impact would be less than significant.

Alternative 2

Alternative 2 would result in small water level changes. The largest change estimated at lower-low tide would be -0.06 foot. A change in water level surface elevation of this magnitude and frequency would not affect the ability of local water users to divert water for their beneficial uses. Therefore, this impact would be less than significant. ~~would result in water level changes so small that they would be difficult to measure. The largest change estimated at lower-low tide during irrigation season would be 0.08 foot, or about 1 inch, and the estimated decrease in water level would not exceed 0.1 foot during irrigation season. A change in water level surface elevation of this magnitude would not affect the ability of local water users to divert water for their beneficial uses. Therefore, this impact would be less than significant.~~

~~*Alternative 3*~~

~~Alternative 3 would most often result in water level changes so small that they would be difficult to measure. The largest estimated change at lower-low tide during irrigation season would be 0.23 foot, which is less than 3 inches, and water level decreases greater than 0.1 foot would occur less than 1 percent of the time during the irrigation season. A change in water level surface elevation of this magnitude and frequency would not affect the ability of local water users to divert water for their beneficial uses. Therefore, this impact would be less than significant.~~

Alternative 4

Alternative 4 would result in small water level changes so small that they would be difficult to measure. The largest change estimated at lower-low tide during irrigation season would be -0.04 ~~0.05~~ foot~~, and the estimated decrease in water level would not exceed 0.1 foot during the irrigation season~~. A change in water level surface elevation of this magnitude would not affect the ability of local water users to divert water for their beneficial uses. Therefore, this impact would be less than significant.

The analysis performed for the Draft EIS/EIR found no significant changes that would adversely affect Delta water levels. When compared to the analysis performed for the Draft EIS/EIR, the conclusion presented above for the updated modeling analysis regarding potential impacts of Alternatives 1, 2 and 4 on Delta water levels has not changed.

Mitigation: None required.

Impact 4.2.5: The project alternatives would not result in a cumulatively considerable contribution to significant adverse cumulative effects on deliveries of water to other users, changes in Delta water quality, or change in Delta water levels. (Less Than Significant Impact)

All Alternatives

A cumulative impact arises when two or more individual effects which, when considered together, are considerable, or which compound or increase other environmental impacts. Cumulative impacts can result from individually minor but collectively significant impacts, meaning that the project's incremental effects must be viewed in connection with the effects of past, current, and probable future projects.

Cumulative impacts were determined considering the reasonably foreseeable projects described in Section 4.1.2 (Vol. 1). The foreseeable future projects or operational conditions that could combine with the impacts of the project alternatives are included in the Common Assumptions for the 2030 level of development conditions in the statewide operations model (CalSim II) and Delta water quality model (DSM2). The assumptions and projects included in the model analyses of 2030 level of development include the following:

- Future level of development, including population growth and land-use changes
- ~~South Delta Improvements Program Phase 1 (permanent operable barriers in the south Delta)~~
- CCWD Rock Slough Canal Replacement
- CCWD-Reclamation Rock Slough Fish Screen Project
- Delta-Mendota Canal-California Aqueduct Intertie
- Freeport Regional Water Project, including delivery of 3.2 TAF per year of CCWD CVP water supply from the Freeport intake through the CCWD- East Bay Municipal Utility District intertie to CCWD
- ~~A limited Environmental Water Account program~~
- Revised operations for SWP and CVP instituting modified export pumping rules to address Delta fishery protection to represent future assumed operations associated with OCAP reconsultation on biological opinions for delta smelt and chinook salmon
- Stockton Drinking Water Supply Project
- Increased discharges from Sacramento Regional County Sanitation District's wastewater treatment plant.

The analysis of the 2030 level of development described under each impact discussion in this section therefore is an analysis of the project's contribution to cumulative impacts, and shows that in the context of combined reasonably foreseeable future development, the project alternatives would not result in a cumulatively considerable contribution to significant cumulative impact on Delta hydrology or water quality. The results of the analyses show that the Delta inflows, outflows, water levels, and water quality, as well as both CVP and SWP deliveries, remain largely unchanged in the Future Without Project condition compared to the Existing Condition, and in the existing or future conditions with the project alternatives.

Additional future projects or operational influences that are not included in the statewide operations model (CalSim II) and Delta water quality model (DSM2) include:

- ~~Stockton Drinking Water Supply Project (DWSP)~~
- Delta Wetlands Project (DWP)
- Bay Delta Conservation Plan (BDCP)

Operational permits have not been issued for the Stockton DWSP. Because specific information on the operation of the project was unavailable, it was not included quantitatively in the modeling used in this cumulative impacts analysis. However, the Stockton DWSP is anticipated to have negligible effects on Delta water supply, water quality, and water levels. Accordingly, the effects of operating the Stockton DWSP are not likely to influence or change the conclusions of this cumulative analysis.

The Delta Wetlands Project released modeling for project alternatives in 2001, but both the affected environment and their project proposals have changed since that release; no current modeling appropriate for this cumulative analysis has been provided by the DWP. In qualitatively assessing the potential for cumulative impacts associated with this project, it is assumed that the terms of a settlement agreement between DWP, CUWA and CCWD will preclude impacts to Delta water quality. Water discharges from the DWP will be managed to avoid causing impacts associated with increases in organic carbon in Delta water quality, and water diversions by the DWP will be managed to avoid causing salinity intrusion impacts in the Delta. Therefore, no cumulative impact to Delta hydrology or water quality based on future operation of Los Vaqueros Reservoir Expansion Project and DWP is anticipated.

As described in Chapter 2, the BDCP is in the early stages of planning, and quantitative information available from that planning process is insufficient for inclusion in this cumulative impacts analysis.

The impacts analyses performed for the project alternatives using assumptions for future level of development indicate no cumulative impact.

The project alternatives are in part a response to changes in Delta water supply that have already occurred and to additional Delta water supply challenges expected in the future. The project alternatives are designed to improve environmental water management and water supply reliability without substantially adversely affecting water supply and quality for others. The potential changes caused by project alternative operations are based on conservative assumptions about Delta and CCWD operations. The determination that the project alternative’s contribution to cumulative impacts would not be significant takes into account the combined impact of existing and future projects, as described above.

A number of future projects and situations might result in Delta water quality degradation and decreased supply, including climate change, population growth, increased water use, wastewater discharges, specific legal rulings, as well as other projects in the Delta. Regardless of whether future cumulative increases in salinity and decreases in water supply are considered to be a significant adverse impact on Delta water users, the changes caused by the project alternatives would remain small and they would not be cumulatively considerable in the context of combined past, present, and probable future projects. These future projects will not change the overall impact of the project alternatives or the conclusion that the alternative's contribution to a significant cumulative effect would not be considerable.

The analysis performed for the Draft EIS/EIR found no cumulative impacts when considering the effects of the Los Vaqueros Reservoir Expansion Project along with the effects of other reasonably foreseeable projects. When compared to the analysis performed for the Draft EIS/EIR, the conclusion presented above for the updated modeling analysis regarding potential cumulative impacts of Alternatives 1, 2 and 4 with other reasonably foreseeable projects has not changed.

Mitigation: None required.

4.3 Delta Fisheries and Aquatic Resources (Updated)

This section describes the existing fishery and aquatic habitat conditions within the Bay-Delta estuary that would potentially be affected by the Los Vaqueros Reservoir Expansion Project, presents the applicable regulatory background, provides an assessment of potential fisheries and aquatic resources effects, and, where appropriate, identifies suitable mitigation to reduce potentially significant impacts to a less-than-significant level.

4.3.1 Affected Environment

Regulatory Setting

Federal

Federal Endangered Species Act

Under the Federal Endangered Species Act (FESA), the Secretary of the Interior and the Secretary of Commerce have joint authority to list a species as threatened or endangered (United States Code [USC], Title 16, Section 1533[c]). FESA prohibits the "take" of endangered or threatened fish and wildlife species, the take of endangered or threatened plants in areas under federal jurisdiction or in violation of state law, or adverse modifications to their critical habitat. Under FESA, the definition of "take" is to "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." The U.S. Fish and Wildlife Service (USFWS) and National Oceanic and Atmospheric Administration/National Marine Fisheries Service (NMFS) also interpret the definition of "harm" to include significant habitat modification that could result in the take of a species.

If an activity would result in the take of a federally listed species, one of the following is required: an incidental take permit under Section 10(a) of FESA, or an incidental take statement issued pursuant to federal interagency consultation under Section 7 of FESA. Such authorization typically requires various measures to avoid and minimize species take, and to protect the species and avoid jeopardy to the species' continued existence.

Pursuant to the requirements of Section 7 of FESA, a federal agency reviewing a proposed project which it may authorize, fund, or carry out must determine whether any federally listed threatened or endangered species, or species proposed for federal listing, may be present in the project area and determine whether implementation of the proposed project is likely to affect the species. In addition, the federal agency is required to determine whether a proposed project is likely to jeopardize the continued existence of a listed species or any species proposed to be listed under FESA or result in the destruction or adverse modification of critical habitat proposed or designated for such species (16 USC 1536[3], [4]).

NMFS administers FESA for marine fish species, including anadromous salmonids such as Central Valley steelhead, winter-run and spring-run chinook salmon, and green sturgeon. USFWS administers FESA for non-anadromous and non-marine fish species such as delta smelt (and longfin smelt, which has been recently proposed for listing). Projects for which a federally listed species is present and likely to be affected by an existing or proposed project must receive authorization from USFWS and/or NMFS. Authorization may involve a letter of concurrence that the project will not result in the potential take of a listed species, or may result in the issuance of a Biological Opinion (BO) that describes measures that must be undertaken to minimize the likelihood of an incidental take of a listed species. A project that is determined by NMFS or USFWS to jeopardize the continued existence of a listed species cannot be approved under a BO.

Where a federal agency is not authorizing, funding, or carrying out a project, take that is incidental to the lawful operation of a project may be permitted pursuant to Section 10(a) of FESA through approval of a habitat conservation plan (HCP).

FESA requires the federal government to designate "critical habitat" for any species it lists under the Endangered Species Act. "Critical habitat" is defined as: (1) specific areas within the geographical area occupied by the species at the time of listing, if they contain physical or biological features essential to the species conservation, and those features that may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species if the agency determines that the area itself is essential for conservation.

Implementation of the State Water Project (SWP) and Central Valley Project (CVP) coordinated Operations Criteria and Plan (OCAP), under which the U.S. Department of the Interior, Bureau of Reclamation, Mid-Pacific Region (Reclamation) and California Department of Water Resources (DWR) jointly manage dam releases to the Delta and exports from the Delta, is a key factor affecting hydrology and aquatic habitat conditions within the Bay-Delta estuary. This is described in Chapter 2 (Vol. 1) and Appendix C3 (Vol. 4).

Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat

The Pacific Fishery Management Council (PFMC) has designated the Delta, San Francisco Bay, and Suisun Bay as Essential Fish Habitat (EFH) to protect and enhance habitat for coastal marine fish and macroinvertebrate species that support commercial fisheries such as Pacific salmon. The amended Magnuson-Stevens Fishery Conservation and Management Act, also known as the Sustainable Fisheries Act (Public Law 104-297), requires that all federal agencies consult with NMFS on activities or proposed activities authorized, funded, or undertaken by that agency that may adversely affect EFH of commercially managed marine and anadromous fish species.

As part of the OCAP Biological Assessment, Reclamation and DWR have addressed anticipated effects of SWP and CVP operations on EFH within the Bay-Delta estuary for use in the reconsultation for compliance with the Act. The EFH provisions of the Sustainable Fisheries Act are designed to protect fishery habitat from being lost due to disturbance and degradation. The Act requires that EFH must be identified for all species federally managed by the PFMC, which is responsible for managing commercial fishery resources along the coasts of Washington, Oregon, and California. Three fishery management plans cover species that occur in the project area, and designate EFH within the entire Bay-Delta estuary:

- Pacific Groundfish Fishery Management Plan: starry flounder

- Coastal Pelagic Fishery Management Plan: northern anchovy and Pacific sardine
- Pacific Salmon Fishery Management Plan: chinook salmon

Clean Water Act

The U.S. Army Corps of Engineers (USACE) administers a number of laws and programs designed to protect fish and wildlife resources. Principal of these, with respect to the project alternatives, is Section 404 of the Clean Water Act. Section 404 regulates activities in wetlands and "other waters of the United States." Wetlands are a subset of waters of the U.S., which are defined in the Code of Federal Regulations (33 CFR 328.3[a]; 40 CFR 230.3[s]) as:

1. All waters that are currently used, were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters that are subject to the ebb and flow of the tide
2. All interstate waters including interstate wetlands. Wetlands are defined by the federal government [33 CFR 328.3(b), 1991] as those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions
3. All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mud flats, sand flats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation, or destruction of which could affect interstate or foreign commerce including any such waters
    - Which are or could be used by interstate or foreign travelers for recreational or other purposes; or
    - From which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or
    - Which are used or could be used for industrial purposes by industries in interstate commerce.
4. All impoundments of waters otherwise defined as waters of the United States under the definition
5. Tributaries of waters identified in paragraphs (1) through (4)
6. The territorial sea
7. Wetlands adjacent to waters identified in paragraphs (1) through (6)

State

California Endangered Species Act

Pursuant to the California Endangered Species Act (CESA) and Section 2081 of the California Fish and Game Code, a permit from the California Department of Fish and Game (CDFG) is required for activities that could result in the take of a state-listed threatened or endangered species (i.e., species listed under CESA). The definition of "take" is to hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill (Fish and Game Code Section 86).

The state definition does not include "harm" or "harass," as the federal definition does. As a result, the threshold for take under CESA is typically higher than that under FESA. Section 2080 of the Fish and Game Code prohibits the taking of plants and animals listed under the authority of CESA, except as otherwise permitted under Fish and Game Code Sections 2080.1, 2081, and 2835. Under CESA, the California Fish and Game Commission maintains a list of threatened species and endangered species (Fish and Game Code Section 2070). The California Fish and Game Commission also maintains two additional lists:

- Candidate species (CDFG has issued a formal notice that the species is under review for addition to either the list of endangered species or the list of threatened species such as longfin smelt)
- Species of special concern, which serves as a watch list

Consistent with the requirements of CESA, a lead agency reviewing a proposed project within its jurisdiction must determine whether any state-listed endangered or threatened species may be present in a proposed project area and determine whether the proposed project may take a listed species. If a take would occur, an incidental take permit would be required from the CDFG, including a mitigation plan that provides measures to minimize and fully mitigate the impacts of the take. The measures must be roughly proportional in extent to the impact of the taking and must be capable of successful implementation. Issuance of an incidental take permit may not jeopardize the continued existence of a state-listed species. For species that are also listed as threatened or endangered under the FESA, CDFG may rely on a federal incidental take statement or incidental take permit to authorize an incidental take under CESA.

Streambed Alteration Agreements

The state's authority to regulate activities in waters of the U.S. resides primarily with CDFG. CDFG provides comment on USACE permit actions under the Fish and Wildlife Coordination Act. CDFG is also authorized under California Fish and Game Code Sections 1600–1616 to develop mitigation measures and enter into streambed alteration agreements with applicants whose projects would obstruct the flow or alter the bed, channel, or bank of a river or stream, including intermittent and ephemeral streams, in which a fish or wildlife resource is present.

Regional Water Quality Control Board

The Federal Clean Water Act, in Section 401, specifies that states must certify that any activity subject to a permit issued by a federal agency, such as USACE, meets all state water quality standards. In California, the State Water Resources Control Board (SWRCB) and the Regional Water Quality Control Boards (RWQCBs) are responsible for certifying activities subject to any permit issued by USACE pursuant to Section 404 or pursuant to Section 10 of the Rivers and Harbors Act of 1899. Such certification actions, also known as a 401 certification or water quality certification, include issuing a 401 certification that the activity subject to the federal permit complies with state water quality standards, issuing a 401 certification with conditions, denying 401 certification, or denying 401 certification without prejudice, should procedural matters preclude taking timely action on a 401 certification application. Should 401 certification be denied, the federal permit is deemed denied also.

Regional boards or their executive officers may issue 401 certifications. The State Board issues 401 certifications for projects that will take place in two or more regions. The regulations governing California's issuance of 401 certifications were updated in 2000, and are contained in Sections 3830 through 3869 of Title 23 of the California Code of Regulations.

Natural Community Conservation Planning Act

The Natural Community Conservation Planning Act (NCCPA) authorizes the Natural Community Conservation Plan (NCCP) program, which is designed to promote conservation of natural communities at the ecosystem scale while accommodating compatible land use.

The following subsection on the CALFED Bay-Delta Program (CALFED) provides additional discussion regarding the NCCP prepared for that program. The East Contra Costa County HCP Association completed a Habitat Conservation Plan/Natural Community Conservation Plan (HCP/NCCP) in 2007. The HCP/NCCP took effect in January 2008. The HCP/NCCP covers terrestrial areas that may be affected by the project alternatives but does not include the aquatic resources inhabiting the Bay-Delta estuary. The East County HCP/NCCP is discussed in greater detail in Section 4.6 (Vol. 2).

CALFED

The CALFED Program, described in Chapter 2, includes an objective to conserve important biological resources that occur in the Bay-Delta estuary and elsewhere within the Central Valley rivers and tributaries. The CALFED Program includes proposals to protect, restore, and enhance many habitats, particularly in the Delta, that have experienced a loss of ecological function due to human-caused activities.

To comply with FESA, CESA, and NCCPA, CALFED prepared a program level Multi-Species Conservation Strategy (MSCS). USFWS and NMFS issued programmatic BOs for the CALFED Program based on the MSCS. CDFG approved the MSCS as in compliance with the NCCPA for certain species including most of the fish species addressed in this document.

The programmatic BOs and NCCPA compliance finding do not provide take authorization. Instead, entities implementing CALFED actions may seek take authorization through an Action Specific Implementation Plan that would be tiered from the MSCS and submitted to USFWS, NMFS, and CDFG as the basis for project-specific BO and NCCPA determination. The Action Specific Implementation Plans would be based on the MSCS, including specifically the conservation measures identified in the MSCS. An action-specific implementation plan (ASIP) will be prepared for the Los Vaqueros Reservoir Expansion Project should one of the project alternatives be approved for implementation.

Existing Los Vaqueros Reservoir

Contra Costa Water District's (CCWD's) operations of the existing Los Vaqueros Reservoir are governed in part by the following three biological documents:

(a) 1993 NMFS BO for winter-run chinook salmon

(b) 1993 USFWS BO for delta smelt

~~(c) 1994 Memorandum of Understanding between CDFG and CCWD regarding the existing Los Vaqueros Reservoir~~

(c) 2009 CDFG Incidental Take Permit for maintenance and operation of the Los Vaqueros Reservoir and Alternative Intake Project

These are described in Chapter 2 and Section 4.2 (Vol. 1).

Environmental Setting

The following discussion primarily addresses the fisheries and aquatic resources of the Delta, where construction- and operations-related impacts on special-status fish species and their habitat could result from the project alternatives. In the case of anadromous (migratory) species, freshwater fishery and habitat conditions upstream of the Delta are included to provide context to the discussion.

In addition to the Delta, aquatic habitat is present within the project area in the form of seasonal freshwater drainages, such as Kellogg Creek, Brushy Creek, and several unnamed drainages. Due to the seasonal nature of these streams, as well as the absence of special-status fish species or critical habitat designations for fish, no project-related impacts on fishery resources would occur in these drainages; thus, these drainages are not further discussed in this section. In addition, Los Vaqueros Reservoir does not support any special-status fish species or designated critical habitat. The reservoir does, however, support a recreational fishery. Potential impacts to the recreational fishery of Los Vaqueros Reservoir are discussed in Section 4.15, Recreation (Vol. 1).

Regional Setting

Both the existing and new water intake structures would be in the south Delta vicinity of Old and Middle rivers, which provides shallow open-water and emergent marsh habitat for a variety of resident and migratory fish and macroinvertebrates. The primarily open-water habitat within the Delta is relatively shallow (typically less than 20 feet deep) and has a relatively uniform channel bottom composed of silt, sand, peat, and decomposing organic matter. Tules (*Scirpus* spp.) and other emergent and submerged aquatic vegetation occur both within the open-water areas and along the shoreline margins of sloughs and channels, providing habitat for fish migration, spawning, juvenile rearing, and adult holding and foraging.

Waters within the south Delta are characterized by low salinity levels under most environmental conditions; however, saltwater intrusion upstream into the central and south Delta does occur under low outflow conditions. Although much of the Delta provides shallow open-water aquatic habitat, the channels within the south Delta vary in size and hydraulic complexity. Levees surrounding the sloughs and channels within the south Delta have been stabilized by riprap and other materials placed along the channel margins. These levees are typically vegetated by native and non-native grasses and shrubs. Mature riparian trees are not abundant along south Delta levees.

The water quality and hydrodynamic conditions that affect fishery habitat within the south Delta are influenced by a variety of factors, including the magnitude of seasonal freshwater inflow to the Bay-Delta estuary from the Sacramento and San Joaquin rivers and east-side tributaries, tidal circulation patterns within the south Delta, salinity, and seasonal variation in water temperature. Turbidity and suspended sediment concentrations within the south Delta are influenced by wind- and wave-induced turbulence and river flows. Specifically, large open-water surface areas such as Mildred Island and Franks Tract promote wind-generated waves, which can in turn resuspend sediments within these shallow open waters.

Sampling for fish populations has been conducted throughout the Delta, including at sampling locations within the project area. These locations are shown in **Figure 4.3-1**. Results of fishery sampling within the Bay-Delta estuary have shown that 55 fish species inhabit the estuary (Baxter et al., 1999), of which about half are non-native introduced species. Many of these non-native species, such as striped bass (*Morone saxatilis*) and American shad (*Alosa sapidissima*), were purposefully introduced to provide recreational and commercial fishing opportunities. Other non-native fish species, such as threadfin shad (*Dorosoma petenense*) and inland silversides (*Menidia beryllina*), were accidentally introduced into the estuary through the movement of water among connecting waterways; a number of other fish species, including yellowfin (*Acanthogobius flavimanus*) and chameleon gobies (*Tridentiger trigonocephalus*), were introduced through ballast water discharges from commercial cargo transports traveling primarily from Asia and the Orient.

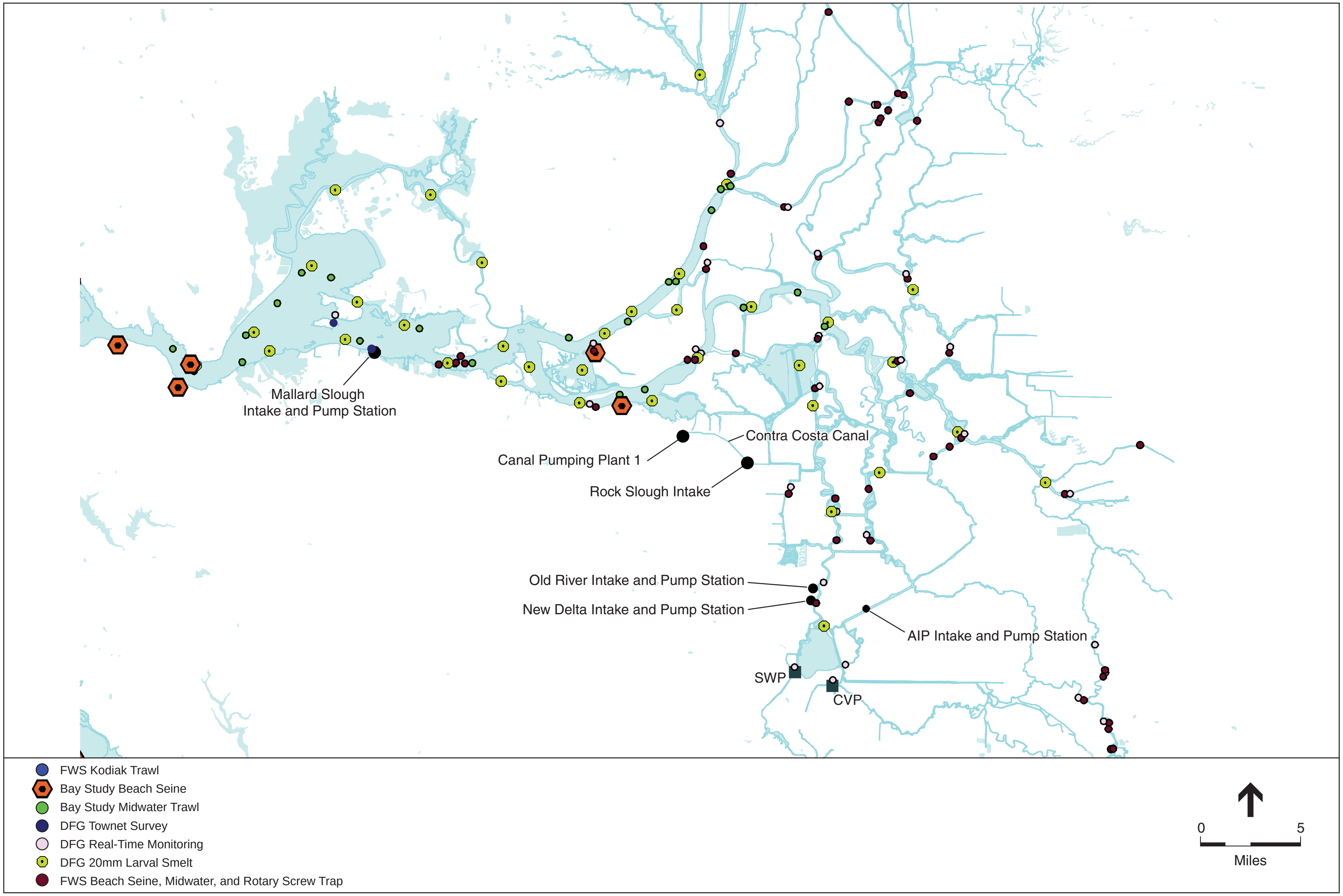
In addition, an estimated 100 macroinvertebrate species have been introduced into the estuary, primarily through ballast water discharges (Carlton, 1979). Many non-native aquatic plants have also become established within the estuary. The purposeful and unintentional introductions of non-native fish, macroinvertebrates, and aquatic plants have contributed to a substantial change in the species composition, trophic dynamics, and competitive interactions affecting the population dynamics of native Delta species. Many of these introduced fish and macroinvertebrates inhabit the central and south Delta.

Pelagic Organism Decline

Pelagic organisms are organisms that inhabit the open water portion of a water body such as the ocean or the Bay-Delta estuary. The Interagency Ecological Program (IEP), a consortium of nine state and federal agencies, has been monitoring fish populations in the San Francisco Estuary for decades.

One of the most widely-used IEP databases is fish catch from the Fall Midwater Trawl (FMWT) Survey, which has been regularly conducted by CDFG since 1967. This survey samples the pelagic fish assemblage in the upper estuary from the Delta to San Pablo Bay. Two of the resident pelagic fishes captured are native species, delta smelt (*Hypomesus transpacificus*) and longfin smelt (*Spirinchus thaleichthys*). Two of the most abundant introduced species are striped bass and threadfin shad.

Annual abundance of these populations is extremely variable and much of this variability is associated with hydrology (Sommer et al., 2007). Historically, the lowest abundance levels for the



SOURCE: Hanson Environmental, 2006; DWR, 2006; DFG, 2006; and ESA, 2008

Los Vaqueros Reservoir Expansion Project EIS/EIR . 201110

Figure 4.3-1
Major Delta Fish Sampling Survey Locations within the Delta

pelagic fishes typically have occurred in dry years, such as a 6-year drought from 1987 to 1992. Between 1995 and 2000, a wet period, abundance indices of most pelagic species increased markedly. Results of analyses have shown that many of the estuarine fish and macroinvertebrates have higher juvenile abundance in wet years when Delta outflows are relatively high, however in recent years the response of these species to hydrologic conditions has been lower than in the past, which has been hypothesized to reflect the effects of introduced non-native species (e.g., the Asian overbite clam Corbula) on the aquatic ecosystem inhabiting the estuary. By 2000, FMWT abundance indices for these four pelagic fishes (delta and longfin smelt, striped bass, threadfin shad) began to decline and continued to do so over the next several years. Abundance indices for the period between 2002 and 2008 included record lows for delta smelt and young-of-the-year striped bass, and near record lows for longfin smelt and threadfin shad (Sommer et al., 2007). By 2004, these declines became widely recognized and discussed as a serious issue, and collectively became known as the Pelagic Organism Decline (POD).

Project Area

Under Alternatives 1 and 2, the new Delta Intake and Pump Station would be constructed on Old River south of CCWD's existing Old River Intake. For the purposes of the impacts analysis concerning in-water construction activities for the new Delta Intake, the project area is considered to be within Old River, extending about 1,000 feet upstream and downstream of the construction site, as this is the estimated distance over which construction-related effects such as increased turbidity and underwater noise may extend. Alternatives 3 and 4 do not include any in-water construction activities at Delta intakes.

Potential operational effects of the Los Vaqueros Reservoir Expansion Project, such as entrainment of larval fish and other aquatic resources, may also occur within this project area. For the purposes of analyzing potential operational effects, the project area also includes any other portions of the Delta where hydraulic or hydrodynamic conditions affecting aquatic habitat may be changed such that there could be project-related indirect effects on fish or other aquatic organisms.

The new Delta Intake would be on Old River within an area of the estuary influenced by freshwater inflow from the Sacramento and San Joaquin River systems, CVP and SWP export operations, and tidal effects from coastal marine waters and the San Francisco Bay. As described in Chapter 2, CCWD currently operates a water intake with positive barrier fish screen on Old River that has been designed and is operated in compliance with the CDFG, NMFS and USFWS criteria (e.g., screen mesh size, approach velocity of 0.2 feet per second (fps), screen cleaning) that has been shown through extensive fishery monitoring to be effective in reducing and avoiding entrainment and impingement of Delta fish species. CCWD is currently constructing a similar intake structure on Victoria Canal (Alternative Intake Project – AIP), which is in the south Delta, that has also been designed to meet the screen design criteria for delta smelt and other fish species.

The new Delta Intake structure on Old River would also be designed and operated in accordance with CDFG, NMFS and USFWS criteria to protect delta smelt, juvenile salmon, and other fish species within the Delta. Old River, in the vicinity of the intake sites, is characterized by shallow water depths ranging from about 15 to 20 feet deep (measured at low slack tide) within 20 feet of the shoreline. Substrate on the channel bottom is characterized by silt and fine- and coarse-grained sand. The channel banks consist of a combination of natural earthen berm and armored riprap. Vegetation is characterized by intermittent stands of tules and submerged aquatic vegetation along the shoreline margins, grass and weedy vegetation along the channel banks, and sparse riparian (shrubs and trees) vegetation along the channel margins.

Table 4.3-1 identifies resident and migratory fish species that are known to occur in the Delta and may potentially be affected by the construction and operation of the project alternatives.

Special-Status Fish Species

Fish species identified for protection under the CESA and/or FESA that are known to occur in the Delta and may potentially be affected by the construction and operation of the project alternatives include green sturgeon, delta smelt, longfin smelt, winter-run chinook salmon, spring-run chinook salmon, and Central Valley steelhead. USFWS and NMFS have designated all or part of the Delta as critical habitat for delta smelt, Central Valley steelhead, and winter-run and spring-run chinook salmon. Therefore, this section provides additional information specifically focusing on these sensitive and protected species and their habitat. Other special-status species, including Sacramento splittail, river lamprey, and hardhead are also discussed. **Table 4.3-2** lists the special-status fish species that may potentially be affected by the construction or operation of the project alternatives.

The following is a brief discussion of the listing status, life history, and factors affecting population abundance for the special-status fish species that seasonally inhabit the Delta and may be affected by construction or operation of the project alternatives.

Chinook Salmon

Chinook salmon are an anadromous species, spawning in freshwater and spending a portion of their life cycle within the Pacific Ocean. The species is divided into the following four runs according to spawning migration timing and reproductive behavioral differences: winter run, spring run, fall run, and late fall run. Chinook salmon generally require cool, clean, and well-oxygenated water in streams and rivers that contain adequately sized spawning gravels, instream cover, and riparian shading. Migration barriers in the form of dams, grade control structures, culverts, or water diversion structures significantly limit chinook salmon access to historical habitat throughout their range. Chinook salmon do not spawn within the Delta in the vicinity of the project area. However, this species seasonally uses the south Delta, including Old River, during adult upstream migration, smolt emigration, and juvenile rearing (Moyle, 2002). The Delta historically served as an important rearing habitat for juvenile chinook salmon. The Delta was characterized by extensive shallow-water habitats with dendritic channels and emergent wetland vegetation such as tules.

Levee construction and reclamation of wetland areas within the Delta for agriculture and other purposes has significantly modified much of the Delta, reducing the areal extent of wetlands and increasing the channelization of tributary rivers and Delta islands. Changes in hydrologic conditions resulting from the construction of upstream water storage impoundments and operations for flood

TABLE 4.3-1
FISH SPECIES INHABITING THE DELTA POTENTIALLY AFFECTED BY CONSTRUCTION OR OPERATION OF THE PROJECT ALTERNATIVES

Common Name	Scientific Name
Pacific lamprey *	*Lampetra tridentate*
River lamprey *	*Lampetra ayersi*
White sturgeon *	*Acipenser transmontanus*
Green sturgeon *	*Acipenser medirostris*
American shad	*Alosa sapidissima*
Threadfin shad	*Dorosoma petenense*
Central Valley steelhead *	*Oncorhynchus mykiss*
chinook salmon (winter, spring, fall, and late-fall runs) *	*Oncorhynchus tshawytscha*
Longfin smelt *	*Spirinchus thaleichthys*
Delta smelt *	*Hypomesus transpacificus*
Wakasagi	*Hypomesus nipponensis*
Northern anchovy*	*Engraulis mordax*
Starry flounder*	*Platichthys stellatus*
Hitch *	*Lavinia exilicauda*
Sacramento blackfish *	*Orthodon microlepidotus*
Sacramento splittail *	*Pogonichthys macrolepidotus*
Sacramento pikeminnow *	*Ptychocheilus grandis*
Fathead minnow	*Pimephales promelas*
Golden shiner	*Notemigonus crysoleucas*
Common carp	*Cyprinus carpio*
Goldfish	*Carassius auratus*
Sacramento sucker *	*Catostomus occidentalis*
Black bullhead	*Ameiurus melas*
Brown bullhead	*Ameiurus nebulosus*
Yellow bullhead	*Ameiurus natalis*
White catfish	*Ameiurus catus*
Channel catfish	*Ictalurus punctatus*
Western mosquitofish	*Gambusia affinis*
Rainwater killfish	*Lucania parva*
Striped bass	*Morone saxatilis*
Inland silverside	*Menidia beryllina*
Bluegill	*Lepomis macrochirus*
Redear sunfish	*Lepomis microlophus*
Green sunfish	*Lepomis cyanellus*
Warmouth	*Lepomis gulosus*
White crappie	*Pomoxis annularis*
Black crappie	*Pomoxis nigromaculatus*
Largemouth bass	*Micorpterus salmoides*
Smallmouth bass	*Micropterus dolomieu*
Tule perch *	*Hysterocarpus traski*
Threespine stickleback *	*Gasterosteus aculeatus*
Yellowfin goby	*Acanthogobius flavimanus*
Shimofuri goby	*Tridentiger bifasciatus*
Shokihaze goby	*Tridentiger barbulatus*
Staghorn sculpin	*Leptocottus armatus*
Prickly sculpin *	*Cottus asper*

* Indicates native species.

SOURCE: CCWD and Reclamation, 2006.

TABLE 4.3-2
SPECIAL-STATUS FISH SPECIES INHABITING THE DELTA POTENTIALLY AFFECTED BY CONSTRUCTION OR OPERATION OF THE PROJECT ALTERNATIVES

	Listing Status[a]		
Species	**Federal**	**State**	**Designated Habitat**
Sacramento River winter-run chinook salmon	FE	CE	Critical Habitat
Central Valley spring-run chinook salmon	FT	CT	Critical Habitat
Central Valley fall/late fall-run chinook salmon	FSC	CSC	Essential Fish Habitat
Central Valley steelhead	FT	–	Critical Habitat
Delta smelt[b]	FT	~~CT~~CE	Critical Habitat
North American green sturgeon	FT	CSC	–
Longfin smelt[c]	Candidate Species	~~Candidate Species~~CT	–
Sacramento splittail	–	CSC	–
River lamprey	–	CSC	–
Hardhead	–	CSC	–
Pacific smelt	Candidate Species	CSC	–
Northern anchovy	–	–	Essential Fish Habitat
Pacific sardine	–	–	Essential Fish Habitat
Starry flounder	–	–	Essential Fish Habitat

a FE = Federal Endangered
FT = Federal Threatened
FSC = Federal Species of Concern
CE = California Endangered
CT = California Threatened
CSC = California Species of Special Concern
b Delta smelt are currently being evaluated as a candidate under ~~CESA~~ FESA for uplisting to endangered status
c Longfin smelt are currently being evaluated as a candidate species for listing under ~~CESA and~~ FESA

control, in combination with increased levels of water diversions both upstream and within the Delta, contributed to reduced habitat quality and availability for juvenile salmon rearing within the Delta. In addition, the introduction of a number of non-native fish (e.g., striped bass, largemouth bass) increased predation mortality for juvenile salmon rearing and migrating through the Delta.

Life Histories of Winter-, Spring-, Fall-, and Late Fall-Run Chinook Salmon

The general seasonal timing of migration and spawning by each of the runs is detailed in **Table 4.3-3**.

Winter-run Chinook Salmon

Winter-run chinook salmon spend 1 to 3 years in the ocean before migrating upstream into the Sacramento River to spawn upstream of Red Bluff. Adult winter-run chinook salmon migrate upstream through San Francisco Bay, Suisun Bay, and the Delta during winter and early spring, with peak migration occurring during March (Moyle, 2002). Spawning occurs from mid-April through August (Moyle, 2002). Egg incubation continues through the fall. Juvenile winter-run chinook salmon rear within the Sacramento River throughout the year, and smolts migrate downstream through the lower reaches of the Sacramento River, Delta, Suisun Bay, and San Francisco Bay during winter and early spring (November through May) (USFWS, 2001).

TABLE 4.3-3
SEASONAL TIMING OF CHINOOK SALMON MIGRATION THROUGH THE SACRAMENTO-SAN JOAQUIN DELTA

	Sacramento River				San Joaquin River
Life stage	**Fall Run**	**Late Fall Run**	**Winter Run**	**Spring Run**	**Fall Run**
Adult upstream migration	July - December	November-May	Late November - June	March-July	September - December
Juvenile Rearing and Emigration	January – July (fry/smolts) October - December (yearlings)	December-April	November - May	October - June (young-of-the-year) mid-October - March (yearlings)	January - June

SOURCES: CCWD and Reclamation 2006.

Cold-water releases from the upstream Shasta and Keswick reservoirs are important in maintaining the quality and availability of suitable habitat in the mainstem Sacramento River for adult holding before spawning, spawning and egg incubation, and juvenile rearing. Adult holding, spawning, and egg incubation occurs primarily in the reach of the river from Keswick Dam downstream to the Red Bluff Diversion Dam (RBDD). Instream flow releases to the mainstem river are important year-round for the various lifestages of winter run salmon. The availability and release of cold water in the mainstem river is particularly important during the late spring, summer, and early fall (winter run salmon spawn and eggs incubate between about July and October – water temperatures less than about 56°F are important for successful egg development and hatching). The Sacramento River mainstem is the primary upstream and downstream migration corridor for winter-run chinook salmon. Winter-run chinook salmon are not present in the San Joaquin River drainage.

Historical Sacramento River winter-run chinook salmon population estimates, which included males and females, were as high as near 100,000 fish in the 1960s, but declined to under 200 fish in the 1990s (Good et al,. 2005). Because of the substantial decline in abundance, the species was listed as endangered under both the FESA and CESA.

Since the 1994 low point, the number of adult winter-run salmon returning to the Sacramento River has gradually increased. Population estimates in 2003 (8,218), 2004 (7,701), and 2005 (15,730) show a recent increase in population size (CDFG GrandTab, February 2007). The 2006 run was the highest since the 1994 listing. Overall, abundance measures over the past decade suggest that the abundance is increasing (Good et al., 2005). However, escapement estimates for 2007 showed a substantial decline in escapement numbers (about 2,500 adults) based on redd counts and carcass surveys.

As with other chinook salmon stocks, NMFS is continuing to evaluate the status of the winter-run chinook salmon population and the effectiveness of various management actions implemented within the Sacramento River, Delta, and ocean to ensure improved protection and reduce mortality for winter-run salmon. The increasing trend in winter-run chinook salmon abundance over the past decade was encouraging and supported preliminary discussions regarding the potential to modify the listing status from endangered to threatened, reflecting the trend toward recovery of the species.

The decline in adult winter-run salmon abundance, and the abundance of other Central Valley salmon observed in 2007, which is thought to reflect poor ocean-rearing conditions, has been identified as a significant concern, particularly given the critically dry hydrologic conditions occurring in 2008 and early 2009. NMFS is currently preparing a recovery plan for Central Valley salmonids, based in part on results of the status review that will provide additional guidance on evaluating the status of winter-run salmon and the criteria for assessing recovery of the species.

Although the majority of adult winter-run chinook salmon migrate upstream in the mainstem Sacramento River, a possibility exists (although low) that adults may migrate into the south Delta and the vicinity of both the existing and new intake structures. The occurrence of adult winter-run chinook salmon within the central and south Delta would be limited to the winter and early spring period of adult upstream migration. The majority of adult winter run salmon are thought to migrate upstream through the Delta during the period from about December to March or early April.

During their downstream migration, juveniles may enter into the central Delta via the Delta Cross Channel, Georgiana Slough, or Three Mile Slough. The migration timing of juvenile winter-run chinook salmon varies within and among years in response to a variety of factors, including increases in river flow and turbidity resulting from winter storms. Thus, potential presence of juvenile winter-run chinook salmon in the vicinity of the Old River, Rock Slough and AIP intake structures, the new Delta Intake structure, and the SWP and CVP south Delta export facilities varies by season and among years within the period from November through May.

Spring-run Central Valley Chinook Salmon

Adult spring-run salmon migrate upstream through the Delta and the Sacramento River from March through October. The adults typically migrate into upstream tributaries, such as Mill, Deer, Butte, and Clear creeks, although some adults also hold and subsequently spawn in the mainstem Sacramento River in the reach from Keswick Dam to about RBDD and in the Feather River downstream of Oroville Dam. Over the summer months, adults hold in deep cold pools within the rivers and tributaries before spawning, which occurs from September to October. Cold-water releases from the upstream Shasta and Keswick reservoirs and Oroville Dam are important in maintaining the quality and availability of suitable habitat in the mainstem Sacramento and Feather rivers for adult holding before spawning, spawning and egg incubation, and juvenile rearing.

Instream flow releases from dams to the mainstem rivers are important year-round for the various lifestages of spring run salmon. The availability and release of cold water in the mainstem rivers is particularly important during the late spring, summer, and early fall (spring run adult salmon hold in the rivers during the summer months and spawn and eggs incubate from about late August through November – water temperatures less than about 56°F are important for successful egg development and hatching).

Fry emerge from spawning areas during the late fall and winter. A portion of the fry migrate downstream soon after emerging and rear in downstream river channels, and potentially in the Delta estuary, during winter and spring months. The remainder of the fry reside in creeks and upstream tributaries/rivers and rear for about 1 year. The juvenile spring-run chinook salmon that remain in the upstream habitats migrate downstream as 1–year-old smolts, primarily during the late fall, winter, and early spring, with peak migration occurring in November (Hill and Weber, 1999).

The downstream migration of both spring-run chinook salmon fry and smolts during the late fall and winter typically coincides with increased flow and water turbidity during winter storm water runoff. Construction of major dams and reservoirs on the Sacramento and San Joaquin River systems eliminated access to the upper reaches for spawning and juvenile rearing and completely eliminated the spring-run salmon population from the San Joaquin River system. Spring-run spawning and juvenile rearing currently occur on a consistent basis only within a small fraction of their previous geographic distribution.

Although the majority of adult spring-run chinook salmon migrate upstream within the mainstem Sacramento River, a possibility exists (although low) that adults may migrate into the central and south Delta. The occurrence of adult spring-run chinook salmon within the Delta in the vicinity of both the existing and new intake structures would be limited to the late winter and spring period (primarily March-May) of adult upstream migration. Juvenile spring-run chinook salmon may migrate from the Sacramento River, including its tributaries, into the Delta during their downstream migration and also use the Delta as a foraging area and migration pathway during the winter and early spring migration period. The occurrence of juvenile spring-run chinook salmon in the vicinity of the Old River, Rock Slough and AIP intake structures, the new Delta Intake structure, and the SWP and CVP south Delta export facilities would be expected during late fall through spring (October-June), when water temperatures within the Delta would be suitable for juvenile spring-run chinook salmon migration.

Fall-run and Late Fall-run Chinook Salmon

Adult fall-run chinook salmon migrate upstream from July through December (greatest migration through the Delta occurs in September-November) and spawn in October through December (Moyle, 2002), with the greatest spawning activity typically occurring in November and early December. Fall run and late fall run chinook salmon migrate upstream and spawn in rivers tributary to the Delta including the American, Feather, mainstem Sacramento, Mokelumne, Cosumnes, Tuolumne, Stanislaus, and Merced rivers and a number of smaller watersheds.

Instream flows and the release of cold water from upstream reservoirs are two of the important factors affecting habitat quality and availability for adults, eggs, and juvenile salmon. The success of fall-run chinook salmon spawning is dependent, to a large extent, on seasonal water temperatures. Seasonal water temperatures are most critical for pre-spawning adults and incubating eggs (primarily September-October) and for juvenile rearing and downstream migration (primarily April-June). After incubating and hatching, the young salmon emerge from the spawning areas as fry. A portion of the fry population migrates downstream soon after emergence, rearing in the downstream river channels and the Delta estuary (including the area next to the Old River, Rock Slough and AIP intakes, the new Delta Intake, and the SWP and CVP south Delta export facilities) during the late winter and spring months.

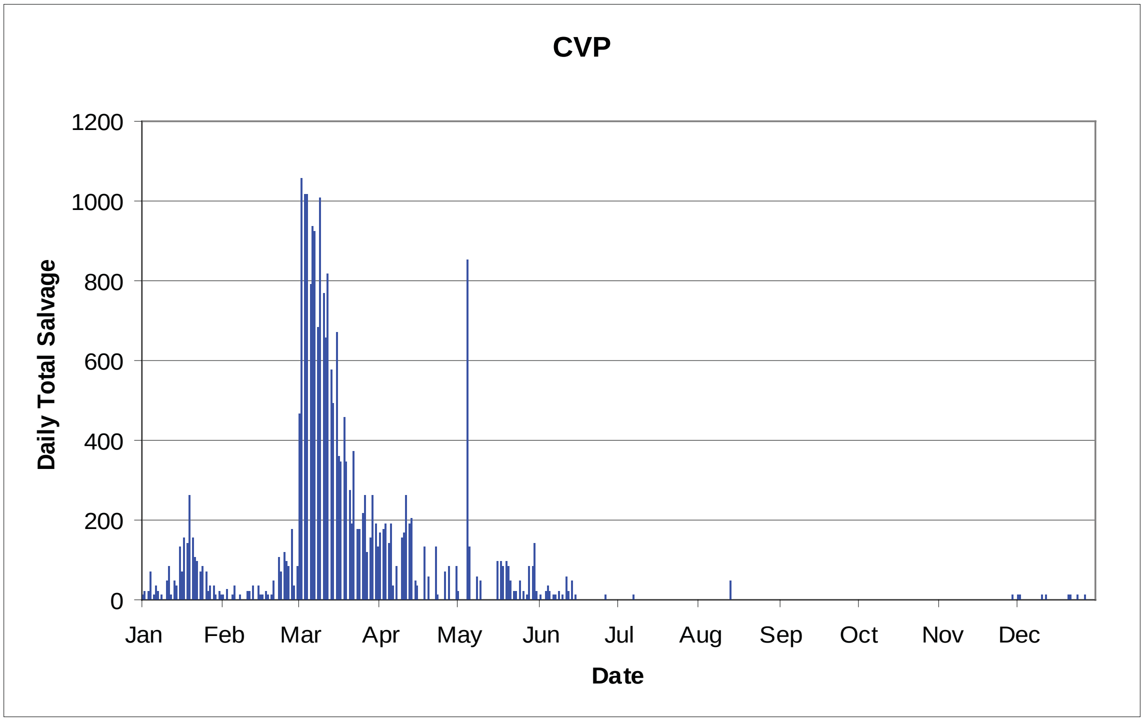
The remaining portion of juvenile salmon continues to rear in the upstream systems through the spring months until they have adapted to migration into salt water (smolting), which typically takes place between April and early June. In some streams, a small proportion of the fall-run chinook salmon juveniles may rear through the summer and fall months, migrating downstream during the fall, winter, or early spring as 1-year-old smolts.

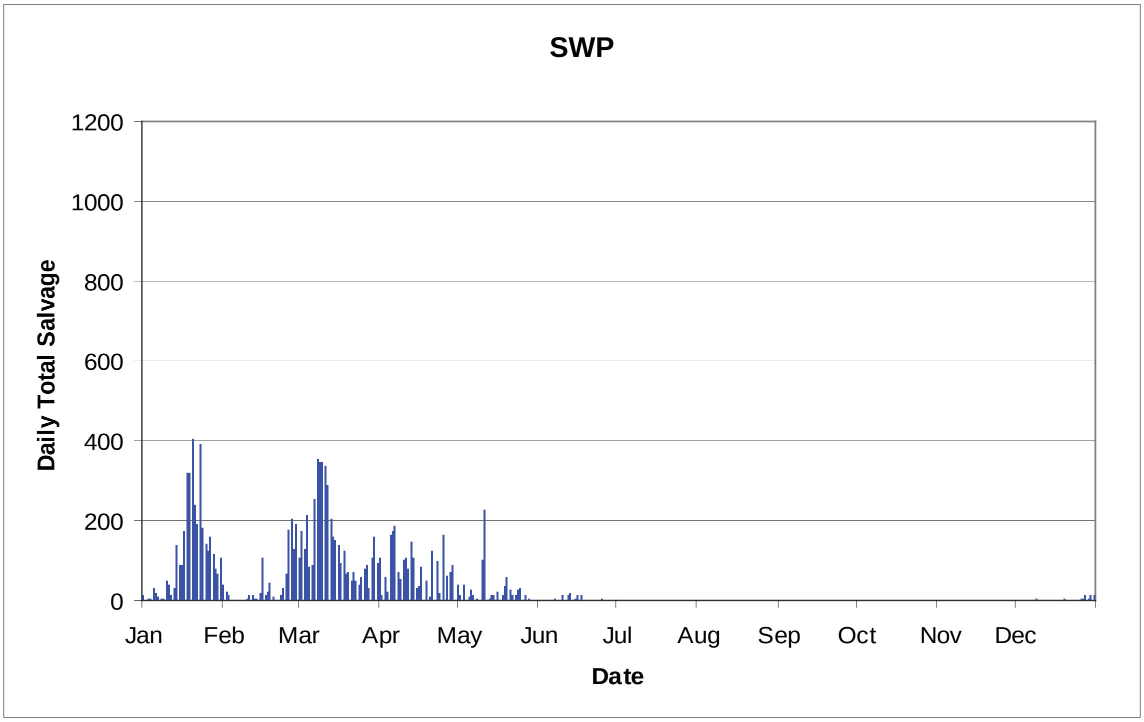
Historically, before construction of major dams and water storage impoundments on Central Valley rivers, spring-run chinook salmon were considered to be the most abundant salmon species inhabiting the Sacramento and San Joaquin river systems (Yoshiyama et al., 1998). Currently, fall-run chinook salmon is the most abundant species of Pacific salmon inhabiting the Sacramento and San Joaquin Delta and Central Valley rivers. However, the 2007 adult spawning escapement for Sacramento River failed to meet the escapement goal of 122,000 to 180,000 adults for the first time in 15 years. The count of "jacks" or immature fish that return to the rivers at age two was a record low of only 2,000. This is much lower than the long-term average of 40,000 and the previous low of 10,000 (Environmental News Service, 2008). Future abundance projections are based on the previous years' jacks and it is estimated that 2008 will also record low numbers. In response to the low observed adult escapement in 2007 and projected low returns in 2008 the PFMC closed the coastal commercial and recreational fisheries for all chinook salmon beginning in spring 2008.

The occurrence of adult fall-run chinook salmon within the south Delta in the vicinity of both the existing and new intake structures would be limited to the fall period (primarily October through December) of adult upstream migration. Juvenile chinook salmon, particularly in the fry stage, may rear within the Delta and Suisun Bay, foraging along channel and shoreline margins and lower velocity backwater habitats. Juvenile fall-run chinook salmon would be expected to occur within the Delta, and specifically within the area of the Old River, Rock Slough, and AIP intakes, the new Delta Intake, and the SWP and CVP south Delta export facilities during late winter (fry; primarily February-March) through early spring (smolts; April-early June), when water temperatures within the Delta would be suitable for juvenile chinook salmon migration.

Late-fall-run chinook salmon adults migrate upstream through the Delta, in the vicinity of the existing and new CCWD intake structures and the SWP and CVP south Delta export facilities, from November through May. Late fall run chinook salmon migrate upstream, primarily into areas such as the mainstem Sacramento River between Keswick Reservoir and RBDD, and spawn from January through April. Juvenile fall-run and late-fall-run chinook salmon migrate downstream through the Delta, in the vicinity of the Old River, Rock Slough and AIP intake structures, the new Delta Intake structure, and the SWP and CVP south Delta export facilities during the late winter and spring migration period (December-April).

The seasonal occurrence of juvenile chinook salmon (all runs) observed during CVP and SWP fish salvage operations (see **Figure 4.3-2**) reflects the seasonal distribution of the species within the south Delta.





SOURCE: DFG, 2005; Central Valley Bay-Delta Branch Fish Salvage Monitoring (http://www.delta.dfg.ca.gov/Data/Salvage/); and ESA, 2007

Figure 4.3-2
2004 Seasonal (Daily) Distribution of Juvenile Chinook Salmon in CVP and SWP Fish Salvage Operations

Factors Affecting Chinook Salmon Populations

The environmental and biological factors that affect the abundance, mortality, and population dynamics of chinook salmon within the Bay-Delta estuary and Central Valley include, but are not limited to the following:

- Loss of access to historical spawning and juvenile rearing habitat within the upper reaches of the Central Valley rivers caused by major dams and reservoirs that act as migration barriers
- River water temperatures affect incubating eggs, holding adults, and growth and survival of juvenile salmon
- Juveniles are vulnerable to entrainment (i.e., the pulling of fish along with current into water diversion facilities) at a large number of unscreened water diversions along the Sacramento and San Joaquin Rivers and in the Delta
- Salvage mortality (defined as the fraction of fish that do not survive fish salvage) at the SWP and CVP export facilities
- Changes in habitat quality, including availability for spawning and juvenile rearing
- Exposure to contaminants
- Predation mortality by Sacramento pike minnow, striped bass, largemouth bass, and other predators
- Competition and interactions with hatchery-produced chinook salmon and steelhead
- Recreational and commercial fishing of subadult and adult chinook salmon
- Ocean survival is affected by climatic and oceanographic conditions
- Adults are vulnerable to predation mortality by marine mammals

In recent years, a number of changes have been made to improve the survival and habitat conditions for chinook salmon. For about the past 15 years, modifications have been made to operations at a number of Central Valley reservoirs, such as Shasta and Keswick, Folsom and Nimbus, Oroville, Camanche, and other dams and reservoirs in response to FESA protections for listed salmonids, Federal Energy Regulatory Commission permits and settlements, SWRCB water right permits, and as part of the CVP Improvement Act, for instream flow and temperature management. Modifications have been made to RBDD gate operations to increase the seasonal period when the dam gates are open to improve the migration and survival of listed salmonids and other fish.

Several large, previously unscreened water diversions on the Sacramento River, such as the Reclamation District (RD) 108 Wilkins Slough Pumping Plant, Princeton Pumping Plant, Glenn Colusa Irrigation District diversion, Sutter Mutual Water Company Tisdale Pumping Plant, and others have been equipped with positive-barrier fish screens. These screens include perforated metal plates, meshes, or other physical devices designed to prevent fish from being entrained into intake facilities while minimizing the stress and injury that can occur when fish are impinged on the screen or are subjected to changes in water velocity caused by the diversion.

Changes have been made in ocean salmon fishing regulations, particularly beginning in 2007 when the coastal ocean commercial and recreational harvest was banned in the San Francisco Bay area. Modifications to SWP and CVP export facility operations have also been made to improve the survival of juvenile chinook salmon during migration through the Delta. Modifications to SWP and CVP export operations in recent years have largely focused on reducing mortality to listed fish such as delta smelt, winter run and spring run chinook salmon, steelhead, and other fish in response to SWRCB Water Rights Decision D-1641 (D-1641), the Vernalis Adaptive Management Plan (VAMP), the CVP Improvement Act, FESA requirements of the USFWS and NMFS OCAP BOs, and federal court order.

These and other changes in management actions, in combination with favorable hydrologic and oceanographic conditions in recent years, are thought to have contributed to increasing abundance of adults returning to the upper Sacramento River since the mid-1990s. However, while chinook salmon have shown increasing abundance over the last decade, recent reports show a sharp decline in the chinook salmon population abundance in recent years. Although the causes for the decline in salmon abundance are not fully understood at this time, changes in ocean conditions are thought to be the primary reason (NMFS, 2008).

Regulatory Listing Status

The listing status of chinook salmon varies among runs. Winter-run chinook salmon are listed as an endangered species under both CESA and FESA; spring-run chinook salmon are listed as a threatened species under both CESA and FESA; and fall-run and late fall-run are not listed,[1] although both fall-run and late-fall-run chinook salmon are California species of special concern and federal species of concern. Critical habitat has been designated for winter- and spring-run chinook salmon, but neither designation includes the south Delta. Fall-run and late-fall-run are included in this environmental analysis because they support important commercial and recreational fisheries and the project alternatives would be within the area of the south Delta identified as EFH for Pacific salmon.

Central Valley Steelhead

Steelhead are the anadromous form of rainbow trout (*O. mykiss*); adults spawn in fresh water and the juveniles migrate to the Pacific Ocean, where they reside for several years before returning to the river system. Rainbow trout that spend their entire life in fresh water and do not migrate to the ocean are known as resident rainbow trout.

Life History of Central Valley Steelhead

Adult steelhead typically migrate through the Delta to upstream spawning areas during the fall and winter months (although the actual seasonal timing of adult steelhead migration may vary among years, the primary period of adult migration appears to be about November through March). A portion of the adult steelhead survive spawning and migrate back downstream (primarily in February-May) to spawn in subsequent years.

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1 In 1998, NMFS proposed that Central Valley fall-run and late-fall-run chinook salmon be listed under FESA as a threatened Evolutionarily Significant Unit (ESU) of the species. Based on further analysis and public comment, NMFS decided that fall-run and late-fall-run chinook salmon did not warrant listing, but should remain a species of concern for further analysis and evaluation.

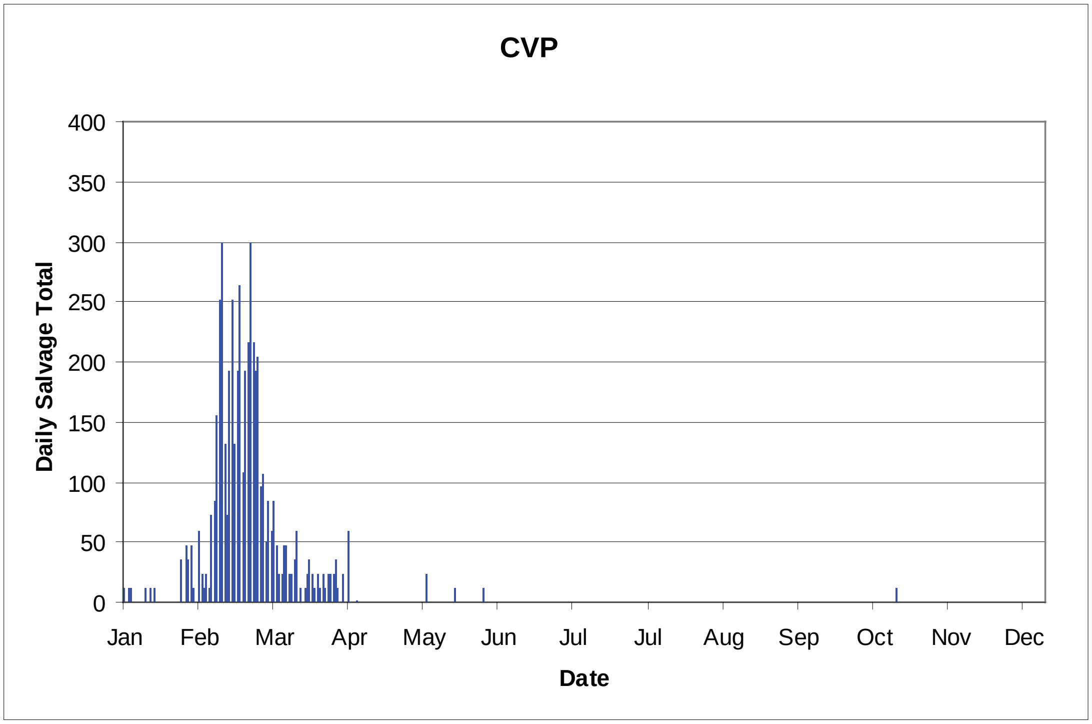
Steelhead spawn in areas characterized by clean gravels, cold water temperatures, and moderately high water velocities. Spawning typically occurs during the winter and spring (December through April), with the majority of spawning activity occurring between January and March. Although the actual geographic distribution of adult steelhead spawning is difficult to assess, adult returns occur on the American, Feather, mainstem Sacramento, Mokelumne, and Cosumnes rivers, as well as a number of smaller watersheds. Low numbers of adult steelhead may also migrate upstream into San Joaquin River tributaries. Instream flow releases and availability of cold water throughout the year from existing dams and reservoirs, in addition to access to suitable spawning and rearing habitat within tributaries, and physical habitat conditions such as spawning gravel and instream cover, have been identified as important factors affecting Central Valley steelhead.

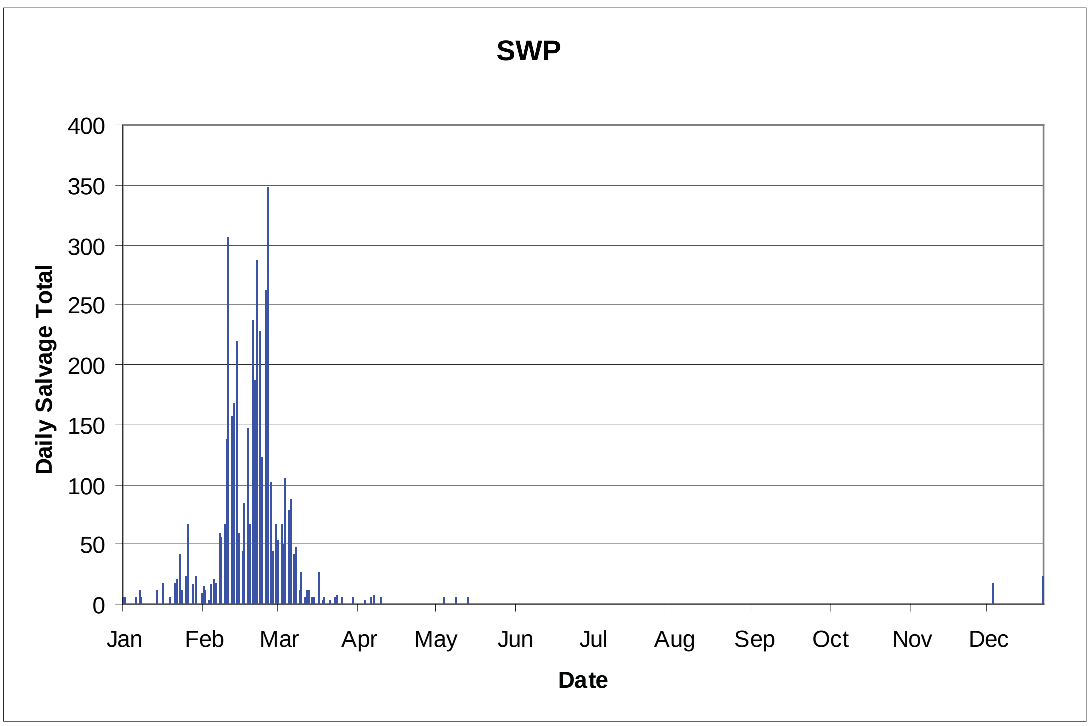
Young steelhead rear in fresh water for 1 to 3 years before migrating to the ocean. Downstream migration of steelhead smolts typically occurs during the late winter and early spring (January through May), as reflected in the seasonal occurrence in CVP and SWP fish salvage (**Figure 4.3-3**). Although the occurrence of juvenile steelhead observed in SWP and CVP fish salvage operations may vary in response to changes in export rates, the general seasonal distribution of steelhead in the fish salvage operations is consistent with observations on the seasonal migration of juvenile steelhead observed in other fishery monitoring programs conducted within the Delta (e.g., USFWS beach seine surveys, Chipps Island trawling). The seasonal timing of juvenile steelhead occurrence in the SWP and CVP salvage (Figure 4.3-3) is considered to be representative of the seasonal period when juvenile steelhead would be present in the south Delta in the vicinity of the Old River, Rock Slough, and AIP intake structures; the new Delta Intake structure; and the SWP and CVP south Delta export facilities. The seasonal timing of downstream migration of steelhead smolts can vary in response to a variety of environmental and physiological factors, including changes in water temperature, stream flow, and increased water turbidity resulting from storm water runoff.

Historically, Central Valley steelhead migrated upstream into the upper reaches of streams and rivers for spawning and juvenile rearing. The construction of dams and other structures on Central Valley rivers created impassable barriers to upstream migration that substantially reduced access to historical spawning grounds, and reduced the overall geographic distribution of steelhead.

Although quantitative estimates of the number of adult steelhead returning to Central Valley streams are not available, anecdotal information and fish counts indicate that population abundance is low. Steelhead distribution is currently restricted to the mainstem Sacramento River downstream of Keswick Dam, the Feather River downstream of Oroville Dam, the American River downstream of Nimbus Dam, the Mokelumne River downstream of Camanche Dam, and a number of smaller tributaries to the Sacramento River system, the Delta, and San Francisco Bay.

Steelhead may also inhabit San Joaquin River tributaries in low abundance. The only consistent data available on steelhead numbers in the San Joaquin River basin come from Spring Kodiak Trawl (SKT) samples collected by CDFG on the lower San Joaquin River at Mossdale. These data indicate a decline in steelhead abundance over the past several decades. The Central Valley steelhead population is composed of both naturally spawning steelhead and steelhead produced in hatcheries.





SOURCE: DFG, 2005; Central Valley Bay-Delta Branch Fish Salvage Monitoring (http://www.delta.dfg.ca.gov/Data/Salvage/); and ESA, 2007

Figure 4.3-3
2004 Seasonal (Daily) Distribution of Juvenile Steelhead in CVP and SWP Fish Salvage Operations

Detailed, long-term, quantitative fishery survey information are not available on the abundance of steelhead inhabiting various Central Valley rivers as spawning and juvenile rearing habitat, or migrating through the Delta. Steelhead, unlike chinook salmon, do not necessarily die after spawning. Therefore, carcass surveys do not provide reliable information on trends in adult steelhead abundance. Adult steelhead spawn during the winter and early spring months, typically when river and stream flows are high and turbidity is high, thereby making visual observations of spawning adults and redds difficult. During rearing in the upstream tributary habitat identification of juvenile anadromous steelhead from resident rainbow trout is difficult and unreliable. In addition, juvenile steelhead migrating downstream through the Delta are typically larger than juvenile salmon, have good swimming performance capability, and have the ability to avoid capture by the conventional fishery sampling methods (e.g., seines and trawls).

The best estimates of trends in abundance of adult steelhead, therefore, come from returns to hatcheries or observations and fish counts at fish ladders such as that operated at the RBDD on the upper Sacramento River. Changes in operations of the RBDD in recent years have reduced the reliability in estimating trends in adult steelhead abundance. The information that is available from these sources (see McEwan, 2001 for a summary of information on trends in adult steelhead abundance at the RBDD) are consistent in showing a substantial decline in abundance of adult steelhead returning the Central Valley rivers each year to spawn.

Although the majority of adult steelhead migrate upstream within the mainstem Sacramento River, some adult steelhead migrate through the central Delta into the Mokelumne and Cosumnes rivers and through the south Delta into the San Joaquin River system. Therefore, adult steelhead would be present seasonally within the vicinity of the Old River, Rock Slough and AIP intake structures, the new Delta Intake structure, and the SWP and CVP south Delta export facilities. Adult steelhead would potentially be expected to occur in the south Delta during the late fall and winter (about November through March). Juvenile steelhead migrate from the upstream spawning and rearing areas through the Delta, Suisun Bay, and San Francisco Bay, including the channels next to the Old River, Rock Slough and AIP intake structures, the new Delta Intake structure, and the SWP and CVP south Delta export facilities during the winter and early spring (primarily January through May).

Steelhead do not spawn within the Delta; however, juvenile steelhead forage within the south and central Delta during emigration and hence would be present within the vicinity of the Old River, Rock Slough and AIP intake structures, the new Delta Intake structure, and the SWP and CVP south Delta export facilities during the late winter and early spring migration period.

Factors Affecting Central Valley Steelhead Populations

Factors affecting steelhead abundance are similar to those described above for chinook salmon and include, but are not limited to:

- Loss of access to historical spawning and juvenile rearing habitat within the upper reaches of the Central Valley rivers caused by major dams and reservoirs acting as migration barriers
- Water temperatures in rivers and creeks, especially in summer and fall, affecting the growth and survival of juvenile steelhead

- Juveniles' vulnerability to entrainment at a large number of unscreened water diversions along the Sacramento and San Joaquin rivers and in the Delta
- Salvage mortality at the SWP and CVP export facilities
- Changes in habitat quality, including availability for spawning and juvenile rearing
- Exposure to contaminants
- Predation mortality by Sacramento pikeminnow, striped bass, largemouth bass, and other predators
- Passage barriers and impediments to migration
- Changes in land use practices
- Competition and interactions with hatchery-produced chinook salmon and steelhead
- Ocean survival affected by climatic and oceanographic conditions
- Adult vulnerability to predation mortality by marine mammals

Unlike chinook salmon, steelhead populations are not vulnerable to recreational and commercial fishing within the ocean, although hatchery-produced steelhead support a small inland recreational fishery.

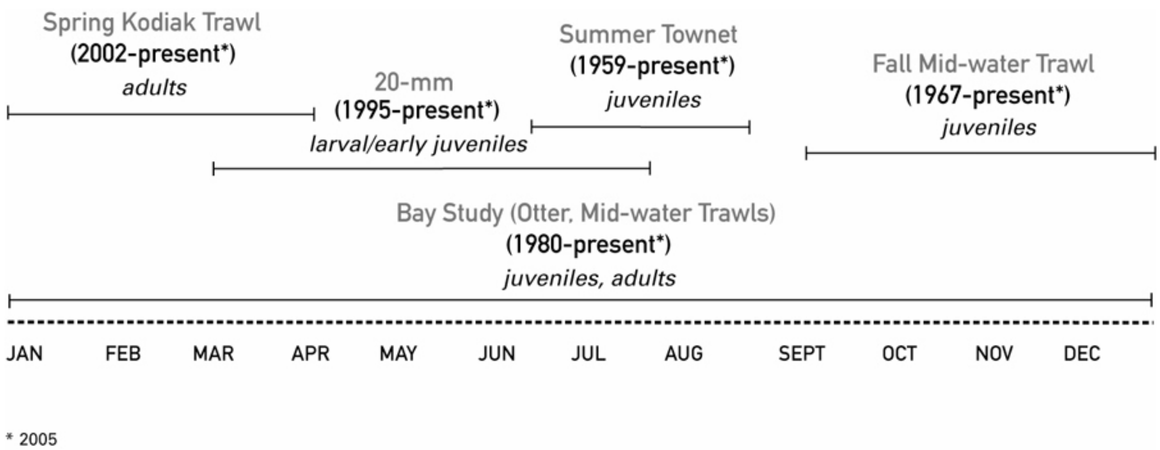
In recent years, a number of changes have been made to improve the survival and habitat conditions for steelhead. Several large, previously unscreened water diversions on the upper Sacramento River (e.g., RD 108 Wilkins Slough Pumping Plant, Glenn Colusa Irrigation District diversion, Sutter Mutual Water Company Tisdale Pumping Plant, and others) have been equipped with positive-barrier fish screens. Modifications to fish passage facilities at locations such as the Woodbridge Irrigation District dam on the Mokelumne River, RBDD on the Sacramento River, and M&T Ranch on Butte Creek, have also been made to improve migration and access to spawning and juvenile rearing habitat. These measures have increased the ability of steelhead to migrate upstream as well as allow juveniles to migrate downstream.

Regulatory Listing Status

Central Valley steelhead are listed as a threatened Distinct Population Segment (DPS) under FESA. Steelhead are not listed for protection under CESA. Critical habitat for Central Valley steelhead was designated in 2005 and became effective in January 2006. The critical habitat designation for this DPS includes the project area.

Delta Smelt

Delta smelt are endemic to the Sacramento–San Joaquin Delta estuary and inhabit the freshwater portions of the Delta, lower reaches of the Sacramento and San Joaquin rivers, and the low-salinity portions of Suisun Bay. Delta smelt experienced a general decline in population abundance over the past several decades leading to their listing as a threatened species under both FESA and CESA. Delta smelt, in addition to several other pelagic species, recently experienced a substantial decline in population abundance, otherwise known as the POD, as described earlier. The substantial declines in delta smelt abundance indices in recent years, as well as declines in other pelagic fish species, have led to widespread concern regarding the pelagic fish community of the Bay-Delta estuary. A number of recent and ongoing analyses have focused on identifying the factors potentially influencing the status and abundance of delta smelt and other pelagic fish species within the estuary. **Figure 4.3-4** indicates the timing of ongoing CDFG Delta fish surveys that collect delta smelt.

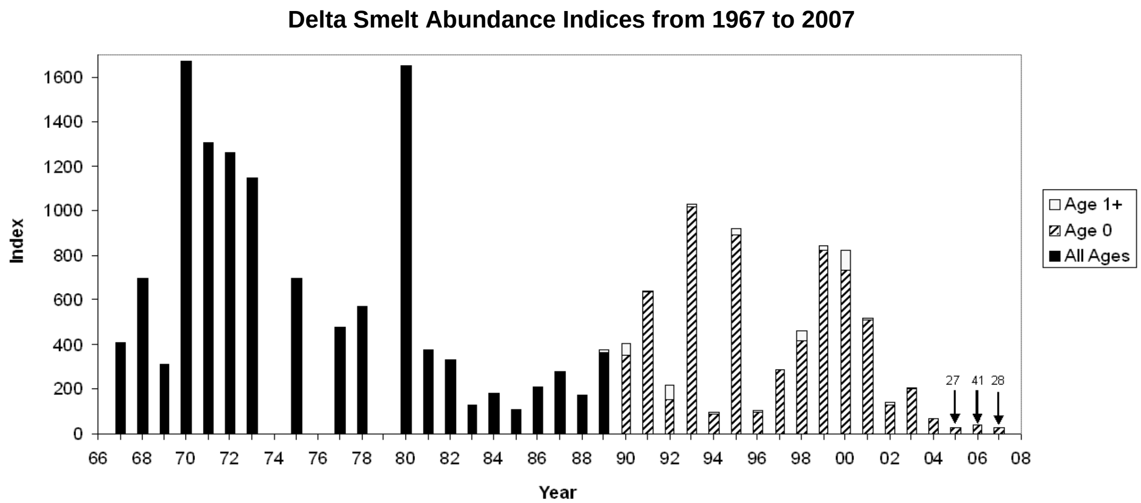


Los Vaqueros Reservoir Expansion Project . 201110

Figure 4.3-4
Time Periods of CDFG Delta Fish Surveys

The FMWT and SKT provide indices of pre-spawning adult delta smelt abundance during late fall and winter. The 20-millimeter (mm) Delta Smelt Survey and Summer Townet Survey provide information on juvenile abundance during spring and summer. Indices of delta smelt abundance have varied substantially among years (**Figure 4.3-5**). Abundance indices were highest from 1970 to 1973, followed by a general decline in abundance extending through the mid-1980s (with the exception of 1980). Abundance was variable, but generally higher from 1991 through 2000 than it had been in the decade prior. Since 2002, abundance indices for delta smelt have been persistently low; 2004 through 2007 reflected the lowest levels on record.

The IEP continues to evaluate the available scientific information regarding the status of delta smelt and the performance of various management actions designed to improve protection, reduce mortality, and enhance habitat quality and availability for delta smelt within the estuary. Additional measures have been taken since the beginning of 2005 (e.g., 20-mm surveys, POD investigations) to assess the seasonal and geographic distribution of early lifestages of delta smelt, factors affecting population dynamics such as the magnitude of entrainment at the CVP and SWP intakes, and to monitor and provide additional information on delta smelt abundance and distribution within the Delta.



SOURCE: CDFG 2008b

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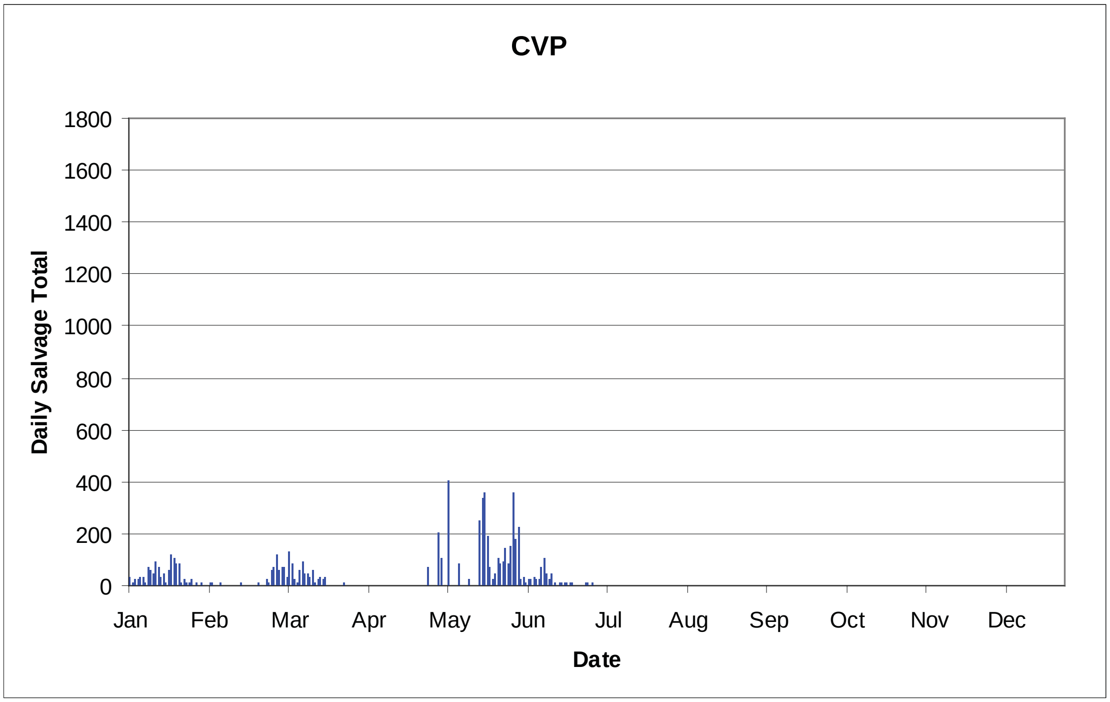
Figure 4.3-5
CDFG Fall Midwater Trawl Abundance Indices for Delta Smelt, 1967–2007

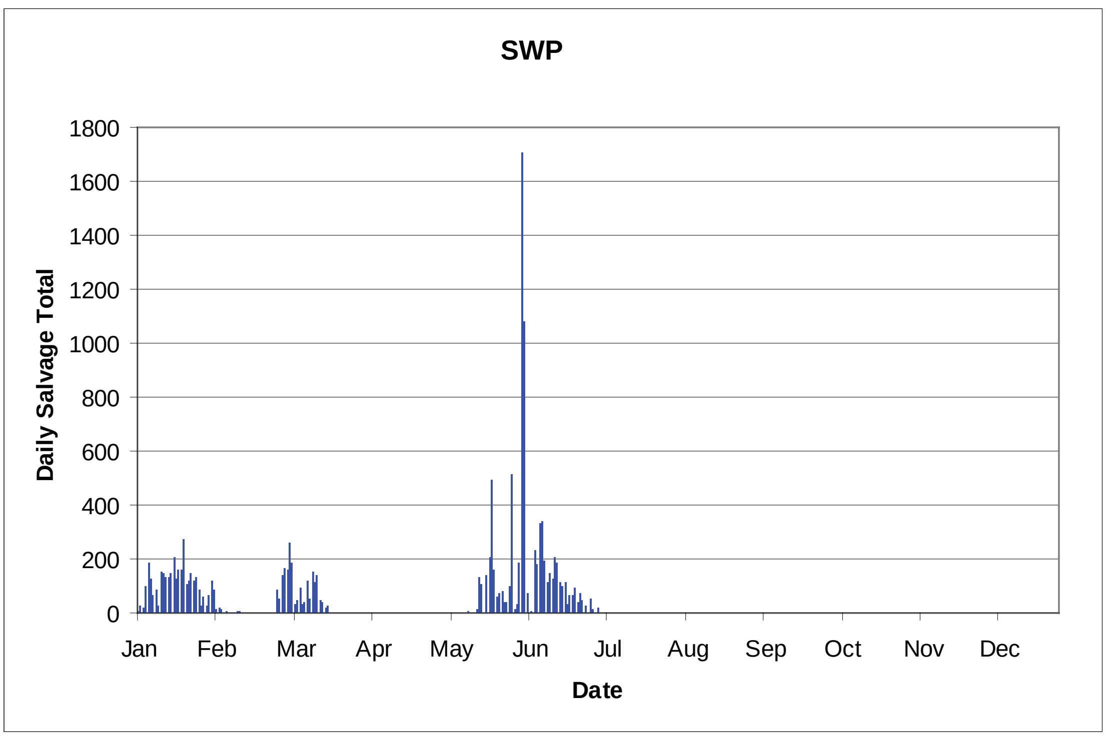
Life History of Delta Smelt

Delta smelt are a relatively small species (2 to 4 inches long) with an annual life cycle, although some individuals may live 2 years. Adult delta smelt migrate upstream into channels and sloughs of the Delta (e.g., lower Sacramento River in the vicinity of Decker Island and Rio Vista) during winter to prepare for spawning. Delta smelt live their entire life cycle within the Bay-Delta estuary. Juveniles and adults typically inhabit open waters of the Delta, including the areas in the vicinity of the Old River, Rock Slough and AIP intake structures, the new Delta Intake structure, and the SWP and CVP south Delta export facilities.

Spawning occurs between February and July; peak spawning occurs during April through mid-May (Moyle, 2002). Females deposit adhesive eggs on substrates such as gravel and sand. Eggs hatch, releasing planktonic larvae that are passively dispersed downstream by river flow. Larval and juvenile delta smelt rear within the estuary for a period of about 6 to 9 months before beginning their upstream spawning movement into freshwater areas of the lower Sacramento and San Joaquin Rivers. They also have been known to move downstream into Napa River during high flows; sometimes they do not move at all if the western end of Suisun Bay freshens; they have also been known inhabit Suisun Marsh.

Juvenile and adult delta smelt are usually most abundant within the south Delta in the vicinity of the Old River, Rock Slough and AIP intakes, the new Delta Intake, and the SWP and CVP south Delta export facilities from winter through early summer, as reflected in SWP and CVP fish salvage records (**Figure 4.3-6**). Although the occurrence of delta smelt observed in SWP and CVP fish salvage operations may vary in response to changes in export rates, the general seasonal distribution of juvenile and adult delta smelt in the fish salvage operations is consistent with observations on the seasonal migration patterns and geographic distribution of delta smelt observed in other fishery





SOURCE: DFG, 2005; Central Valley Bay-Delta Branch Fish Salvage Monitoring (http://www.delta.dfg.ca.gov/Data/Salvage/); and ESA, 2007

Figure 4.3-6
2004 Seasonal (Daily) Distribution of Juvenile and Adult Delta Smelt in CVP and SWP Fish Salvage Operations

monitoring programs conducted within the Delta (e.g., 20 mm, SKT, USFWS beach seine surveys, Chipps Island trawling). The seasonal timing of delta smelt occurrence in the SWP and CVP salvage (Figure 4.3-6) is considered to be representative of the seasonal period when delta smelt would be present in the south Delta in the vicinity of the Old River, Rock Slough and AIP intake structures, the new Delta Intake structure, and the SWP and CVP south Delta export facilities.

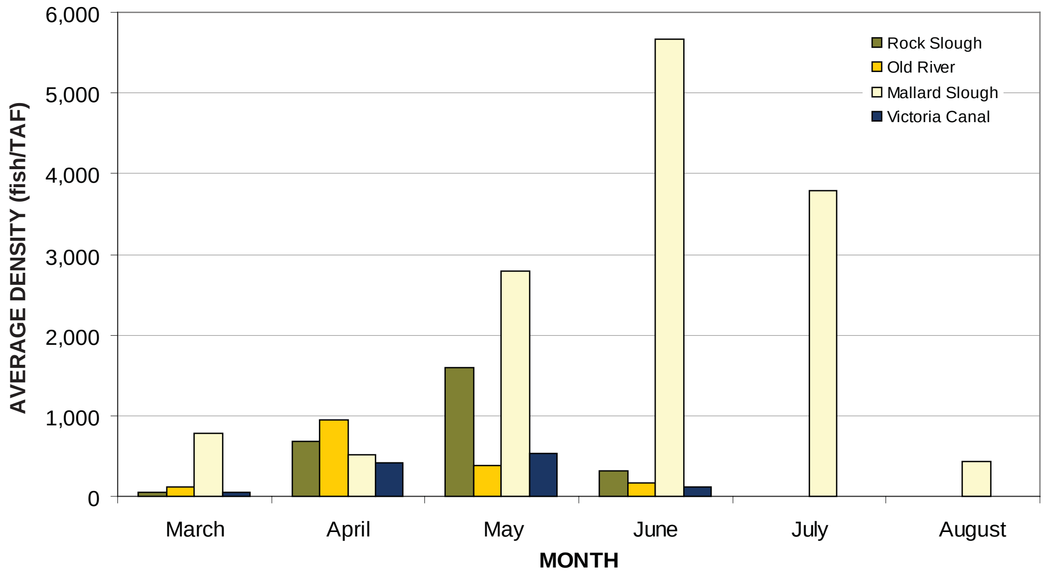
Juvenile and adult delta smelt do not typically inhabit the south Delta during summer, when water temperatures exceed about 77 degrees Fahrenheit, and high water clarity tends to keep them out during the fall (Nobriga et al., 2008; Feyrer et al., 2007). Adult delta smelt spawn within the Delta during late winter and spring, and larvae occur within the Delta during spring (**Figure 4.3-7**). As a result of their life history and geographic distribution, delta smelt may occur seasonally within the vicinity of the Old River, Rock Slough, and AIP intake structures, the new Delta Intake structure, and the SWP and CVP south Delta export facilities as larvae, juveniles, and adult life stages.

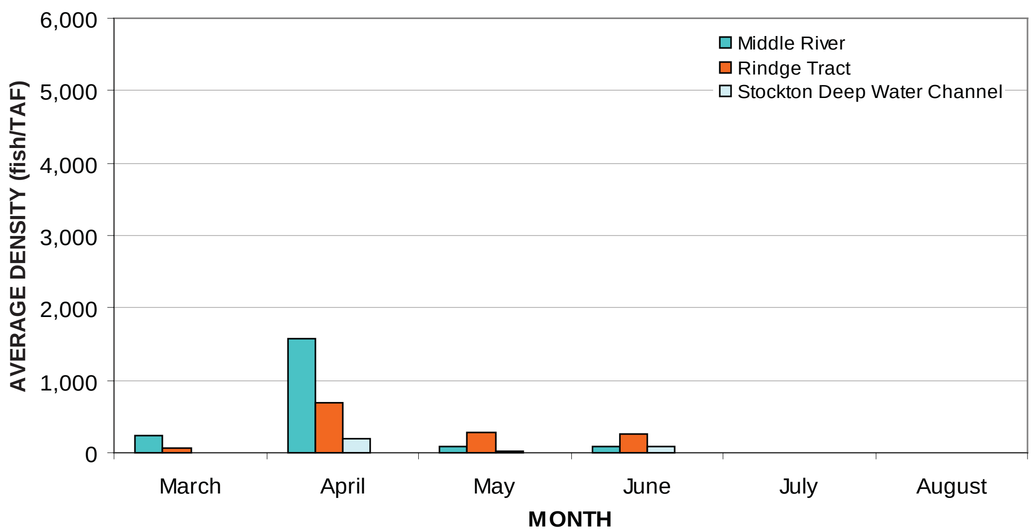
Modifications to SWP and CVP export facility operations have been made over the past decade to improve the survival of delta smelt and other fish species. Modifications to SWP and CVP export operations in recent years have largely focused on reducing mortality to listed fish such as delta smelt, winter run and spring run chinook salmon, steelhead, and other fish in response to SWRCB D-1641, VAMP, CVP Improvement Act, FESA requirements of the USFWS and NMFS OCAP BOs, and federal court order.

Factors Affecting Delta Smelt Populations

A variety of environmental and biological factors affect the abundance of delta smelt within the estuary (Moyle, 2002). These factors include, but are not limited to:

- Changes in the seasonal timing and magnitude of freshwater inflow to the Delta and outflow from the Delta
- Entrainment of larval, juvenile, and adult delta smelt into a large number of unscreened water diversions (primary agricultural) throughout the Delta (CBD, TBI and NRDC, 2006)
- Entrainment and salvage mortality at the CVP and SWP water export facilities
- Predation by striped bass, largemouth bass, and a number of other fish species inhabiting the estuary has also been identified as a source of mortality for delta smelt
- Exposure to toxic substances resulting in direct or indirect effects
- Variation in the quality and availability of low-salinity habitat within the Delta and Suisun Bay, in response to seasonal and interannual variability in hydrologic conditions within the Delta
- Reduced food (prey) availability thought to be the result of reduced primary production due, in part, to a reduction in seasonally-inundated wetlands, competition for food resources with non-native fish and macroinvertebrates (e.g., filter feeding by the non-native Asian overbite clam Corbula), and competition among native and non-native zooplankton species





SOURCE: DFG, 2005 (http://www.delta.dfg.ca.gov/Data/20mm/); and ESA, 2007

Figure 4.3-7
1995-2005 DFG 20mm Larval Smelt Survey
Average Densities in the South Delta near
CCWD Intakes and the Vicinity

Regulatory Listing Status

Delta smelt is listed as a threatened species under ~~both CESA and~~ FESA and listed as endangered under CESA. In March 2006, a petition seeking to relist delta smelt as an endangered species was submitted to the USFWS. On July 10, 2008 USFWS announced in a 90-day finding that consideration for reclassification of delta smelt was warranted and, after an information collection stage, a status review would be initiated. On March 25, 2009, USFWS initiated a 5-year status review of 58 species, including the delta smelt. ~~The proposal to elevate the listing status remains under review and USFWS has, as yet, not acted on the petition.~~ Critical habitat for delta smelt has been designated by USFWS within the Sacramento–San Joaquin River system, including the project area.

In June 2007, the California Fish and Game Commission accepted a petition to uplist delta smelt from threatened to endangered status under CESA. On March 4, 2009, the California Fish and Game Commission elevated the status of delta smelt to endangered under CESA. ~~This action is currently under review.~~

North American Green Sturgeon

Green sturgeon is a large, bottom-dwelling, anadromous fish that is widely distributed along the Pacific coast of North America. North American green sturgeon is the most broadly distributed, wide ranging, and marine-oriented species of the sturgeon family; however, they are not very abundant in comparison to white sturgeon. San Francisco Bay, San Pablo Bay, Suisun Bay, the Delta, and the Sacramento River support the southernmost reproducing population of green sturgeon.

Life History of Green Sturgeon

Habitat requirements of green sturgeon are poorly understood, but spawning and larval ecologies are probably similar to those of white sturgeon. Indirect evidence indicates that green sturgeon spawn mainly in the upper reaches of Sacramento River (e.g., Colusa to Keswick Dam). They are slow growing and late maturing, spawning every 3 to 5 years between March and July. Adult fish spawn in fresh water and then return to estuarine or marine environments. Preferred spawning habitat occurs in large rivers that contain large cobble in deep and cool pools with turbulent water (CDFG, 2002; Moyle, 2002; Adams et al., 2002). Larval and juvenile green sturgeon may rear for up to 2 years in fresh water and then migrate to an estuarine environment, primarily during summer and fall. They remain near estuaries at first, but may migrate considerable distances as they grow larger (SWRCB, 1999).

Both adult and juvenile North American green sturgeon are known to occur in the lower reaches of the San Joaquin River and in the south Delta. Juveniles have been captured in the vicinity of Santa Clara Shoals and Brannan Island State Recreation Area, and in the channels of the south Delta (NMFS, 2006). The occurrence of green sturgeon in fishery sampling and CVP/SWP fish salvage is extremely low. As a result, very little information is available on the habitat requirements, geographic distribution, or seasonal distribution of various life history stages of green sturgeon within the estuary. However, adults and juveniles have the potential to occur within the project area throughout the year.

Factors Affecting Green Sturgeon Populations

A variety of environmental and biological factors affect the abundance of green sturgeon within the estuary:

- Spawning habitat made inaccessible or altered by dams
- Destruction of riparian and stream channel habitat used for spawning
- The introduction of invasive benthic organisms such as the overbite clams and Chinese mitten crab have altered the benthic invertebrate communities
- The introduction of non-native invasive plant species such as water hyacinth and Brazilian waterweed have altered habitat by raising temperatures, reducing turbidity and dissolved oxygen, and inhibiting access to shallow water habitat (CDFG, 2002)
- Reduced rearing habitat due to historical reclamation of wetland and islands that has degraded the availability of suitable in- and off-channel rearing habitat (Sweeny et al., 2004)
- Increased water temperatures (Myrick and Cech, 2004; Allen et al., 2006a, b)
- Predation by native and non-native fish, including prickly sculpin, striped bass, and largemouth bass
- Harvest in the recreational sport fisheries and poaching (illegal harvest)

The abundance of green sturgeon is apparently reduced throughout its range. The CDFG estimated the abundance of adult green sturgeon inhabiting the Bay-Delta estuary ranged from about 500 to 1000 fish between 1967 and 1991 (EPIC, CDB, and WaterKeepers, 2001). EPIC et al. (2001) reported that the abundance of legal-size green sturgeon in 1998 was estimated to be 418 fish. While population estimates are not precise, the population is so small that a collapse could occur, but such a collapse would be difficult to detect due to the limited occurrence in conventional fishery sampling programs (SWRCB, 1999).

Regulatory Listing Status

The southern DPS of North American green sturgeon is listed as threatened under FESA and is a California species of special concern. Critical habitat for green sturgeon has not been designated.

Longfin Smelt

Longfin smelt is a small, planktivorous fish species found in several Pacific coast estuaries from San Francisco Bay to Prince William Sound, Alaska.

Life History of Longfin Smelt

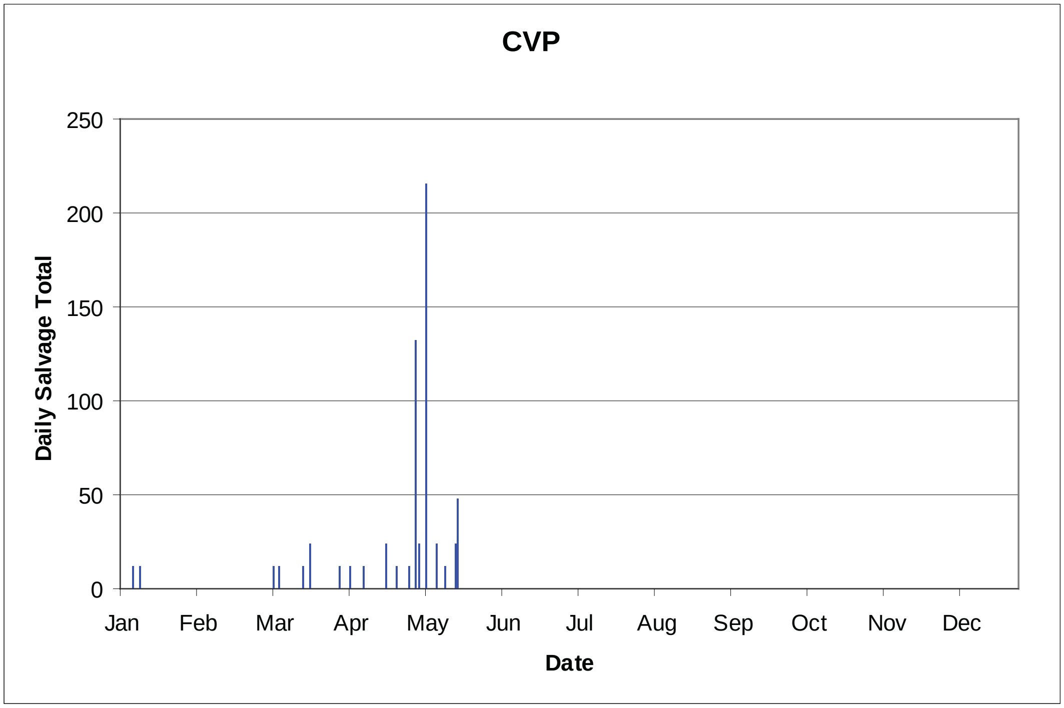
Longfin smelt can tolerate a broad range of salinity concentrations, ranging from fresh water to seawater (TBI et al., 2007). Spawning is believed to occur in the lower reaches of the Sacramento River (downstream of Rio Vista). Spawning is also thought to occur in the eastern portion of Suisun Bay and larger sloughs within Suisun Marsh. Historically, spawning probably occurred in the lower San Joaquin Rivers (TBI, 2007). Spawning may take place as early as November and may extend into June. The majority of spawning occurs between January and March (TBI et al., 2007). Adult longfin smelt are found mainly in Suisun, San Pablo, and San Francisco Bays, although their distribution is shifted upstream into the western Delta in years of low outflow (Baxter, 1999; Moyle, 2002). The seasonal occurrence of longfin smelt in CVP and SWP salvage operations (**Figure 4.3-8**) is considered to be representative of the seasonal periods when juvenile and adult longfin smelt would be in the vicinity of the Old River, Rock Slough and AIP intake structures and the new Delta Intake structure.

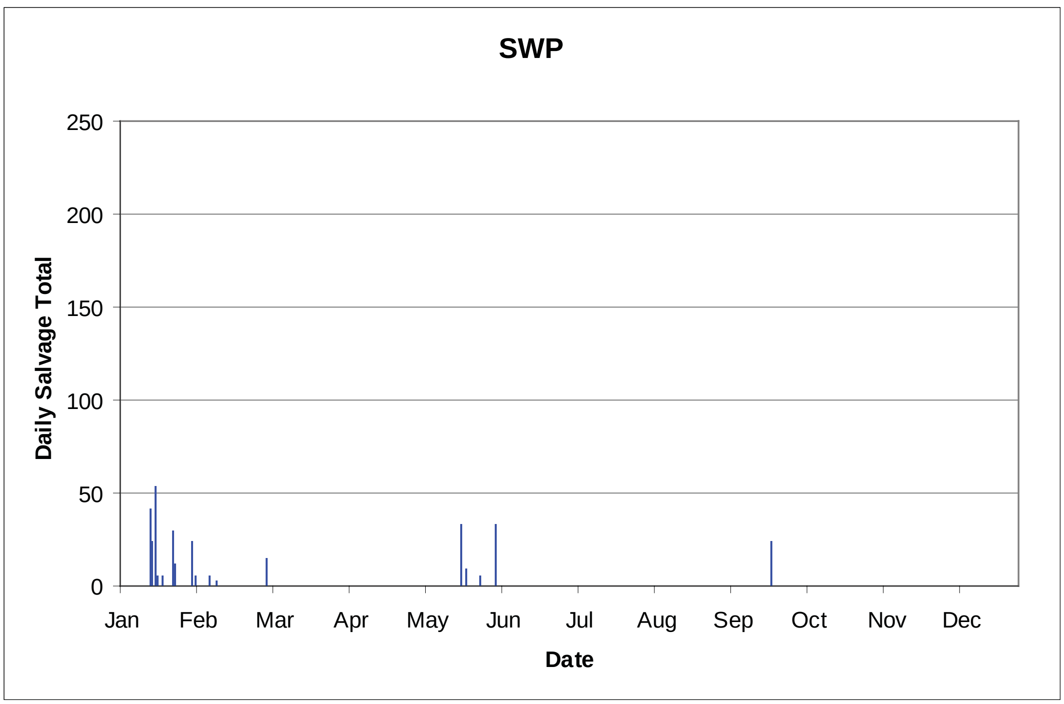
Like delta smelt, longfin smelt spawn adhesive eggs in river channels of the eastern estuary, and after hatching their larvae are carried downstream (planktonic drift) to nursery areas by freshwater outflow. In contrast to delta smelt, longfin smelt juveniles and adults are broadly distributed and inhabit the more saline regions of the Bay-Delta estuary and nearshore coastal waters. During non-spawning periods longfin smelt are most often concentrated in Suisun, San Pablo, and North San Francisco Bay (Baxter, 1999; Moyle, 2002). The easternmost catch of longfin smelt in FMWT samples has been at Medford Island in the central Delta. A measurable portion of the longfin smelt population consistently survives into a second year. During the second year of life, the adult longfin smelt inhabit San Francisco Bay and occasionally have been found in nearshore ocean surveys (Rosenfield and Baxter, 2007). Therefore, longfin smelt are often considered anadromous (SWRCB, 1999).

Factors Affecting Longfin Smelt Populations

Longfin smelt were once one of the most common fish in the Delta. Their abundance has fluctuated widely in the past, but, since 1982, abundance has declined significantly, reaching its lowest levels during drought years. Longfin abundance indices, although variable, show a general pattern of declining abundance between 1967 and 2007. Longfin smelt are among the POD species showing a substantial decline in abundance in recent years. The causes of decline are likely multiple and synergistic (Armor et al., 2006), including:

- Reduction in Delta outflows during the late winter and spring
- Entrainment losses to water diversions
- Reduced spawning and rearing habitat
- Reduced food (prey) availability thought to be the result of reduced primary production due, in part, to a reduction in seasonally-inundated wetlands, competition for food resources with non-native fish and macroinvertebrates (e.g., filter feeding by the non-native Asian overbite clam Corbula), and competition among native and non-native zooplankton species
- Climatic variation
- Exposure to toxic substances, however no known direct link exists between chemical concentration and larval mortality (Resources Agency, 2007)
- Predation, and introduced species (SWRCB, 1999)





SOURCE: DFG, 2005; Central Valley Bay-Delta Branch Fish Salvage Monitoring (http://www.delta.dfg.ca.gov/Data/Salvage/); and ESA, 2007

Figure 4.3-8
2004 Seasonal (Daily) Distribution of Longfin Smelt in CVP and SWP Fish Salvage Operations

Regulatory Listing Status

Longfin smelt is ~~a federal species of concern and~~ a CESA ~~candidate~~ threatened species. In August 2007, USFWS was petitioned to list longfin smelt as endangered. On May 6, 2008, USFWS found that the listing may be warranted and initiated a status review to determine if listing this species is in fact warranted. On April 9, 2009, the USFWS determined that the Bay-Delta population did not meet the legal criteria for protection as a species subpopulation under the FESA. The USFWS simultaneously announced that it is seeking additional information for a broader assessment of the longfin smelt that could lead to future action, although no decision can be made before reviewing any new information.

On February 7, 2008 the California Fish and Game Commission accepted a petition to list longfin smelt under CESA. Following ~~, thus initiating a~~ the 1-year status review period, the California Fish and Game Commission listed the status of longfin smelt as threatened under the CESA on June 26, 2009.~~after which the Commission will determine if listing is warranted. Under CESA, candidate species have the same level of protections against take as listed species until a final ruling is made regarding listing the species.~~

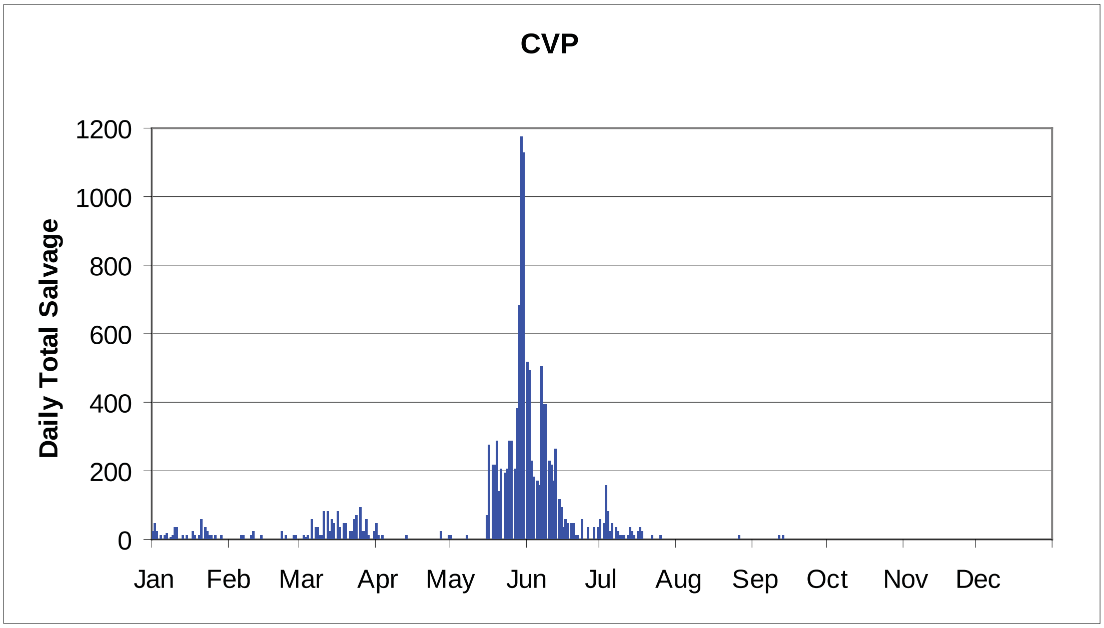
Given the current petitions and biological reviews of the status of the species under ~~both~~ FESA ~~and CESA~~ longfin smelt may become a federally ~~and/or state~~ listed species by the time any of the project alternatives is implemented.

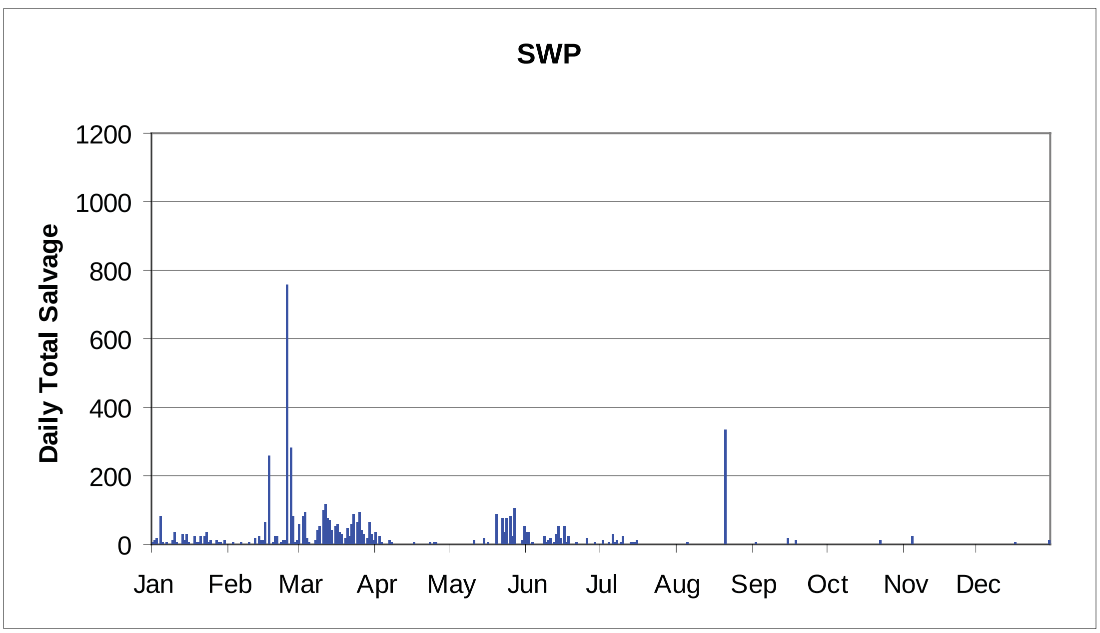
Sacramento Splittail

Sacramento splittail is a large minnow endemic to the Bay-Delta estuary. Splittail are well adapted for living in estuarine waters with fluctuating salinity conditions. Adults and sub-adults have an unusually high tolerance for saline waters up to 18 parts per thousand, for a member of the minnow family. The species is relatively long-lived (5 to 7 years), and matures at the end of the first year (males) or third year (females). As is typical of a fish species evolved in a highly variable riverine system, juvenile abundance fluctuates annually depending on spawning success.

Life History of Sacramento Splittail

Spawning, which seems to be triggered by increasing water temperatures and day length, occurs from February through July in the Delta, upstream tributaries, Napa Marsh, Napa and Petaluma Rivers, Suisun Bay and Marsh, and the Sutter and Yolo bypasses (Baxter et al., 1996; Meng and Moyle, 1995; Sommer et al., 1997). Spawning, egg incubation, and juvenile rearing occur primarily in seasonally inundated floodplains on submerged vegetation. Juvenile splittail may occur in shallow and open waters of the Delta and Suisun Bay, but are most abundant in the northern and western Delta (Sommer et al., 2001). Adults migrate upstream to spawn during high flows that inundate floodplain spawning habitat. This habitat consists of vegetation temporarily submerged by flooding of riparian and upland habitats. The seasonal occurrence of juvenile splittail in CVP and SWP fish salvage (**Figure 4.3-9**) is representative of the periods when juvenile splittail would potentially inhabit the region of the south Delta in the vicinity of the Old River, Rock Slough and AIP intake structures and the new Delta Intake structure. Observations on the seasonal occurrence of juvenile splittail at the SWP and CVP fish salvage facilities are consistent with results of fishery surveys conducted throughout the estuary (e.g., USFWS beach seine survey).





SOURCE: DFG, 2005; Central Valley Bay-Delta Branch Fish Salvage Monitoring (http://www.delta.dfg.ca.gov/Data/Salvage/); and ESA, 2007

Figure 4.3-9
2004 Seasonal (Daily) Distribution of Juvenile and Subadult Splittail in CVP and SWP Fish Salvage Operations

Young-of-the-year splittail abundance appears to fluctuate widely from year to year. Young splittail abundance declined substantially during the 1987 to 1992 drought (Baxter et al., 1996). In recent years, indices of juvenile splittail abundance have continued to fluctuate substantially among years (Sommer et al., 1997). In contrast to young splittail, adult abundance showed no obvious decline during the 1987 to 1992 drought (Sommer et al., 1997). The species' long lifespan and multiple year classes moderate adult population variation.

Factors Affecting Sacramento Splittail Populations

Once found throughout low-elevation lakes and rivers of the Central Valley from Redding to Fresno, this native species now occurs in the lower reaches of the Sacramento and San Joaquin Rivers and tributaries, Suisun and Napa Marshes, the Sutter and Yolo bypasses, and the tributaries of north San Pablo Bay. Environmental factors affecting splittail abundance include, but are not limited to:

- Dams, diversions, levee construction and reclamation, and agricultural development have eliminated or altered much of the lowland floodplain habitat that provides spawning and rearing habitat
- Changes in the seasonal timing and magnitude of freshwater inflow to the Delta and outflow from the Delta
- Entrainment of larval and juvenile splittail into a large number of unscreened water diversions (primary agricultural) throughout the Delta
- Entrainment and salvage mortality at the CVP and SWP water export facilities
- The introduction of non-native invasive plant species such as water hyacinth and Brazilian waterweed have altered habitat by raising temperatures, reducing turbidity and dissolved oxygen, and inhibiting access to shallow water habitat (CDFG, 2002)
- Predation by striped bass, largemouth bass, and a number of other fish species inhabiting the estuary has also been identified as a source of mortality for splittail
- Exposure to toxic substances resulting in direct or indirect affects
- Variation in the quality and availability of low-salinity habitat within the Delta and Suisun Bay, in response to seasonal and interannual variability in hydrologic conditions within the Delta Reduced food (prey) availability thought to be the result of reduced primary production due, in part, to a reduction in seasonally-inundated wetlands, competition for food resources with non-native fish and macroinvertebrates (e.g., filter feeding by the non-native Asian overbite clam Corbula), and competition among native and non-native zooplankton species
- Harvest of adult splittail by recreational anglers (SWRCB, 1999)

Regulatory Listing Status

Sacramento splittail have no federal listing status. Splittail were listed as a threatened species under the FESA in 1999 and were delisted in 2003. Splittail are designated as California species of special concern.

River Lamprey

River lamprey is an anadromous species widely distributed along the Pacific coast from Northern California to Alaska.

Life History of River lamprey

River lamprey has been captured mostly in the upper portion of the Sacramento–San Joaquin estuary and its tributaries. Adults migrate from the ocean upstream into fresh water in fall and spawn during winter or spring in small tributary streams. The lifespan of river lamprey is about 6 or 7 years (Moyle, 2002). River lamprey ammocoetes (larvae) are morphologically similar to those of the Pacific lamprey. This similarity, coupled with their overlapping seasonal and geographic distributions, makes positive identification of ammocoetes very difficult. The ammocoetes, transforming adults, and newly transformed adults have been collected in plankton nets in Suisun Bay, Montezuma Slough, and Delta sloughs (CDFG unpublished data). The presence of river lamprey in collections made above dams, such as on upper Sonoma Creek, indicates that some river lamprey may spend their entire life in fresh water.

Factors Affecting River Lamprey Populations

River lamprey has become uncommon in California, and it is likely that the populations are declining because the Sacramento, San Joaquin, and Russian Rivers and their tributaries have been severely altered by dams, diversions, pollution, land use changes, and other factors. Two tributary streams where spawning has been recorded in the past (Sonoma and Cache Creeks) are both severely altered by channelization, urbanization, and other problems (Moyle, 2002).

Regulatory Listing Status

River lamprey is a federal species of concern and a California species of special concern.

Hardhead

Hardhead is typically found in undisturbed areas of larger middle- and low-elevation streams between the Pit River in the north and Kern River in the south and is widely distributed in streams of the Sacramento–San Joaquin drainage (Moyle, 2002).

Life History of Hardhead

Hardhead is a bottom feeder that forages for benthic invertebrates and aquatic plant material as well as drifting insects and algae. Hardhead mature after their second year and presumably spawn from May through June in Central Valley streams, although the spawning season is thought to extend into August in the foothill streams of the Sacramento–San Joaquin drainage (University of California Cooperative Extension, 2003). Occurrences of hardhead in the project area are rare, with only one specimen captured between 1976 and 2005 during USFWS beach seine surveys in Old River (USFWS, 2005).

Factors Affecting Hardhead Populations

For their long-term survival, hardhead require large to medium sized, cool to warm-water streams with natural flow regimes. Because such streams are increasingly dammed and diverted—thus eliminating habitat, isolating upstream areas, or creating temperature and flow regimes unsuitable for hardhead—populations are declining or disappearing gradually throughout the species' range.

Regulatory Listing Status

Hardhead is a California species of special concern.

Pacific Smelt

Pacific smelt (*Thaleichyhys pacificus*), also commonly referred to as eulachon or candlefish, is a small (8–12 inch), planktivorous (feeding on zooplankton) fish species endemic to the northeast Pacific (northern California to Alaska). Pacific smelt are an anadromous species which spend the majority of their life in coastal marine waters but return to spawn primarily in the lower freshwater reaches of large rivers. In that portion of their range south of the US-Canadian border (Southern DPS proposed by Cowlitz Indian Tribe, 2007) the largest population spawns in the Columbia River and several of its major tributaries. Within California Pacific smelt have been reported to occur in several larger rivers including Humboldt Bay, Mad River, Redwood Creek, Russian River, and the Sacramento River (Cowlitz Indian Tribe, 2007; Moyle, 2002).

Life History of Pacific Smelt

Pacific smelt are an anadromous species within a life history similar to that of Pacific salmon. Pacific smelt spawn in freshwater near the upper extent of saltwater intrusion into a river. The smelt spawn over coarse sand or gravel substrate and typically adults die after spawning. Spawning typically occurs during the winter or early spring (December-May peaking in February-March; Moyle, 2002). Eggs are fertilized in the water column and the fertilized eggs slowly drift downstream and sink to the bottom where they adhere to the substrate. After hatching the larval smelt are planktonic drifting downstream into the estuary and nearshore coastal waters where they rear.

Pacific smelt typically spend 3 to 5 years in the marine environment (with a range from 2 to up to 9 years) before migrating upstream to spawn. Larval Pacific smelt imprint on the chemical olfactory signature of their natal river as juveniles, which allows adults to return to the natal stream to spawn.

Pacific smelt are preyed on by a variety of marine fish, birds, and marine mammals. Pacific smelt support both commercial and recreational fisheries in the Columbia River and further north. Commercial catch of Pacific smelt has declined substantially in recent years in the Columbia River basin, which is consistent with declines in other fishery surveys. Pacific smelt have not been reported in CDFG otter trawl and FMWT surveys or USFWS beach seine surveys conducted in the central or southern Delta. Other populations in California such as those inhabiting the Lower Klamath River, Mad River, and Redwood Creek have been extirpated (Cowlitz Indian Tribe, 2007).

Factors Affecting Pacific Smelt Populations

Factors that have been identified as affecting population abundance of Pacific smelt within the southern DPS described by the Cowlitz Indian Tribe (2007) include:

- Ocean rearing conditions and reduced productivity that result in reduced food availability (zooplankton abundance) associated with changes in ocean water temperatures and current patterns (e.g., El Nino events, Pacific Decadal Oscillation, upwelling)
- Climatic variation
- Modification of freshwater spawning habitat by dams, diversions, changes in hydrology, loss of gravel substrate and accumulation of fine sediments, increased water temperatures, and land use changes
- Exposure to pollutants
- Commercial and recreational harvest
- Predation mortality

Regulatory Listing Status

A petition to list Pacific smelt for protection under FESA was filed with NMFS in July 1999 to list the Columbia River smelt population. NMFS found in November 1999 that the listing petition failed to present substantial scientific information that the action was warranted. A second petition was filed with NMFS in November 2007 proposing that the population south of the Canadian border be listed as a DPS and receive protection under FESA. NMFS found that the petition was warranted and in March 2008 initiated a status review to determine whether the species or DPS warrants FESA listing. The status review is ongoing and no action has been taken on the federal listing decision. Pacific smelt is a California Species of Special Concern.

Northern Anchovy

Northern anchovy range from Cape San Lucas, Baja California to Queen Charlotte Island, British Columbia. Northern anchovy are one of the most prolific fish, in terms of numbers and biomass, along the northeastern coastal waters of the Pacific Ocean. There are three subpopulations, the northern subpopulation occurs in the estuary. This species can be the most abundant species in San Francisco Bay, constituting 85 percent of all fish. An individual anchovy can spawn two to three times a year. Post-larvae swim near the surface and are most abundant in San Francisco Bay and San Pablo Bay. As the salt wedge moves upstream within the estuary in the summer, anchovy larvae can be found in Suisun Bay and the western Delta. The juveniles use inshore bays and estuaries as their nursery ground, while adults are typically found in offshore waters. Given the typical salinity gradient in the Delta, it is highly unlikely that northern anchovy would be found in the vicinity of the Old River, Rock Slough and AIP intake structures, the new Delta Intake structure, or the SWP and CVP south Delta export facilities.

Northern anchovy is managed under the *Coastal Pelagic Species Fishery Management Plan*. EFH for this species has been designated within the project area.

Pacific Sardine

The Pacific sardine is a schooling pelagic species distributed from northern Mexico to southeastern Alaska. Each year, beginning in their second summer, sardines migrate northwards early in summer and travel south again in fall. They form large schools (up to 10 million individuals) and are often associated with anchovy. Main spawning areas are off the coast of Southern California. Like northern anchovy, there are three stocks of Pacific sardine, of which the northern stock enters the estuary. Given the typical salinity gradient in the Delta, it is highly unlikely that Pacific sardine would be found in the vicinity of the Old River, Rock Slough and AIP intake structures, the new Delta Intake structure, or the SWP and CVP south Delta export facilities.

Pacific sardine is managed under the *Coastal Pelagic Species Fishery Management Plan*. EFH for this species has been designated within the project area.

Starry Flounder

Starry flounder occur on the Pacific coast from Santa Barbara to Alaska. The species is found over sand, mud, and gravel bottoms in coastal ocean waters, bays, sloughs, and occasionally fresh water. Males spawn at the end of their second year and females in their third year. The spawning season extends from November through February, with the greatest activity in September-March (Moyle, 2002). Starry flounder is one of the most numerous fish in San Francisco Bay, but are relatively uncommon in the Delta. They may occur in the vicinity of the Old River, Rock Slough and AIP intake structures, the new Delta Intake structure, and the SWP and CVP south Delta export facilities.

Starry flounder is managed under the *Pacific Groundfish Fishery Management Plan*. EFH for this species has been designated within the project area.

Recreational Fisheries

The Delta supports regionally important recreational fisheries for a variety of resident and migratory fish. Recreationally important fish species harvested within the Delta include:

- **Chinook Salmon.** Fall run chinook salmon (previously described) support a recreational fishery within the Delta during the fall (October to December) when adult salmon are migrating from the ocean through the Delta into the upstream rivers to spawn. A ban on recreational fishing for chinook salmon was imposed in 2007 in response to the low numbers of returning adults.

- **Central Valley Steelhead.** Steelhead (previously described) support an inland recreational fishery for hatchery-produced steelhead within upstream rivers. No recreational fishing for steelhead occurs in the Delta.

- **Striped Bass.** Striped bass are a large anadromous non-native species introduced into the Delta in the late 1800s to support commercial and recreational fisheries. Commercial fishing for striped bass is no longer allowed; however, the species supports one of the largest recreational fisheries within the Delta. Striped bass begin spawning in the spring when the water temperature reaches 60°F, with most spawning occurring at temperatures between 61°F and 69°F, the spawning period usually extends from April to mid-June. Striped bass spawn in open fresh water, especially the Delta and lower San Joaquin River between the Antioch Bridge and the mouth of Middle River, and other channels in this vicinity. Another important spawning area is the Sacramento River between Sacramento and Princeton. About one-half to two-thirds of the eggs are spawned in the Sacramento River and the remainder are spawned in the Delta. Female striped bass usually spawn for the first time in their fourth or fifth year, when they are 21 to 25 inches long. Some males mature when they are 2 years old and only about 11 inches long. Most males are mature at age three and nearly all females at age five (CDFG, 2008a).

Adult striped bass abundance has decreased over the past several decades, from about 1.7 million in the early 1970s to about 1 million in the late 1970s and 1980s, then to about 625,000 in 1992 (CDFG, 2008b). CDFG has hypothesized that this trend can be largely explained by the detrimental effect on young bass production of increasing water exports and decreasing freshwater flow. Distribution of adult bass, based on tag recaptures by anglers, has changed substantially. Striped bass no longer make extensive use of San Francisco Bay and instead spend a greater part of the year in the Delta and other upstream areas. Summer use of nearby ocean waters may have increased also in recent years. Total mortality of adult striped bass has increased over the past decade due to an increase in natural mortality, while angling mortality has declined. Variations in adult abundance are correlated with the combination of the 38 mm young-of-the-year index and losses to water exports after the 38 mm index is set. The 38 mm index and subsequent export losses are both dependent on export rates and outflow, so that adult abundance is affected by exports and outflow throughout the year (CDFG, 2008b).

- **White Sturgeon.** White sturgeon are a popular recreationally harvested species, with the primary fishery downstream of the Delta in Suisun and San Pablo bays. Habitat requirements of white sturgeon are not well understood, but spawning and larval ecologies are probably similar to those of green sturgeon (previously described). White sturgeon are characterized by a large body size, large head and mouth, and long cylindrical body. The white sturgeon is a slow growing, late maturing anadromous fish. White sturgeon spawn in large rivers in the spring and summer months and remain in fresh water while young. Older juveniles and adults are commonly found in rivers, estuaries, and marine environments.

  Anadromous white sturgeon most commonly move into large rivers in the early spring, and spawn in May through June. Spawning usually takes place in rivers having a swift current with a rocky bottom, near rapids. White sturgeon can spawn multiple times during their life, and apparently spawn every 4 to 11 years as they grow and mature. Females can produce from 100,000 to several million eggs each. Older white sturgeon produce more eggs with longer intervals between spawns. Adults apparently broadcast spawn in the water column and the fertilized eggs sink and attach to the bottom where egg incubation takes place. Research shows that eggs can hatch in 4 days to 2 weeks, depending on water temperature. It has been estimated that white sturgeon reach maturity in 5 to 11 years.

  Because of their life history, geographic distribution, and large size, white sturgeon have a lower vulnerability to entrainment into water diversions than many of the other fish inhabiting the Delta. Seasonal hydrology within the rivers and estuary has been identified as factor affecting habitat conditions for white sturgeon.

- **Catfish.** A variety of species of catfish inhabit the Delta and are harvested in the local recreational fisheries. These species include black, brown, yellow, white, and channel catfish. These catfish (also referred to as bullhead) were primarily introduced into the Delta during the late 1800s from eastern watershed to support local recreational fisheries (Moyle, 2002). White catfish are among the more common species and are the most important catfish species harvested by recreational anglers within the Delta (before 1953 white catfish supported a commercial fishery within the Delta; Moyle, 2002).

Catfish typically inhabit areas characterized by lower water velocities (e.g., sluggish channels, sloughs, and backwaters) where turbidity is high and waters are relatively warm. Catfish inhabit areas of the Delta where salinity is low, because most species have a low salinity tolerance. Catfish feed on a variety of organisms including shrimp and other macroinvertebrates, clams, worms, and small fish. As a result of their life history and size, catfish are generally less vulnerable to entrainment at water diversions than many other fish. Hydrologic conditions within the Delta influence the geographic distribution of catfish, primarily through regional variation in salinity.

- **Largemouth (Black) Bass.** Over the past decade the Delta has become known as a world-class fishery for largemouth bass. Both northern and Florida strain largemouth bass have been introduced into the Delta (northern strain in the late 1800s and Florida strain in the 1960s) to support recreational fisheries. Largemouth bass typically inhabit areas of the Delta having relatively shallow water with associated emergent vegetation, submerged vegetation, or other cover and structures. Largemouth bass are abundant in habitat along major channels, sloughs, and backwaters with salinities less than about 3 parts per thousand (Moyle, 2002). Largemouth bass are a major predatory fish within the Delta. Juvenile and adult largemouth bass forage aggressively on crayfish, fish, and other organisms such as frogs. Largemouth spawn in the spring (April-June) in nests that are guarded by the adult until the fry emerge and begin feeding.

  Within the Delta there has been a growing popularity for largemouth bass recreational angling tournaments. Tournaments are held year-round with prizes awarded based on weight of individual bass and total weight of up to five bass. Tournament anglers are required to maintain the bass alive, which are then released back into the Delta after completing the weigh-in. The number of bass anglers, the number of tournaments, and the size of individual bass have all been increasing in recent years. Several of the recreational tournaments held recently in the Delta have been televised nationally (e.g., Bass Masters Invitational). As a result of their life history and size, largemouth bass are generally less vulnerable to entrainment at water diversions than many other fish. Hydrologic conditions within the Delta influence the geographic distribution of catfish, primarily through regional variation in salinity.

- **Other Popular Sportfish.** The Bay-Delta estuary supports a number of other fish species that are harvested by recreational anglers. The majority of these species, such as Pacific halibut, surfperch, flounder and sole, inhabit the more saline regions of the estuary including San Pablo and San Francisco bays. As a result of the low salinities that occur year-round in the south Delta these species are rare or absent in the vicinity of the Old River, Rock Slough and AIP intake structures, the new Delta Intake structure, and the SWP and CVP south Delta export facilities.

Recreational fishing in the Delta includes shore, small-craft, and charter-boat fishing. A brief description of these fisheries is provided below.

Shore Fishing

Shore fishing is conducted throughout the Delta, including along many of the levees bordering the river channels. Shore anglers primarily target species such as striped bass, catfish, and sturgeon. Anglers fish from levees and several public and private access locations.

Small-Boat Fishing

Recreational angling from small boats (e.g., 12 to 40 feet) is common throughout the Delta. The majority of angling occurs on weekends from April through October or November. There are public boat launches and a number of marinas within the Delta in the general vicinity of Old River. Several hundred small boats may launch at the marinas in the area on a weekend day, depending on the time of year and the weather, to fish within the Delta channels. Although small-boat angling occurs throughout the year, peak months for recreational fishing are April, May, and June, when target species are striped bass, largemouth bass, and catfish. Many of the recreational anglers fishing within the central Delta participate in local bass tournaments.

Charter-Boat Fishing

As many as 50 commercial party boats operate out of the Bay-Delta ports, many of which are small six-passenger boats that operate seasonally. Many party boats are focused on salmon, rockfish, sanddab, Dungeness crab, and occasionally albacore tuna fishing outside the Golden Gate. Commercial party boats also target halibut, striped bass, and sturgeon in San Francisco Bay, Suisun Bay, and the Delta. Anglers on small charter boats fish within the central Delta, targeting species such as striped bass and sturgeon. Although party boats fish within the estuary throughout the year, the peak months for fishing are April, May, and June, when striped bass are most abundant.

4.3.2 Environmental Consequences

The impact analysis focuses on the Delta fishery and aquatic resources that could be present in the project area. Potential impacts to other project area aquatic habitats such as Kellogg Creek, Brushy Creek, and several unnamed drainages, as well as Los Vaqueros Reservoir, are covered under Section 4.5, Local Hydrology, Drainage, and Groundwater (Vol. 1), and Section 4.6, Biological Resources (Vol. 2). Potential impacts on recreational fishing during construction of an expanded Los Vaqueros Reservoir are discussed in Section 4.15, Recreation (Vol. 2).

Methodology

An impact assessment of fisheries and aquatic resources was performed to evaluate the potential effects of the project alternatives. The effects were based on consideration of:

- Construction activities at the new Delta Intake site and the surrounding area expected to be disturbed
- Existing habitat conditions in the project area in the south Delta
- Known or presumed occurrence of special-status species near the Old River Intake, Rock Slough and AIP Intakes, the new Delta Intake and the SWP and CVP export facilities
- The results of hydrologic and particle tracking modeling combined with biological information such as the efficiency of positive barrier fish screens at project intakes, and the historical distribution and density of important fish species, to evaluate changes in regional habitat conditions within the Delta in response to changes in hydrodynamics and changes in fish entrainment potential associated with the project alternatives

Additional information regarding the data, assumptions, and methods used to evaluate potential effects of operational alternatives for the Los Vaqueros Reservoir Expansion project is presented in Appendix C7 (Vol. 4).

The potential construction- and operation-related effects are discussed with regards to the Delta fishery resources as a whole. However, some species-specific effects are discussed separately where appropriate. Information on the seasonal timing of occurrence of various resident and migratory fish in the project area is also used to assess the potential for adverse impacts on various fish species.

The fish species identified as potentially occurring in the project area have different life histories, habitat requirements, and differing abilities to avoid or withstand potentially adverse conditions. Results of biological monitoring and experimental investigations have shown that certain fish species, such as delta smelt, are more sensitive than other species to changes in environmental conditions that may arise as a result of intake structure construction (e.g., exposure to suspended sediments) and operations (e.g., increased vulnerability of larvae to entrainment, changes in hydrodynamics that affect habitat conditions, etc.). Relative to delta smelt, juvenile chinook salmon have greater tolerance to suspended sediments, are more likely to be excluded due to their larger size at small-mesh screens, and are better able to avoid impingement on a fish screen due to stronger swimming performance. Other resident fish species within the project area such as striped bass, largemouth bass, and catfish also have substantially greater tolerance to changes in various conditions when compared to more sensitive species. To be most protective of the fishery, the assessment of potential for adverse impacts and the development of avoidance and mitigation measures, where necessary, has been based on information for the species determined to have the highest level of sensitivity to potential changes in conditions caused by the project.

The impact analysis presented discusses both: (1) potential short-term impacts associated with construction activities, and (2) potential long-term impacts associated with facility operations. The issues and considerations involved in evaluation of the long-term operational impacts are described in more detail below. The analysis evaluates the potential direct, indirect, and cumulative impacts on fisheries and aquatic resources resulting from implementation of the project. Cumulative impacts are embodied in the analysis of hydrologic modeling of future conditions, which assesses the overall impacts of the project alternatives in light of projected 2030 levels of demand, and planned changes or additions to water resources infrastructure (as discussed in Vol. 1, Section 4.1), and therefore are included in analyses conducted for future conditions.

Operational Considerations for Potential Long-Term Impacts

The operational considerations for the evaluation of potential long-term impacts are changes in the seasonal timing and magnitude of water diversions from the Delta under all alternatives and the addition of a new diversion location with the new Delta Intake under Alternatives 1 and 2. These changes may affect aquatic species directly through changes in entrainment and/or impingement, or indirectly through changes in hydrologic conditions and aquatic habitat.

The evaluation of potential fishery and aquatic resource impacts due to project operations is based, in part, on the hydrologic modeling results describing water diversion operations over a range of environmental and hydrologic conditions (see Appendix C (Vol. 4) for details on the modeling methodology and results). Hydrologic modeling results provide the foundation for assessing effects of diversion operations on fish species and their habitat within the Bay-Delta estuary. The assessment relies on a comparative analysis of operational and environmental conditions within the estuary under without project conditions and with the project alternatives (including both 2005 and 2030 levels of development). Modeling output that was evaluated as part of the fisheries analysis includes:

- Water export operations at the SWP Banks Pumping Plant and CVP Jones Pumping Plant, as well as diversions at the Rock Slough ~~Intake~~, Old River and AIP Intakes, and new Delta Intake
- Hydrologic conditions in the Delta, such as total Delta inflow and outflow, flows within Old and Middle Rivers, flows within the lower San Joaquin River (Qwest), and the location of the 2 parts per thousand salinity isohaline also known as X2
- The effects of hydrologic conditions and intake operations on larval and planktonic assemblages as reflected by particle tracking model (PTM) simulations

An overview of the tools used to measure the indirect and direct effects of project operations is provided in the discussion below. A more detailed presentation of the individual metrics and their biological significance is provided under the discussion of each potential impact.

Indirect Effects Assessment

Indirect effects of project operations on hydrologic and aquatic habitat conditions were examined during specific times of the year when sensitive fish species and their vulnerable life stages have been shown to be present within the Delta. Potential effects on fish populations were measured using a number of different parameters that have been shown to be, or are thought to be, significant factors that affect habitat conditions and the reproduction of various fish and macroinvertebrate species inhabiting the Bay-Delta estuary. These include habitat parameters such as the location of X2, flow factors such as net Delta outflow and net flow on the lower San Joaquin River, salinity in the interior Delta (described in Vol. 4, Chapter 5, Section 5.3, Updates to Section 4.2, Delta Hydrology and Water Quality), river flows upstream of the Delta, and circulation within the Delta.

The model tools used in this assessment included the statewide operations model (CalSim II), the Delta hydrodynamic model (DSM2), and a particle tracking model (PTM). CalSim II and DSM2 are discussed in Vol. 4, Chapter 5, Section 5.3, Updates to Section 4.2, Delta Hydrology and Water Quality, and in Appendix C2 and Appendix C3 (Vol. 4). The particle tracking model is discussed in Appendix C7 (Vol. 4). Consideration in the analysis was also given to changes in Delta habitat conditions reflecting a range of hydrologic conditions (e.g., wet or dry water years) within the Central Valley.

Additional information on the parameters used to assess indirect effects and a summary of the results is presented under Impact 4.3.6, with additional details presented in Appendix C7 (Vol. 4).

Direct Effects Assessment

The assessment of direct effects involved a determination of changes in potential entrainment and impingement of various fish species at Delta intakes. ~~Three~~Two analyses were performed. The analyses were complementary as each analysis alone had its own distinct assumptions and limitations. The analyses and methods are summarized below with additional details in Appendix C7 (Vol. 4).

The first analytical method estimated fish entrainment potential by using historical field survey data for ~~a number of~~ fish species monitored in the vicinity of the Rock Slough ~~Intake~~, Old River and AIP intakes, the new Delta Intake, and the CVP and SWP export facilities. Indices of potential fish entrainment for each month of the year were developed by multiplying the average monthly fish density near an intake (fish per acre-foot) by the volume of water diverted at each intake location for that month (acre-foot per month). Average fish densities are based on fishery monitoring conducted between 1995 and 2007, as described below and in Appendix C7 (Vol. 4). Monthly pumping volumes are determined through CalSim II modeling for each alternative being evaluated.

The second method used the same PTM tool described under the indirect effects assessment, simulating a release of particles at various locations within the Delta that are either known to represent important fish habitat or important hydrologic locations. For the assessment of direct effects of entrainment, particles were tracked and counted when they entered Delta water intakes (e.g., the Rock Slough Intake, Old River and AIP Intakes, and new Delta Intake, the SWP or CVP export facilities, or agricultural intakes). Because the particles simulated in the model are neutrally buoyant (and therefore have no swimming behavior or other independent movement), results of these analyses are most relevant to the planktonic early larval stages of various organisms such as larval delta smelt that do not move independently in the water column. The particles are not considered to reflect the movement or entrainment of juvenile or adult fish, such as chinook salmon, steelhead, or sturgeon within the Delta. Additionally, PTM does not account for the efficiency of various fish screens. Consideration of these limitations is applied post-simulation during interpretation of the PTM results with respect to the entrainment risk for various fish species and lifestages included in the analysis.

~~A third method involves comparison of net flows in Old and Middle River. Limits on net flow in Old and Middle River are being used as a control mechanism in the interim order by Judge Wanger in *NRDC v. Kempthorne* to reduce the potential for entrainment of delta smelt at the CVP and SWP export facilities. Two approaches were used to evaluate effects on net flow Old and Middle rivers. One approach was to calculate the value of net Old and Middle river flows based on hydrologic and hydrodynamic modeling; this analysis is presented as part of the indirect effects assessment discussed above. The other approach uses a flow index that has been correlated to pre-spawning adult delta smelt salvage at the CVP and SWP export facilities in the southern Delta during the winter months. This method is similar to the measured value of Old and Middle River net flow; however, because this method correlates diversions at the export facilities with salvage at the export facilities, it is a direct method to examine potential entrainment.~~

These analytical methods were used to evaluate the benefits and impacts of the Los Vaqueros Reservoir Expansion Project on Delta fisheries under a range of project operations. Each of the methods used for evaluating fishery effects provides useful information, but each method also has limitations; the

~~suite of~~ methods were used together to develop a comprehensive understanding of project impacts and benefits. The analyses universally show that the project (Alternatives 1, 2 and 4) has no adverse impacts on fish, and provides a range of benefits for fish, including changing the timing of water diversions, improvement in flow conditions, temperature, or other benefits that contribute to restoration of aquatic ecosystems and native fish and wildlife. The actual level of benefits achieved would ultimately depend on the project alternative selected and its final permits, including federal and state endangered species act permits, and any other requirements under state or federal law.

A third method of analysis was used in the Draft EIS/EIR to assess direct effects of potential entrainment by calculating a flow index based on a correlation between diversions at the CVP and SWP export facilities in the south Delta with fish salvage at these facilities, based on a relationship presented in *NRDC v. Kempthorne* to address the effects of OMR net flow. This method was not used in the Final EIS/EIR analysis, because the calculation of OMR net flow in the Final EIS/EIR analysis has been updated to reflect the terms of the OCAP BOs. This update allows direct analysis of OMR net flow within the CalSim II model according to the terms of the OCAP BOs, and makes the third method of analysis for direct entrainment unnecessary.

Additional information on the~~se three~~ two methods used to assess direct effects of potential entrainment is presented under Impact 4.3.7, with additional details presented in Appendix C7 (Vol. 4).

Significance Criteria

The California Environmental Quality Act Guidelines, Section 15065, and Appendix G, the Council on Environmental Quality definition of "significant" (40 CFR 1508.27) and professional judgment indicate that the project alternatives would result in a significant impact on Delta fisheries and aquatic resources if it would do any of the following:

- Directly or indirectly reduce the growth, survival, reproductive success, or recovery of individuals of species listed or proposed for listing as threatened or endangered under CESA or FESA
- Directly or indirectly reduce the growth, survival, or reproductive success of substantial portions of candidate species populations, federal species of concern, state species of special concern, or regionally important commercial or game species
- Reduce the quality or quantity of important or unique habitat for fish species or their prey that would adversely affect the ability of the species to successfully reproduce and maintain self-sustaining populations
- Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites
- Conflict with the provisions of an adopted HCP, NCCP, or other approved local, regional, or state HCP.

The last criterion is not applicable here because, as discussed in Section 4.3.1 (Vol. 1), fish species are not covered in the East Contra Costa County HCP/NCCP and the CALFED Multi-Species

Conservation Strategy (MSCS) and related BOs and NCCPA determination are programmatic documents that do not provide coverage for the Los Vaqueros Reservoir Expansion Project or any specific CALFED actions. Rather, the MSCS provides the basis for preparing an Action Specific Implementation Plan that could be used to comply with federal and state Endangered Species Acts and the NCCPA.

Impact Summary

Table 4.3-4 provides a summary of the impact analysis for issues related to fisheries and aquatic resources based on actions and alternatives described in Chapter 3.

TABLE 4.3-4 (REVISED)*
SUMMARY OF IMPACTS – DELTA FISHERIES AND AQUATIC RESOURCES

	Project Alternatives			
Impact	**Alternative 1**	**Alternative 2**	**Alternative 3**	**Alternative 4**
4.3.1: In-channel construction activities associated with the new Delta Intake structure would increase short-term localized suspended sediment, turbidity, and possibly contaminant concentrations within Old River, which would increase exposure of various life stages and species of fish to temporarily degraded water quality conditions.	LSM	LSM	NI	NI
4.3.2: Underwater sound-pressure levels generated during cofferdam installation for the new Delta Intake could result in behavioral avoidance or migration delays for special-status fish species.	LSM	LSM	NI	NI
4.3.3: Dewatering of the cofferdam for the new Delta Intake could result in stranding of fish.	LSM	LSM	NI	NI
4.3.4: The new Delta Intake structure and associated fish screens in Old River would physically exclude fish from a small area of existing aquatic habitat and modify existing aquatic habitat.	LSM	LSM	NI	NI
4.3.5: The new Delta Intake structure and associated fish screens in Old River would modify hydraulic conditions next to the intake structure, but would not disorient special-status fish or attract predatory fish.	LS	LS	NI	NI
4.3.6: Operation of the project alternatives would not result in changes to Delta hydrologic conditions that affect Delta fish populations or quality and quantity of aquatic habitat within the Sacramento-San Joaquin River system, including the Delta.	LS	LS	~~LS~~NA	LS
4.3.7: Operation of the new screened intake, or changes to diversions at existing intakes, could affect direct entrainment or impingement of fish	B	B	~~SU~~NA	LS
4.3.8: Fish screen maintenance activities would not significantly increase fish entrainment at the new Delta Intake or the expanded Old River Intake.	LS	LS	LS	NI
4.3.9: The project alternatives, when combined with other planned projects or projects under construction in the area, could cumulatively contribute to substantial adverse impacts to Delta fisheries and aquatic resources.	LSM	LSM	~~SU~~NA	LS

* Results presented in this table have been updated based on analysis for the Final EIS/EIR.

SU = Significant and Unavoidable
LSM = Less-than-Significant Impact with Mitigation
LS = Less-than-Significant Impact
NI = No Impact
B = Beneficial
NA = Potential for operational impacts of Alternative 3 are not analyzed in Final EIS/EIR analysis.

Impact Analysis

No Project/No Action Alternative

Under the No Project/No Action Alternative, no new facilities would be constructed and no existing facilities would be modified. CCWD operations in the near-term would be unchanged. To maintain supply reliability to its customers over time, CCWD would implement actions identified in its Future Water Supply Plan, including acquisition of water transfers as needed to provide reliable dry-year water supply. No increase in entrainment would occur at the CCWD intakes in the near term. However, under future levels of CCWD demand, there would be an expected increase in direct losses from these intakes.

CVP and SWP facilities and operations would not change in the near-term. CVP and SWP operations would be expected to change in the future in response to changes in future levels of demand, and also because of changes in infrastructure, as discussed in Section 4.1 (Vol. 1); however the modeling studies indicate very little change in operations under Future Without Project conditions compared to existing conditions. In the No Project/No Action alternative, CVP and SWP exports from the Delta continue to be made through their existing export facilities.

Impact 4.3.1: In-channel construction activities associated with the new Delta Intake structure would increase short-term localized suspended sediment, turbidity, and possibly contaminant concentrations within Old River, which would increase exposure of various life stages and species of fish to temporarily degraded water quality conditions. (Less than Significant with Mitigation for Alternatives 1 and 2; No Impact for Alternatives 3 and 4)

Alternative 1

New Delta intake In-Channel Construction Activities

Under Alternative 1, a new Delta Intake would be constructed on Old River, south of the existing Old River Intake and Pumping Station. The new Delta Intake would include a trapezoidal concrete water intake structure with state-of-the-art positive barrier fish screens. An inlet channel and wet well would be downstream from the intake structure that would include louvered baffles or other structures to fine-tune velocity distribution through the intake screen. The intake structure would also include a pumping plant, water conveyance pipelines, and other infrastructure. An earthen setback levee would be installed to provide protection during construction of the intake and maintain continuity of the road system along the dike after construction. This setback levee would be a permanent structure and would be designed to contain Old River should the existing levee fail beside the intake structure.

Geotechnical conditions at the intake site show that the intake facility would need to be supported on a foundation system such as driven concrete, steel piles, or stone columns. Preliminary analysis indicates that piles would be founded at an elevation of about -50 feet relative to mean sea level (msl) and spaced about 15 feet apart on a square grid. In addition to the piles, soil densification would likely be required beneath the intake structure and setback levee to reduce the liquefaction potential of the soil and to improve its lateral strength during seismic events. Preloading of the soils beneath the levee may also be required to reduce long-term settlement of the levee.

Most of the in-channel construction activities associated with the new Delta Intake would be conducted in a dewatered cofferdam and would be isolated from Old River. A cofferdam would be installed in Old River to isolate the work area from the water and provide a means to conduct construction work in a dewatered environment. After installation of the cofferdam, the water in the cofferdam enclosure would be treated (as necessary) and discharged back to Old River, and the remaining intake construction work would be conducted in the dewatered construction area.

Excavation would be required in Old River, in the immediate vicinity of the new Delta Intake in an area of about 2,400 square feet. The need for excavation as part of site preparations before intake construction would be determined during final design based on the results of field bathymetry and geotechnical survey data. Excavated materials at the cofferdam site would be transferred to the designated containment or disposal areas on the land side of the levee. An earthen dike or siltation fences would enclose the containment area(s). Retention of the excavated materials would promote settling of the suspended sediments. Any excess water (desilted supernatant) would be returned back into Old River.

Benefits of Cofferdam

The use of a cofferdam would substantially reduce or avoid potential construction-related adverse impacts on water quality and fishery habitat. The use of a cofferdam during construction of the new Delta Intake and positive barrier fish screen to isolate the construction site and activities from the adjacent aquatic habitats is an important element of the project design that avoids and minimizes potentially significant adverse impacts to aquatic species and habitats within the Delta.

Use of a cofferdam to isolate intake construction activity from aquatic habitat within the adjacent waters has proven in other similar projects (e.g., RD 108 Wilkins Slough fish screen, RD 108 Poundstone fish screen and pumping plant, Sutter Mutual Water Company Tisdale fish screen, and others) to be an effective method for minimizing and avoiding fishery impacts. For example, suspended sediment concentrations within the river are reduced during site excavation, the risk of chemical spills entering the river is reduced, and the potential exposure of fish to underwater sounds during pile driving and foundation supports are reduced by the containment within the cofferdam. In addition, construction of a fish screen and intake structure within a cofferdam improves the fit and finish of the intake (e.g., better alignment of screen panels within the intake, smoother intake surfaces, improved screen seals) that serve to improve the performance of the intake in protecting fish during operations.

Potential Water Quality Impacts to Fish of In-Channel Construction

Installation of the cofferdam and excavation as part of site preparation would result in temporary localized increases in turbidity and suspended sediment concentrations. A substantial body of scientific information exists regarding the response of juvenile and adult chinook salmon, steelhead, and other fish and macroinvertebrates to elevated suspended sediment concentrations and turbidity (Hanson et al., 2004). For example, reduced feeding activity was reported for adult chinook salmon exposed to suspended sediment concentrations of 25 milligrams per liter (mg/L) over a 4-hour exposure period (Phillips, 1970). A 50 percent mortality for juvenile chinook salmon was observed after a 36-hour exposure to volcanic ash at a concentration of 9,400 mg/L, however no mortality or apparent adverse affects was observed on adult chinook salmon after a 24-hour exposure to volcanic ash at a suspended sediment concentration in excess of 39,000 mg/L (Newcombe and Flagg, 1983).

The extensive body of information available with respect to suspended sediment and turbidity effects on various life stages of chinook salmon and many other fish and macroinvertebrate species was used to determine potential impacts on aquatic species inhabiting Old River and other areas within the estuary. The potential for adverse effects resulting from suspended sediment and/or turbidity depends on the magnitude of the concentration of sediments, the duration of exposure, the type of material, the species and life stage of the organism, and other factors (Hanson et al., 2004).

Based on the construction of cofferdams at other intake structures, the increase in exposure to suspended sediment concentrations is expected to be below levels reported in the literature to cause adverse effects. The potentially adverse effects would be temporary and localized, and limited to those occurring during installation of the cofferdam.

The area temporarily affected by sedimentation and turbidity caused by installation or removal of the cofferdam is expected to be about 500 feet wide and 500 feet long, varying in size and shape depending on tidal conditions and flow within the Old River channel. It has been conservatively assumed that construction activities could affect habitat up to 1,000 feet upstream or downstream of the new intake site on Old River. These effects would occur intermittently during the estimated 60-day period at the beginning of construction and during the specified work window, when construction activity could disturb sediments and increase turbidity during construction.

The in-water construction activity associated with site preparation and installation of the cofferdam would occur during the summer and early fall (August 1 through November 30). That timing is consistent with the seasonal work window identified by USFWS, NMFS, and CDFG for reducing the potential for significant adverse impacts to sensitive fishery resources within the Delta.

Gasoline, oil, grease, concrete, and a variety of other chemicals and substances would be used during construction of the project alternatives. Construction activities could result in a chemical spill that could have adverse effects on Delta fisheries and aquatic resources. In the event of such a spill, the use of a cofferdam would help to contain these types of substances during construction, thus reducing the potential risk of exposing species to these materials. Hazardous Materials Mitigation Measure 4.13-2 involves best management practices to keep hazardous materials from accidental release.

Fish Species Potentially Affected by Cofferdam Installation

The assessment of potential construction-related impacts resulting from suspended sediment exposure during cofferdam installation has been based on the following:

- Results of fishery monitoring by CDFG within the Delta;
- Results of SWP and CVP export salvage monitoring showing the seasonal occurrence of various fish species and lifestages within the south Delta in the vicinity of the cofferdam and intake structure during the August 1 to November 30 in-river work window;

- Information on the expected sensitivity of various fish to exposure to suspended sediments (Hanson et al., 2004) associated with cofferdam installation, and
- The localized and intermittent effects of cofferdam installation.

Results of the assessment are summarized below.

Sacramento River winter-run chinook salmon. Adult winter-run chinook salmon migrate upstream through the Delta during the winter and spring months (late November to June) and therefore would not be expected to occur in the project area during the work window. Juvenile winter-run salmon inhabit upstream rearing areas within the Sacramento River and typically migrate downstream through the Delta during the late winter and early spring (November to May). Although a potential exists for juvenile winter-run salmon to be in the Delta in November, these juveniles occur primarily in the Sacramento River and are not concentrated in the south Delta in the vicinity of the project site.

Central Valley spring-run chinook salmon. Adult spring-run salmon migrate upstream through the Delta during the late winter and spring months (March to July) and therefore would not be expected to occur in the project area during the work window. Juvenile spring-run salmon inhabit upstream rearing areas within the rivers and typically migrate downstream through the Delta during the late winter and early spring, but may occur in the Delta in low numbers beginning as early as mid-October. These juveniles occur primarily in the Sacramento River and are not concentrated in the south Delta in the vicinity of the project site.

Central Valley fall/late fall-run chinook salmon. Adult fall-run chinook salmon returning to the San Joaquin River system migrate upstream through the Delta during the fall (primarily September to December). These adult fall-run salmon would potentially occur in the vicinity of the project alternatives during the work window. Late fall-run adult salmon migrate upstream starting around November, and would potentially occur in the Delta during the later part of the work window, however, the late fall-run salmon migrate upstream into the Sacramento River and would not be expected to be abundant in the south Delta in the vicinity of the project area. Results of studies have shown that adult salmon have a high tolerance, especially for short duration, to elevated concentrations of suspended sediments. Juvenile fall-run and late fall-run salmon inhabit upstream rearing areas within the rivers and typically migrate downstream through the Delta during the late winter and spring; some late fall-run juveniles may migrate downstream as early as November.

Central Valley steelhead. Adult steelhead migrate upstream through the Delta during the late fall and winter months. Juvenile steelhead inhabit upstream rearing areas within the rivers and typically migrate downstream through the Delta during the late winter and early spring (January to May).

Delta smelt. Juvenile and pre-spawning adult delta smelt inhabit Suisun Bay and areas of the western Delta during the summer months where water temperatures are suitable. Water temperatures in the south Delta in the project area are within the range considered to be highly stressful and unsuitable for delta smelt during the summer. Delta smelt migrate into the interior Delta and upstream into the rivers beginning in the fall. Although delta smelt are widely distributed geographically during the fall, the potential exists that individuals would occur in the project area during the later part of the work window. The broad distribution of delta smelt in the fall, their tolerance to a wide range of suspended sediment concentrations that occur naturally within the Delta, and the localized and intermittent effects of cofferdam installation reduce the potential impact of cofferdam installation to less than significant.

North American green sturgeon. Juvenile and adult sturgeon may occur in the project area during the construction window. Sturgeon are widely dispersed throughout the Bay-Delta estuary during the summer and fall and are not concentrated in the project area. Sturgeon are tolerant of exposure to high levels of suspended sediments.

Longfin smelt. Longfin smelt inhabit more marine waters within San Francisco Bay and near-shore coastal habitat during the summer and fall and would not be expected to be affected by construction of the intake.

Sacramento splittail. Juvenile and adult splittail may occur in the project area during the construction window. Habitat conditions in Old River are generally poor for splittail given the high velocities, deep water, and lack of emergent vegetation. Splittail are expected to have a high tolerance to suspended sediments based on information for similar species and their natural habitat conditions.

River lamprey. Juvenile lamprey inhabit riverine areas upstream of the Delta during the summer and fall and would not be expected to occur in the project area. Adult lamprey migrate into freshwater in the fall (Moyle, 2002) and would potentially occur in the project area during the work window. No specific information was found regarding the tolerance of adult lamprey to suspended sediment concentrations; however, based on their life history and exposure to elevated suspended sediments within the rivers and Delta, it is expected that tolerance would be high.

Hardhead. Hardhead inhabit low velocity freshwater habitat upstream of the Delta and would not be expected to occur in the project vicinity during the summer and fall.

Pacific smelt. Pacific smelt inhabit marine coastal waters during the summer and fall and would not be expected to occur or be affected by construction of the intake.

Northern anchovy. Northern anchovy inhabit more marine waters within San Francisco Bay and near-shore coastal habitat during the summer and fall and would not be expected to be affected by construction of the intake.

Pacific sardine. Pacific sardine inhabit more marine waters within San Francisco Bay and near-shore coastal habitat during the summer and fall and would not be expected to be affected by construction of the intake.

Starry flounder. Starry flounder inhabit more marine waters within San Francisco Bay and near-shore coastal habitat during the summer and fall. Starry flounder are expected to have high tolerance to suspended sediments based on tolerance for similar flatfish.

Striped bass. Juvenile and adult striped bass may occur in the project area during the construction window. Striped bass are widely dispersed throughout the Bay-Delta estuary during the summer and fall and are not concentrated in the project area. Striped bass are tolerant of exposure to high levels of suspended sediments.

White sturgeon. Juvenile and adult white sturgeon may occur in the project area during the construction window. White sturgeon are widely dispersed throughout the Bay-Delta estuary during the summer and fall and are not concentrated in the project area. Sturgeon are tolerant of exposure to high levels of suspended sediments.

Catfish. Juvenile and adult catfish may occur in the project area during the construction window. Habitat conditions in Old River are generally poor for catfish given the river's high velocities. Catfish are tolerant of exposure to high levels of suspended sediments.

Largemouth bass. Juvenile and adult largemouth bass may occur in the project area during the construction window. Habitat conditions in Old River are generally poor for bass given the high velocities, deep water, and lack of emergent vegetation. Bass are tolerant of exposure to high levels of suspended sediments.

Other sportfish. Sportfish such as halibut, perch, flounder and sole inhabit more marine waters within San Francisco Bay and would not be expected to be affected by construction of the intake.

Alternative 1 Summary

Implementation of the cofferdam during construction would prevent extended exposure of fish in the river to the potentially adverse effects of excavation and intake construction. The potentially adverse effects would be temporary and localized, and limited to those occurring during installation of the cofferdam.

Based on monitoring during construction of other cofferdams, the increase in exposure to suspended sediment concentrations is expected to be below levels reported in the literature to cause adverse effects. Thus, the seasonal in-channel construction window and cofferdam that are part of Alternative 1 are likely to prevent any significant impact from sedimentation or turbidity to special-status or regionally important game fish species from Delta water quality effects caused by construction. Because, however, of the residual risk that would remain from sedimentation and turbidity, or from the possibility of a chemical spill that could escape the containment area, this impact would be significant without concurrent implementation of Mitigation Measure 4.3.1 described below.

Alternative 2

Potential water quality impacts on Delta fisheries and aquatic resources resulting from in-channel construction activities associated with the new Delta Intake under Alternative 2 would occur to the same extent as those discussed for Alternative 1. With implementation of Mitigation Measure 4.3.1 described below, the impact would be less than significant.

Alternative 3

Expanded Old River Intake and Pump Station

Under Alternative 3, the existing Old River Intake would be expanded to 320 cubic feet per second (cfs); the Old River intake structure would not need to be changed to allow for the capacity increase. Additional fish screens would be installed in existing bays, the existing automated fish screen cleaning system would be modified to accommodate the new screens, and additional baffles or screen panels would be installed if needed to achieve uniform velocities throughout the intake structure. All of the intake construction activities would occur within the existing footprint of the facility and no in-channel construction activities would be required at the Old River Intake and Pump Station to expand the capacity to 320 cfs. This is because the concrete structure for the additional intake capacity is already in place, and the expansion of the intake structure would involve replacement of existing solid plates with additional screens, which can be done from the existing facility without working in the river channel. Thus, no impacts to Delta fish species would occur due to construction.

Alternative 4

Under Alternative 4, no new Delta intake would be constructed and the existing Old River Intake would not be expanded. This alternative would not involve any in-channel construction activities. Thus, no impacts to fisheries resources and aquatic habitat from in-channel construction activities would occur under Alternative 4.

Mitigation Measures

Implementation of Hazardous Materials Mitigation Measure 4.13.2: This mitigation measure involves implementation of best management practices to keep hazardous materials from accidental release. See Section 4.13 (Vol. 2) for description of this measure.

Implementation of Hydrology Mitigation Measures 4.5.1a: This mitigation measure specifies preparation and implementation of a storm water pollution prevention plan. See Section 4.5 (Vol. 1) for description of this measure.

Measure 4.3.1: To minimize sediment, turbidity, and contaminants in Old River during construction of the new Delta Intake (primarily excavation and cofferdam installation), CCWD or its contractors will obtain and comply with RWQCB Section 401 water quality certification, CDFG streambed alteration agreement, USACE Clean Water Act Section 404 permit, as needed, and adhere to the following requirements:

- Monitor periods of construction activity and coordinate with the contractor to identify periods when localized increases in turbidity may occur.

- Install a silt curtain to reduce the dissipation of suspended sediments during dredging and cofferdam installation.
- Ensure that cofferdam(s) installation occurs during the designated construction window of August 1 through November 30 to avoid the potential risk of adverse impacts on chinook salmon, steelhead, delta smelt, and other aquatic species which are more abundant in the area during fall, winter, and spring. This construction window may be shifted through consultation with USFWS, NMFS, and CDFG if the best available fish survey data indicate that a different construction window for cofferdam installation will avoid or minimize effects on special-status species.
- Minimize substrate disturbance during construction activities.
- Ensure project construction activities will not cause significant turbidity increases in surface waters, as follows:
  - Where natural turbidity is between 0 and 5 Nephelometric Turbidity Units (NTU), increases will not exceed 1 NTU.
  - Where natural turbidity is between 5 and 50 NTU, increases will not exceed 20 percent.
  - Where natural turbidity is between 50 and 100 NTU, increase will not exceed 10 NTU.
  - Where natural turbidity is greater than 100 NTU, increases will not exceed 10 percent.

  These limits will be eased during in-water working periods to allow a turbidity increase of 15 NTU over background turbidity as measured in surface waters 300 feet downstream from the working area. In determining compliance with the above limits, appropriate averaging periods may be applied, provided that Delta fisheries and aquatic resources would be fully protected.
- Ensure project construction activities will not cause settleable matter to exceed 0.1 milliliters per liter in surface waters, as measured in surface waters 300 feet downstream from the project.
- In the event that project construction activities create a visible plume in surface waters, initiate monitoring of turbidity levels at the discharge site and 300 feet downstream, taking grab samples for analysis of NTU levels twice per day during the work period while the visible plume persists.
- Notify the RWQCB, CDFG, USFWS, and NMFS if the above criteria for turbidity are exceeded.
- Notify the RWQCB, CDFG, USFWS, and NMFS of any spill of petroleum products, oil/grease, or other organic or earthen materials.
- If the required permits from RWQCB, CDFG, USFWS or NMFS include conditions equivalent to any mitigation measure set forth above, substitute the permit condition for the equivalent mitigation measure.

The updates to the modeling analysis of potential operational impacts of the project alternatives did not require re-analyzing Impact 4.3.1. The conclusions regarding this potential impact have not changed from those presented in the Draft EIS/EIR.

Impact Significance after Mitigation: Less than Significant.

Impact 4.3.2: Underwater sound-pressure levels generated during cofferdam installation for the new Delta Intake could result in behavioral avoidance or migration delays for special-status fish species. (Less than Significant with Mitigation for Alternative 1 and 2; No Impact for Alternatives 3 and 4)

Alternative 1

Installation of the cofferdam for construction of the new Delta Intake would be performed using a vibration hammer, a percussion hammer, or both, depending on substrate conditions. Observations during construction of the Bay Bridge and other projects within the Bay-Delta estuary that involve pile driving have shown adverse effects, including fish kills, resulting from pile driving when underwater sound pressure levels are high. Information obtained from the scientific literature and through field observations at other construction sites within the Bay-Delta estuary indicates that exposure of fish species to underwater sound-pressure levels exceeding about 180 decibels (dB) may result in sublethal or lethal effects. Exposure of fish to underwater sound-pressure levels exceeding about 160 dB may result in behavioral avoidance or migration delays.

Cofferdam installation using percussion hammers and, to a lesser degree, vibrational hammers create underwater sound pressure levels that may adversely affect fish species. Fish may be injured or killed by the impact sounds generated by percussive pile driving. Their hearing may also be affected or their behavior altered such that it constitutes harassment or harm. The specific effects of underwater sound pressures on fish depend on a wide range of factors including the type of hammer, fish species, environmental setting, and many other factors (Popper et al., 2006).

The loss of hearing sensitivity may adversely affect a salmonid’s ability to orient itself (due to vestibular damage), detect predators, locate prey, or sense their acoustic environment (NMFS, 2006). Fish also may exhibit noise-induced avoidance behavior that causes them to move into less-suitable habitat. During cofferdam installation activities for the new Delta intake component of the project alternatives, this may result in salmonids fleeing the project area. Likewise, chronic noise exposure can reduce their ability to detect piscine predators, either by reducing the sensitivity of the auditory response in the exposed salmonid or by masking the noise of an approaching predator. Disruption of the exposed salmonid’s ability to maintain position or swim with the school may enhance its potential as a target for predators. Non-salmonid special-status species, including delta smelt, are likely affected in similar manners.

Because Old River serves as a migration corridor for juvenile and adult chinook salmon migrating to and from San Joaquin River tributaries, and also serves as seasonal habitat for delta smelt and other resident and migratory fish, underwater sound pressures generated during cofferdam installation could adversely affect special-status fish species. Winter-run chinook salmon, spring-run salmon, fall-run and late fall-run salmon, steelhead, green sturgeon, longfin smelt, splittail, and lamprey are most abundant in the south Delta in the vicinity of the project alternatives during the late fall, winter, and spring. Limiting pile driving and installation of the cofferdam to the summer and early fall would reduce and avoid potential impacts to these special-status species.

Many of the other special-status species and recreationally important species, such as hardhead, Pacific smelt, northern anchovy, Pacific sardine, starry flounder, halibut, perch, flounder, and sole occur rarely in the Delta (habitats for these species are either upstream or downstream of the Delta) and would not be expected to significantly impacted by project construction. Several of the species supporting recreational angling, such as striped bass, catfish, and largemouth bass are present, but widely distributed, in the Delta throughout the year.

Limiting the seasonal period of in-water construction activity such as installation of the cofferdam to the summer and early fall (August 1 through November 30) serves to reduce the potential for adverse impacts to sensitive fish species such as juvenile chinook salmon, steelhead, delta smelt and longfin smelt, resulting from exposure to underwater sound pressure levels. Many other fish species are resident within the south Delta year-round and would potentially be adversely impacted by elevated underwater sound pressure levels from cofferdam installation. This would be a significant impact without concurrent implementation of mitigation measure 4.3.2, described below.

Alternative 2

The potential impact on Delta fisheries and aquatic resources resulting from underwater sound pressures from cofferdam installation for the new Delta Intake under Alternative 2 would be the same as that discussed for Alternative 1. This would be a significant impact without concurrent implementation of mitigation measure 4.3.2, described below.

Alternative 3

Alternative 3 entails installation of new fish screens into existing bays at the Old River Intake, but does not require in-channel work, or the associated installation of a cofferdam. Thus, no underwater sound pressure impacts to fisheries resources would occur under Alternative 3.

Alternative 4

Under Alternative 4, no new Delta intake would be constructed on Old River and the existing Old River Intake and Pump Station capacity would not be expanded. There would be no in-channel construction activities. Thus, no underwater sound pressure impacts to fisheries resources would occur.

Mitigation Measures

Measure 4.3.2: As discussed in Mitigation Measure 4.3.1, construction of the cofferdam for the new Delta Intake will be limited to the seasonal period between August 1 and November 30. This measure will also help avoid potential impacts to special-status fish species due to underwater sound pressure levels generated during coffer dam installation.

To further reduce and avoid impacts to resident fish present in the south Delta in the immediate vicinity, the cofferdam would be installed using a vibration hammer that minimizes underwater sound pressure levels.

If it is determined that a higher intensity percussion hammer would be required for installing the cofferdam, underwater sound pressure level monitoring would be performed by an acoustic expert to document sound pressure levels during cofferdam construction. Limiting construction related underwater sound pressure levels during cofferdam installation to less than 160 dB would reduce potential fishery impacts to a less-than-significant level. If monitoring indicates higher sound pressure levels than 160 dB, in-water construction activity would be suspended and avoidance of potential adverse effects would be achieved by consulting with USFWS, NMFS, and CDFG to determine and implement the appropriate actions, which would include one or more of the following:

- Surveying Old River at the intake site to determine fish presence before installation, and modifying the work window accordingly;
- Use of an air bubble curtain to deflect and absorb sound pressure;
- Use of lower intensity underwater sounds to repel fish from the immediate construction area before use of a high-pressure hammer;
- Limiting the duration and frequency of high-pressure underwater sound levels during cofferdam installation.

The updates to the modeling analysis of potential operational impacts of the project alternatives did not require re-analyzing Impact 4.3.2. The conclusions regarding this potential impact have not changed from those presented in the Draft EIS/EIR.

Impact Significance after Mitigation: Less than Significant.

Impact 4.3.3: Dewatering of the cofferdam for the new Delta Intake could result in stranding of fish. (Less than Significant with Mitigation for Alternatives 1 and 2; No Impact for Alternatives 3 and 4)

Alternative 1

Dewatering of the cofferdam for intake and fish screen construction activities at the new Delta Intake has the potential to strand fish and macroinvertebrates during the dewatering process. As water is lowered from the pool behind the cofferdam, the trapped fish and macroinvertebrates have no opportunity to escape. Without mitigation measures, all aquatic fish and most macroinvertebrates would be stranded and fish mortality would be 100 percent. This would be a significant impact without concurrent implementation of Mitigation Measure 4.3.3, described below.

Alternative 2

Potential impacts on Delta fisheries and aquatic resources resulting from stranding during cofferdam dewatering under Alternative 2 would be the same as those described for Alternative 1. This would be a significant impact without concurrent implementation of Mitigation Measure 4.3.3, described below.

Alternative 3

Alternative 3 entails installation of new fish screens into existing bays at the Old River Intake, but does not require in-channel work, or the associated installation of a cofferdam. Thus, no stranding impacts to fisheries resources would occur under Alternative 3.

Alternative 4

Under Alternative 4, no new Delta Intake would be constructed and the existing Old River Intake capacity would not be expanded. There would be no in-channel construction activities and no stranding impacts to fishery resources.

Mitigation Measures

Measure 4.3.3: As discussed in Mitigation Measure 4.3.1, construction of the cofferdam for the new Delta Intake will be limited to the seasonal period between August 1 and November 30. This measure will also help avoid potential impacts to special-status fish species due to coffer dam dewatering.

Additionally, CCWD will implement a fish rescue plan acceptable to CDFG, USFWS, and NMFS. CCWD shall ensure that a qualified fishery biologist designs and conducts the fish rescue and relocation effort to collect fish (all species) from the area behind the cofferdam. The fish rescue would be implemented during the dewatering of the area behind the cofferdam for the new Delta Intake and would involve capturing and relocating the fish to suitable habitat within Old River. To ensure compliance, a fisheries biologist shall be present onsite during initial dewatering activities.

CCWD shall monitor progress of installation of the cofferdam and the schedule for dewatering. CCWD shall coordinate the dewatering schedule with the construction contractor and fishery biologist to allow for the fish rescue to occur before completely closing the cofferdam, and again during dewatering when water is about 2 feet deep at the shallowest point within the cofferdam. USFWS, NMFS, and CDFG shall be notified at least 48 hours before the fish rescue. Information on the species and sizes of fish collected in the rescue and estimates of survival just before release would be recorded during the time of the fish rescue and provided in a letter report to be submitted within 30 days after the fish rescue to USFWS, NMFS, and CDFG.

<u>The updates to the modeling analysis of potential operational impacts of the project alternatives did not require re-analyzing Impact 4.3.3. The conclusions regarding this potential impact have not changed from those presented in the Draft EIS/EIR.</u>

Impact Significance after Mitigation: Less than Significant.

Impact 4.3.4: The new Delta Intake structure and associated fish screens in Old River would physically exclude fish from a small area of existing aquatic habitat and modify existing aquatic habitat. (Less than Significant with Mitigation for Alternatives 1 and 2; No Impact for Alternatives 3 and 4)

Alternative 1

New Delta intake

The new Delta Intake, including associated fish screens and pumping plant, would be constructed along the existing levee on Old River. This project component would permanently exclude fish from a small area of existing open water and emergent wetland habitat and would modify existing substrate habitat.

Lost habitat. Aquatic habitat at the intake site is characterized as highly disturbed, degraded, and not unique. Nevertheless, habitat in the vicinity of the intake location is used by resident fish and macroinvertebrates for spawning, juvenile rearing, migration, foraging, and adult holding. Adult and juvenile chinook salmon and steelhead use the area as a migratory corridor and juvenile rearing area during downstream migration. Delta smelt, longfin smelt, and sturgeon are known to occur in the area. Resident fish species, such as striped bass, catfish, and largemouth bass, inhabit the area year-round. Depending on final site selection, up to about 0.2 acre of emergent wetland and open water habitat may be lost as a result of project implementation.

Altered habitat. The habitat within Old River at the new Delta intake site is characterized by riprap-stabilized levees and silt and sand substrate. Tules and other emergent vegetation associated with shallow water habitat occur in the general area.

To stabilize local channel banks, riprap would be installed along the existing levee for a distance of up to 500 feet upstream and downstream of the new intake. Assuming that riprap would extend vertically from +8 feet msl (100-year flood elevation) to about -25 feet msl (presumed channel bottom), a combined total of up to 0.74 acre of riprap will placed along the sides of the intake. Additionally, assuming that the intake sill elevation will be at -12.5 feet msl and the length of the intake will be about 180 feet, a total of up to 0.05 acre of riprap will be placed along the channel bank and bottom below the intake. The total area of riprap would be up to 0.79 acre. Because much of this riprap would be replacement of existing riprap which currently lines both levees along Old River, the new riprap would not significantly change aquatic habitat conditions.

The loss of aquatic habitat described above would be a significant impact without concurrent implementation of Biological Resources Mitigation Measure 4.6.2b.

Alternative 2

Potential impacts on Delta fisheries and aquatic resources resulting from aquatic habitat loss under Alternative 2 would be the same as those discussed for Alternative 1 and would be significant without concurrent implementation of Biological Resources Mitigation Measure 4.6.2b. Potential impacts on Delta fisheries and aquatic resources resulting from alteration of existing aquatic habitat under Alternative 2 would be the same as those discussed for Alternative 1 and would be less than significant.

Alternative 3

Expanded Old River Intake and Pump Station

Under Alternative 3, the Old River Intake and Pump Station capacity would be expanded to 320 cfs by installing additional screens into existing, vacant bays. Because this expansion work would not involve any in-channel construction activities, no aquatic habitat loss or modification would occur. No new Delta intake would be constructed under Alternative 3. Thus, no aquatic habitat loss or modification would occur under Alternative 3.

Alternative 4

Under Alternative 4, no new Delta intake would be constructed and the existing Old River Intake and Pump Station capacity would not be expanded. There would be no in-channel construction activities. Thus, no aquatic habitat loss or modification would occur under Alternative 4.

Mitigation Measures

Implementation of Biological Resources Mitigation Measure 4.6.2b: This mitigation measure provides for compensatory mitigation for the permanent impacts to habitat. See Section 4.6 (Vol. 2) for description of this measure.

The updates to the modeling analysis of potential operational impacts of the project alternatives did not require re-analyzing Impact 4.3.4. The conclusions regarding this potential impact have not changed from those presented in the Draft EIS/EIR.

Impact Significance after Mitigation: Less than Significant.

Impact 4.3.5: The new Delta Intake structure and associated fish screens in Old River would modify hydraulic conditions next to the intake structure, but would not disorient special-status fish or attract predatory fish. (Less than Significant for Alternatives 1 and 2; No Impact for Alternatives 3 and 4)

Alternative 1

The new Delta Intake structure would contribute to localized changes in hydraulic conditions (e.g., water velocities, water depths, and water circulation periods) within Old River in the immediate vicinity of the intake structure. These changes in current patterns could affect localized movement patterns for fish and macroinvertebrates within the area. Concern has also been expressed that physical structures, such as an intake and fish screen as well as riprap bank stabilization within the Delta, would attract predatory fish and increase the vulnerability of prey (e.g., juvenile chinook salmon, steelhead, delta and longfin smelt, splittail, and other fish), to predation mortality.

The new Delta Intake structure and fish screens would be designed and oriented in the channel to reduce the effect of the structure on local turbulence and to minimize changes in local hydrodynamic current patterns within Old River. The dominant flow and current patterns in Old River reflect the combined result of tidal flows and pumping at the SWP and CVP export facilities.

The fish screen would be positioned so that the river flow would primarily be oriented parallel to the fish screen surface, resulting in relatively large sweeping (parallel to screen) velocities as compared to approach velocities (perpendicular to screen). Results of field velocity measurements at other similarly positioned intake structures and fish screens (e.g., RD108 Wilkins Slough Pumping Plant) have shown that the effect of through-screen pumping on local hydrodynamics, as indicated by measurable approach velocities, extends less than 1 foot from the screen surface. Old River in the vicinity of the new Delta Intake is about 300 to 500 feet wide, so the modified hydraulic conditions would extend about 0.3 percent of the width of Old River at this location.

Based on observations at other intake locations with similar structures to the new Delta Intake, it would be expected that local effects of the structure on turbulence and current patterns would be limited to only the area of the channel in the immediate vicinity of the structure (e.g., less than 100 feet upstream and downstream of the structure). As part of designing the intake structure, simulation modeling and analyses would be performed of local hydrodynamic conditions in the area of the intake and the ability of the intake to maintain a uniform approach velocity of 0.2 fps or less. The intake design and support information would be made available for review by state and federal agency engineers during the design process to identify any potential changes or refinements to the design and hydraulic performance of the intake.

After intake construction, approach and sweeping velocities would be measured and the intake baffles or other similar structure adjusted to ensure uniformity of approach velocities and compliance with the CDFG and NMFS design criteria. Experience and observations at other intake structures with similar design criteria indicate that the new Delta Intake would not significantly influence hydrodynamic conditions within Old River or adversely affect fish behavior or migration. The intake structures would not affect the channel cross-section and would not create a physical barrier or impediment to migration.

Physical structures such as water intakes and diversion facilities may attract various species of fish to the area. A number of predatory fish species, such as striped bass and largemouth bass, are attracted to water intake facilities, where they prey on juvenile fish. Experience and observations of fish predation at other water diversion and intake sites within the Sacramento River and Delta (e.g., RBDD, Clifton Court forebay, Woodbridge Irrigation District dam) have shown that increased vulnerability of fish such as juvenile chinook salmon and steelhead to predation is typically related to physical structures that create turbulence and disorient fish.

The risk of attracting predatory fish species to the new Delta intake structure, or the potential risk of increased predation mortality for fish migrating through or inhabiting the south Delta, would be minimized by designing the intake and fish screen to avoid areas where predatory fish would congregate (e.g., avoid structural elements of the intake that create turbulence and structures that provide cover and hiding/ambush locations for predators). In addition, the intake and fish screen would not include collection or bypasses/fish return systems that have been found to attract predators and increase the concentrations of prey fish and their vulnerability to predation. The distribution of predatory fish inhabiting the area right next to the intake structure could change as a result of project implementation, but an increase in the overall abundance of predatory fish inhabiting Old River in the vicinity of the new Delta Intake is not expected.

As described in Impact 4.3.4 above, the new Delta Intake would require replacement of a small amount of existing silt/sand substrate with riprap to stabilize local channel banks just upstream and downstream of the intake structure. The existing channel banks, along the reach of Old River where the new Delta Intake would be sited, are currently lined by riprap, both upstream and downstream of the site. As part of intake construction, existing riprap would be removed from the site and replaced after the intake construction is complete to ensure that the local levees are stable and protected from scour and erosion by high tidal water velocities that occur in the channel.

Results of fishery surveys conducted by CDFG within the Delta have shown that predatory fish, such as striped bass, are frequently associated with riprap channel banks. No studies have been conducted within the Delta to quantify the effects of riprap on predation mortality for special-status fish. Fishery studies conducted in the Pacific Northwest (e.g., Knudsen and Diley, 1987; Peters et al., 1998) have found both positive and negative effects of riprap on the distribution and occurrence of juvenile salmonids. Because riprap is currently present and used to stabilize channel levees within Old River, and the new Delta Intake would replace existing riprap with new riprap, the addition of a small extent of riprap would not be expected to significantly affect the vulnerability of special-status species to predation within Old River or their ability to avoid predators, when compared to without project conditions.

These considerations indicate that incremental changes in localized hydraulics and aquatic habitat characteristics, including predator attraction, would be minor. Thus, this impact would be less than significant.

Alternative 2

Potential impacts on Delta fisheries and aquatic resources resulting from changes in hydraulic conditions under Alternative 2 would be the same as those discussed for Alternative 1. This impact would be less than significant.

Alternative 3

Under Alternative 3, no physical in-channel alterations would be required to expand the existing intake capacity at the Old River Intake and Pump Station to 320 cfs, because the capacity enlargement entails replacement of existing solid plates in existing intake bays with new screens. This replacement would not change the existing channel geometry. No new Delta intake would be constructed for this alternative. Thus, potential impacts on Delta fisheries and aquatic resources resulting from changes in hydraulic conditions would not occur.

Alternative 4

Under Alternative 4, the Old River Intake and Pump Station would not be expanded and no new Delta intake would be constructed. Thus, potential impacts on Delta fisheries and aquatic resources resulting from changes in hydraulic conditions next to the intake structure would not occur.

The updates to the modeling analysis of potential operational impacts of the project alternatives did not require re-analyzing Impact 4.3.5. The conclusions regarding this potential impact have not changed from those presented in the Draft EIS/EIR.

Mitigation: None required.

Impact 4.3.6: Operation of the project alternatives would not result in changes to Delta hydrologic conditions that affect Delta fish populations or quality and quantity of aquatic habitat within the Sacramento-San Joaquin River system, including the Delta. (Less than Significant for Alternatives 1, 2 and 4)

The project alternatives would alter the location and timing of water diversions from the Delta. The following analysis addresses the potential for these changes to adversely or beneficially affect Delta fish populations or the quality and quantity of aquatic habitat within the Bay-Delta estuary. As described in the description of updated modeling performed for the Final EIS/EIR in the updated Section 4.2 (Vol. 4, Chapter 5, Section 5.3), the operation of the CVP and SWP systems under the OCAP BOs has now been simulated for this analysis. Operation of the project alternatives was also modified in response to the inclusion of the OCAP BOs; these modifications are also described in the updated Section 4.2 (Vol. 4, Chapter 5, Section 5.3).

Effects on fish populations were analyzed using a number of different parameters that have been shown to be, or are thought to be, significant factors that affect habitat conditions and the reproduction of various fish and macroinvertebrate species inhabiting the Bay-Delta estuary. These habitat parameters are grouped into the following three categories:

- Measures of flows upstream of the Delta, including total Delta inflow, Sacramento River flow at Freeport, and San Joaquin River flow at Vernalis;
- Regulatory standards that are currently required by SWRCB D-1641 for fish and wildlife beneficial use, including net Delta outflow, the location of X2, and the Export-to-Inflow (E/I) ratio;
- Measures of Delta circulation, including particle tracking analysis, net flow on the lower San Joaquin River (Qwest), and net flow in Old and Middle rivers.

The assessment relies on a comparative analysis of operational and resulting environmental conditions within the estuary between without project conditions and each of the project alternatives. The changes in these parameters for each alternative are obtained from the hydrologic modeling results, which describe water diversion operations over a range of environmental and hydrologic conditions (see Appendix C (Vol. 4) for a detailed presentation of the modeling methodology and results). Hydrologic modeling results provide the technical foundation for assessing adverse effects of project diversions and CVP and SWP export operations on fish species and their habitat within the Bay-Delta estuary.

As described in Section 4.2 and Appendix C-3, moderate and severe fishery restrictions were simulated, in an attempt to bracket the range of background conditions that might occur, and evaluate the environmental effects of the project alternatives under this range of conditions. Additionally, cComparisons were performed for both the 2005 level of development and the 2030 level of development. For the 2005 level of development, the project alternatives are compared to the Existing Condition. For the 2030 level of development, the project alternatives are compared to the Future Without Project condition.

Changes to each of the parameters were evaluated on a monthly basis. For the purpose of evaluating the potential effect of each project alternative, the incremental changes for each alternative are averaged by water year type, resulting in a long-term monthly average for each water year type (e.g., long-term average incremental change in January of wet water years). Results of this analysis are discussed below. Summary tables are presented below that show long-term monthly average (e.g., long-term average incremental change in January for all years); the monthly average values by water year type that were the basis for the analysis are presented in Appendix C7 (Vol. 4).

Effects of changes to upstream tributary river flows

Delta Inflow. Changes in Delta inflow could be caused by the operation of the project alternatives, if the alternatives would influence the timing of releases from upstream reservoirs, including but not limited to Shasta, Oroville, and Folsom. Changes in Delta inflow could affect hydrologic conditions within Delta channels, hydraulic residence times, salinity gradients, and the transport and movement of various lifestages of fish, invertebrates, phytoplankton, and nutrients into and through the Delta. Delta inflow serves as a surrogate metric for a variety of habitat conditions within the Delta that directly or indirectly affect fish and other aquatic resources.

Long-term average changes to Delta inflows under 2005 level of development are shown in **Table 4.3-5** with additional averages by water year presented in Appendix C7 (Vol. 4). For purposes of evaluating the potential effect of changes in Delta inflow on fishery habitat within the Bay-Delta, and considering the accuracy and inherent noise within the hydrologic model, changes in the average monthly simulated flows that were within 5 percent (+ or -) of the Existing Condition would not be expected to result in a detectable effect on habitat quality or availability or affect the transport mechanisms provided by Delta inflow, which may influence resident or migratory fish or the zooplankton and phytoplankton that they rely on for a food resource.

Results of the analysis showed that Delta inflow under 2005 level of development was slightly lower in a number of comparisons between without project conditions and the project alternatives and slightly higher in a number of comparisons. However, the changes in Delta inflow attributable to the project are generally less than 1 percent, and none are larger than 5 percent. Typically only a change that reduced average monthly Delta inflow would be considered to have a potentially adverse effect on fishery resources. Based on results of this analysis it was concluded that the

TABLE 4.3-5 (REVISED)*
LONG-TERM MONTHLY AVERAGE OF DELTA INFLOW UNDER 2005 LEVEL OF DEVELOPMENT

		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Existing Condition		14,747	18,597	32,636	47,195	58,182	49,100	33,193	27,131	21,719	22,461	18,111	19,072
Percent Change from Existing Condition	Alt 1	0.0%	-0.2%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%	0.3%	0.0%	-0.1%	-0.1%
	Alt 2	0.0%	-0.2%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%	0.3%	-0.1%	-0.1%	-0.1%
	Alt 4	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%	0.2%	0.0%	-0.1%	0.0%

* Modeling results presented in this table have been updated based on analysis for the Final EIS/EIR.

% = percent
Alt = alternative
cfs = cubic foot (feet) per second

project alternatives would result in a less than significant incremental effect on fishery habitat as a consequence of changes in Delta inflow under 2005 level of development.

Long-term average changes to Delta inflows under 2030 level of development are shown in **Table 4.3-6** with additional averages by water year presented in Appendix C7 (Vol. 4). Similar to the 2005 level of development, Delta inflows under 2030 level of development were observed to be slightly lower under many of the project alternatives operations as well as slightly higher than Future Without Project conditions depending on month and water year type. None of the comparisons between the Future Without Project and operations under the project alternatives exceeded 5 percent.

TABLE 4.3-6 (REVISED)*
LONG-TERM MONTHLY AVERAGE OF DELTA INFLOW UNDER 2030 LEVEL OF DEVELOPMENT

		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Future Without Project		14,650	18,851	32,765	47,421	58,078	49,685	34,427	27,073	21,825	22,365	18,160	19,014
Percent Change from Future Without Project	Alt 1	0.1%	0.0%	-0.1%	0.0%	0.1%	0.1%	-0.1%	0.1%	0.1%	-0.1%	-0.2%	-0.1%
	Alt 2	0.2%	0.0%	-0.1%	0.0%	0.1%	0.1%	-0.1%	0.0%	0.1%	-0.1%	-0.2%	-0.1%
	Alt 4	0.1%	0.0%	-0.1%	0.0%	0.1%	0.0%	-0.1%	0.0%	0.1%	0.0%	-0.2%	0.0%

* Modeling results presented in this table have been updated based on analysis for the Final EIS/EIR.

% = percent
Alt = alternative
cfs = cubic foot (feet) per second

The results of this comparison indicate that each of the project alternatives would have a less than significant incremental effect on fishery habitat and hydrologic transport processes within the Delta and Suisun Bay.

Sacramento River Flow. Flow within the Sacramento River has been identified as an important factor affecting the survival of emigrating juvenile chinook salmon, and as important to the downstream transport of planktonic fish eggs and larvae such as delta and longfin smelt, striped bass and shad. Sacramento River flows have also been identified as important for seasonal floodplain inundation that has been shown to be important habitat for successful spawning and larval rearing by species such as Sacramento splittail and as seasonal foraging habitat for juvenile chinook salmon and steelhead (Sommer et al., 2001). Sacramento River flows are also important in the transport of organic material and nutrients from the upper regions of the watershed downstream into the Delta. A reduction in Sacramento River flow as a result of operation of the project alternatives, depending on the season and magnitude of change, could adversely affect habitat conditions for both resident and migratory fish species. An increase in river flow is generally considered to be beneficial for aquatic resources within the normal range of typical project operations and flood control. Very large changes in river flow could also affect sediment erosion, scour, deposition, suspended and bedload transport, and other geomorphic processes within the river and watershed.

Results of the comparative analysis of Sacramento River flow, by month and water year type, under both 2005 and 2030 levels of development are provided in Appendix C7 (Vol. 4) with long-term monthly averages shown in **Table 4.3-7** and **Table 4.3-8,** respectively. Results of these analyses show a variable response in Sacramento River flow with the operations of the project alternatives resulting in both increases and decreases in river flow compared to without project conditions, depending on month and water year. Changes in estimates of SWP and CVP operations in the CalSim II studies for project alternatives result in changes in flow on the Sacramento River, but changes attributable to the operation of project alternatives are less than 5 percent, and are generally less than 1 percent.

TABLE 4.3-7 (REVISED)*
LONG-TERM MONTHLY AVERAGE OF SACRAMENTO RIVER INFLOW TO THE DELTA UNDER 2005 LEVEL OF DEVELOPMENT

		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Existing Condition		11,691	15,199	26,085	32,870	38,988	33,566	23,345	19,211	16,465	19,131	15,813	16,487
Percent Change from Existing Condition	Alt 1	0.0%	-0.2%	-0.1%	0.1%	0.0%	0.0%	-0.1%	0.0%	0.4%	0.0%	-0.1%	-0.1%
	Alt 2	0.0%	-0.2%	-0.1%	0.1%	0.0%	0.0%	-0.1%	0.1%	0.3%	-0.2%	-0.1%	-0.1%
	Alt 4	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.1%	0.3%	0.0%	-0.1%	0.0%

* Modeling results presented in this table have been updated based on analysis for the Final EIS/EIR.

% = percent
Alt = alternative
cfs = cubic foot (feet) per second

TABLE 4.3-8 (REVISED)*
LONG-TERM MONTHLY AVERAGE OF SACRAMENTO RIVER INFLOW TO THE DELTA UNDER 2030 LEVEL OF DEVELOPMENT

		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Future Without Project		11,526	15,255	26,165	33,094	39,068	33,694	23,423	19,057	16,454	19,018	15,845	16,386
Percent Change from Future Without Project	Alt 1	0.2%	0.0%	-0.1%	0.0%	0.2%	0.1%	-0.1%	0.1%	0.2%	-0.1%	-0.3%	-0.1%
	Alt 2	0.2%	0.0%	-0.1%	0.0%	0.2%	0.1%	-0.1%	0.0%	0.2%	-0.1%	-0.2%	-0.1%
	Alt 4	0.2%	0.0%	-0.1%	0.0%	0.1%	0.1%	-0.1%	0.1%	0.2%	0.0%	-0.2%	0.1%

* Modeling results presented in this table have been updated based on analysis for the Final EIS/EIR.

% = percent
Alt = alternative
cfs = cubic foot (feet) per second

Based on these results, it was concluded that the incremental effect of the project alternatives on fishery habitat and transport mechanisms within the lower Sacramento River and Delta would be less than significant.

San Joaquin River Flow at Vernalis. Flow within the San Joaquin River has been identified as an important habitat parameter because it is known to affect:

- the survival of juvenile chinook salmon migrating downstream from the tributaries through the mainstem San Joaquin River and Delta;
- downstream transport of planktonic fish eggs and larvae such as striped bass;
- seasonal floodplain inundation that is considered to be important habitat for successful spawning and larval rearing by species such as Sacramento splittail and as seasonal foraging habitat for juvenile chinook salmon;
- transport of organic material and nutrients from the upper regions of the watershed downstream into the Delta.

A reduction in San Joaquin River flow as a result of operations of the project alternatives, depending on the season and magnitude of change, could adversely affect habitat conditions for both resident and migratory fish species. An increase in river flow is generally considered to be beneficial for aquatic resources within the normal range of typical project operations and flood control. Very large changes in river flow could also affect sediment erosion, scour, deposition, suspended and bedload transport, and other geomorphic processes within the San Joaquin River and watershed.

Results of the comparative analysis of San Joaquin River flow, by month and year type under 2005 and 2030 level of development, are provided in Appendix C7 (Vol. 4) with long-term monthly averages presented in **Table 4.3-9** and **Table 4.3-10**. Results of these analyses show that the project alternatives would have little effect on seasonal flows as compared with existing conditions within the San Joaquin River (percent change remains below 0.05 percent). Similarly, modeling results showed that the project alternatives would have little effect on flows or fishery habitat as compared with Future Without Project conditions.

TABLE 4.3-9 (REVISED)*
LONG-TERM MONTHLY AVERAGE OF SAN JOAQUIN RIVER AT VERNALIS UNDER 2005 LEVEL OF DEVELOPMENT

		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Existing Condition		2,815	2,484	3,246	4,704	6,285	6,547	6,399	6,418	4,601	3,194	2,052	2,299
Percent Change from Existing Condition	Alt 1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Alt 2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Alt 4	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

* Modeling results presented in this table have been updated based on analysis for the Final EIS/EIR.

% = percent
Alt = alternative
cfs = cubic foot (feet) per second

TABLE 4.3-10 (REVISED)*
LONG-TERM MONTHLY AVERAGE OF SAN JOAQUIN RIVER AT VERNALIS UNDER 2030 LEVEL OF DEVELOPMENT

		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Future Without Project		2,899	2,675	3,280	4,701	6,094	6,968	7,529	6,514	4,716	3,209	2,072	2,342
Percent Change from Future Without Project	Alt 1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Alt 2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Alt 4	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

* Modeling results presented in this table have been updated based on analysis for the Final EIS/EIR.

% = percent
Alt = alternative
cfs = cubic foot (feet) per second

These results indicate that the project alternatives would have a less than significant incremental effect on fishery habitat or transport mechanisms within the lower San Joaquin River and Delta under either current or future conditions.

Effects of changes to net Delta outflow, the location of X2, and the Export-to-Inflow Ratio

Delta outflow. Seasonal variations in Delta outflow influence the transport of planktonic organisms, such as zooplankton, fish eggs and larvae, through the Delta and into Suisun and San Francisco bays. Flows from February through June play an especially important role in determining the reproductive success and survival of many estuarine species including salmon, striped bass, American shad, delta smelt, longfin smelt, splittail, and others (Stevens and Miller, 1983; Stevens et al., 1985; Meng and Herbold, 1994; Meng and Moyle, 1995). Delta outflow also has a significant influence on the geographic location of the low salinity zone within the estuary. One important indicator that is used to assess estuarine habitat conditions is the location of the salinity condition that is commonly referred to as the X2 location (defined as the 2 parts per thousand salinity isohaline). Results of fishery monitoring over a number of years within the estuary have shown that the survival and abundance of the juvenile lifestages of a number of fish and macroinvertebrate species typically increases when Delta outflows are high and the X2 location is within Suisun Bay during the late winter and spring. A reduction in Delta outflow or an easterly movement of the X2 location during the winter and spring (February through June) is used as one indicator of a project's potential negative effects on estuarine habitat conditions.

Long-term average results of the comparison of net Delta outflow under 2005 level of development with and without each of the project alternatives are shown for reference in **Table 4.3-11**; the monthly average values by water year type that were the basis for the analysis are presented in Appendix C7 (Vol. 4). For purposes of evaluating the potential effect of changes in Delta outflow on fishery habitat within the Bay-Delta estuary, and considering the accuracy and inherent "noise" within the hydrologic model, changes in the average monthly flows modeled under project alternatives that were within 5 percent (+ or -) of the Existing Condition would not be expected to result in a detectable effect on habitat quality or availability, or affect the transport mechanisms provided by

TABLE 4.3-11 (REVISED)*
LONG-TERM MONTHLY AVERAGE OF DELTA OUTFLOW UNDER 2005 LEVEL OF DEVELOPMENT

		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Existing Condition		7,102	11,178	23,773	41,723	51,806	42,136	29,869	22,576	12,616	7,850	5,810	8,224
Percent Change from Existing Condition	Alt 1	-0.4%	-0.6%	0.1%	-0.2%	-0.1%	0.4%	-0.6%	-0.2%	0.1%	-0.6%	-0.1%	-0.2%
	Alt 2	-0.4%	-0.8%	0.1%	-0.2%	-0.1%	0.3%	-0.6%	-0.2%	0.0%	-0.5%	-0.2%	-0.2%
	Alt 4	-0.3%	-0.3%	0.1%	-0.2%	0.0%	0.2%	-0.5%	-0.1%	0.1%	-0.2%	0.0%	0.0%

* Modeling results presented in this table have been updated based on analysis for the Final EIS/EIR.

% = percent
Alt = alternative
cfs = cubic foot (feet) per second

net Delta outflow, which may influence resident or migratory fish or the zooplankton and phytoplankton that they rely on for a food resource. In general, changes were found to be far smaller than 5 percent, as shown in Table 4.3-11 and in the results presented in Appendix C7 (Vol. 4).

As shown in Appendix C7 (Vol. 4), Delta outflow under 2005 level of development varied in years of different water year type, reflecting variation in Central Valley hydrology under both the Existing Condition and each of the project alternatives. Variation attributable to the project between the Existing Condition and each of the project alternatives is generally less than 1 percent, and did not exceed 5 percent for Alternatives 1, 2, and 4 for any water year type.

~~As shown in Appendix C-7, analysis of Alternative 3 indicates a long-term average monthly reduction in Delta outflow of about 6 percent in critical water years in February under the 2005 level of development with moderate fishery restrictions; average February Delta outflow for critical water years in the Existing Condition is 14,890 cfs and is reduced about 900 cfs in Alternative 3. However, upon closer examination, this reduction was found to be due to an anomaly in one month when the model reduced Delta outflow in Alternative 3 by about 7,500 cfs from the Existing Condition. This particular instance represents an artifact of the model tools used in these analyses, and is not representative of the effects of the project alternative (see discussion of step functions in CalSim II in Section 4.2 for more information on this type of artifact).~~ Results of this analysis indicate that all of the project alternatives would result in less than significant incremental effects on fishery habitat as a consequence of changes in Delta outflow under the 2005 level of development.

Long-term average net Delta outflow under 2030 level of development with and without each of the project alternatives is shown for reference in **Table 4.3-12**; the monthly average values by water year type that were the basis for the analysis are presented in Appendix C7 (Vol. 4). As discussed in the 2005 level of development above, Delta outflows under many of the project alternatives were observed to be both slightly lower and slightly higher compared to the Future Without Project conditions depending on month and water year type. The long-term monthly average percent change of net Delta outflow between the alternatives and the Future Without Project is generally less than 1 percent, and never exceeds 5 percent for Alternatives 1, 2 and 4 for any water year type.

TABLE 4.3-12 (REVISED)*
LONG-TERM MONTHLY AVERAGE OF DELTA OUTFLOW UNDER 2030 LEVEL OF DEVELOPMENT

		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Future Without Project		7,142	11,334	23,912	41,921	51,793	42,484	30,921	22,479	12,549	7,917	5,847	8,199
Percent Change from Future Without Project	Alt 1	0.0%	-0.6%	-0.1%	-0.1%	0.2%	0.5%	-0.9%	-0.3%	0.3%	-0.5%	-0.5%	0.1%
	Alt 2	0.0%	-0.7%	0.0%	-0.1%	0.2%	0.4%	-0.9%	-0.3%	0.2%	-0.6%	-0.5%	0.0%
	Alt 4	0.1%	0.1%	-0.4%	0.0%	0.1%	0.3%	-0.8%	-0.3%	0.3%	-0.2%	-0.4%	0.2%

* Modeling results presented in this table have been updated based on analysis for the Final EIS/EIR.

% = percent
Alt = alternative
cfs = cubic foot (feet) per second

~~Alternative 2 indicates an average reduction in Delta outflow of about 5 percent in above normal water years in November under 2030 level of development with severe fishery restrictions; average November Delta outflow for above normal water years in the Future Without Project is 9,919 cfs and is reduced about 330 cfs in Alternative 2. This reduction in above normal water years in November would not have a significant impact on fishery habitat.~~

~~As shown in Appendix C-7, Alternative 3 indicates an average reduction in Delta outflow of about 10 percent in critical water years in December under 2030 level of development with severe fishery restrictions; average December Delta outflow for critical water years in the Future Without Project is 5,661 cfs and is reduced about 580 cfs in Alternative 3. However, this reduction was found to be due to an anomaly in one month when the model reduced Delta outflow in Alternative 3 by about 6,200 cfs from the Future Without Project. This instance is an artifact of the model tools used in these analyses, and is not representative of the effects of the project alternative (see discussion of step functions in CalSim II in Section 4.2 for more information on this type of artifact).~~

The results of this comparison show that all of the project alternatives would have a less than significant incremental effect on fishery habitat and hydrologic transport processes within the Bay-Delta estuary.

Low Salinity Habitat and Location of X2. Salinity is an important factor affecting habitat quality and availability for fish and macroinvertebrates inhabiting the Delta and Suisun Bay. All estuarine species have optimal salinity ranges, and their survival may be affected by the amount of habitat available within the species' optimal salinity range. Because the location of the salinity field in the Delta and Suisun Bay is largely controlled by freshwater outflows, the level of outflow may determine the surface area of optimal salinity habitat that is available to a species (Hieb and Baxter, 1993; Unger, 1994).

The transition area between saline waters within San Francisco Bay and fresh water within the rivers, frequently referred to as the low salinity zone, is within Suisun Bay and the western Delta. The low salinity zone has also been associated with the entrapment zone, a region of the estuary characterized by higher levels of particulates, higher abundances of several types of organisms, and a turbidity maximum. It is commonly associated with the specific position of X2, the 2 parts per thousand isohaline, but actually occurs over a broader range of salinities (Kimmerer, 1992). Originally, the primary mechanism responsible for this region was thought to be gravitational circulation, a circulation pattern formed when freshwater flows seaward over a dense, landward-flowing marine tidal current. However, recent studies have shown that gravitational circulation does not occur in the entrapment zone in all years, nor is it always associated with X2 (Burau et al., 1998). Lateral circulation within the Delta and Suisun Bay or chemical flocculation may play a role in the formation of the turbidity maximum of the entrapment zone.

Although recent evidence indicates that the location of X2 and the entrapment zone are not as closely related as previously believed (Burau et al., 1995), X2 continues to be used as an index of the location of the area of increased biological productivity. Historically, X2 has varied between San Pablo Bay (River kilometer [km] 50), measured upstream from the Golden Gate Bridge) during periods of high Delta outflow and Rio Vista (River km 100) during periods of very low Delta outflow. ~~In recent years, X2 has typically been between about Honker Bay and Sherman Island (River km 70 to River km 85).~~ The location of X2 is managed, in part, by Delta inflow and releases from upstream reservoirs during the February through May period each year as required by the SWRCB D-1641. X2 location is controlled directly by the volume of Delta outflow, although changes in X2 location lag behind changes in outflow. Minor modifications in outflow do not greatly alter X2.

Jassby et al. (1995) observed that when X2 is in the vicinity of Suisun Bay, several estuarine organisms tend to show increased abundance. However, it is not certain that X2 has a direct effect on any of the species. The observed correlations may result from a close relationship between X2 and other factors that affect these species. Studies and analyses are continuing to better define and understand the relationships between X2/Delta outflow and the production and survival (abundance) of various species of fish and macroinvertebrates inhabiting the Delta and Suisun Bay.

For purposes of evaluating changes in habitat quantity and quality for estuarine species, a significance criterion of an upstream change in X2 location within 1 km of the without project condition was considered to be less than significant. The 1 km X2 criterion used in this analysis was derived from the criterion applied to the environmental analysis of the Environmental Water Account (Reclamation and DWR, 2003). The criterion was applied to a comparison of hydrologic model results between the without project condition and each of the project alternatives, using a long-term monthly average by water year type.

Long-term average changes in X2 position are shown in **Table 4.3-13** and **Table 4.3-14**. Changes in X2 position averaged by water year type, shown in Appendix C7 (Vol. 4), never exceed 0.35~~75~~ km with both variable upstream and downstream movement of the X2 location depending on month and water year type. These results are consistent with model results for Delta outflow, described above, that also showed a less than significant change. Results of these analyses show that the impacts of changes in hydrologic conditions affecting X2 location under ~~each of the project~~ ~~a~~Alternatives 1, 2 and 4 would be less than significant.

Export-to-Inflow Ratio. The E/I ratio, which is the percentage of Delta inflow exported from the Sacramento and San Joaquin river systems and the Delta by SWP and CVP facilities in the south Delta, provides an indicator of several key ecological processes, including: (1) migration and transport

TABLE 4.3-13 (REVISED)*
LONG-TERM MONTHLY AVERAGE OF X2 LOCATION UNDER 2005 LEVEL OF DEVELOPMENT

		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Existing Condition		84	85	82	75	67	61	62	64	68	75	81	85
Change from Existing Condition	Alt 1	0.0	0.0	0.1	0.0	0.0	0.0	-0.1	0.1	0.0	0.0	0.0	0.0
	Alt 2	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
	Alt 4	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0

* Modeling results presented in this table have been updated based on analysis for the Final EIS/EIR.

Alt = alternative
km = kilometer
X2 = 2 parts per thousand salinity isohaline

TABLE 4.3-14 (REVISED)*
LONG-TERM MONTHLY AVERAGE OF X2 LOCATION UNDER 2030 LEVEL OF DEVELOPMENT

		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Future Without Project		84	84	82	75	67	61	61	64	68	75	81	85
Change from Future Without Project	Alt 1	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	0.1	0.1	0.0	0.0	0.0
	Alt 2	0.0	0.0	0.1	0.0	0.0	-0.1	-0.1	0.1	0.1	0.0	0.0	0.0
	Alt 4	0.0	0.0	0.0	0.0	0.1	0.0	-0.1	0.1	0.1	0.0	0.0	0.0

* Modeling results presented in this table have been updated based on analysis for the Final EIS/EIR.

Alt = alternative
km = kilometer
X2 = 2 parts per thousand salinity isohaline

of various lifestages of resident and anadromous fishes using the Delta; (2) salinity levels at various locations within the Delta as measured by the locations of X2; and (3) the risk of direct and indirect fish losses resulting from export operations. Although no specific biological relationships have been developed regarding the abundance of various fish and macroinvertebrate species and the E/I ratio, the ratio is used in SWRCB D-1641 as one of the bases for regulating the rate of freshwater exports from the Delta. The E/I ratio reflects the balance between freshwater inflows to the Delta and the corresponding percentage of inflows that can be exported through the SWP and CVP diversion facilities. The maximum allowable E/I ratio varies with the season of the year; the E/I ratio is limited to 35 percent during the February-June period when juvenile fish are most vulnerable to losses resulting from diversions and increases to 65 percent during the remainder of the year. The E/I ratio represents a tool for reducing the effects of diversion operations from the SWP and CVP on resident and migratory fish inhabiting the estuary. If the E/I ratio is close to the regulatory limit, then additional increase in the E/I ratio, indicating greater exports from the Delta relative to the inflow of freshwater from the tributary rivers, would generally be interpreted as an increase in the potential risk of adverse effects on fishery resources and their habitat resulting from entrainment and salvage at the SWP and CVP export facilities.

As discussed in Chapter 3, Alternatives 1 and 2 shift a portion of the South Bay water agencies' Delta diversions to the expanded Los Vaqueros system, which provides improved fish screening, a No-Diversion Period, and multiple intake locations to better protect Delta fish. For the purpose of the E/I ratio analysis, this shifted water supply is still counted as exports, such that the E/I ratio is not changed simply by shifting the diversions to the expanded Los Vaqueros system.

Results for the E/I ratio under 2005 level of development and 2030 level of development are presented in **Table 4.3-15** and **Table 4.3-16**, respectively. As shown, between January and June the E/I ratio is substantially less than the regulatory limit for this parameter. This is due to the fishery restrictions assumed in these analyses, which reduce exports but do not reduce inflow when surplus water is available in the Delta. Changes in E/I ratio ~~under all~~ project ~~a~~Alternatives 1, 2 and 4 are not substantial and would likely not result in a significant reduction in the quality or quantity of aquatic habitat within the estuary, or the risk of entrainment and salvage mortality at the water export facilities.

TABLE 4.3-15 (REVISED)*
LONG-TERM MONTHLY AVERAGE OF EXPORT TO INFLOW RATIO (%)
UNDER 2005 LEVEL OF DEVELOPMENT

		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Existing Condition		45	40	39	24	19	18	7	9	23	45	50	51
Change from Existing Condition	Alt 1	0.1	0.2	-0.2	0.2	0.1	-0.2	0.0	0.0	1.0	0.1	-0.2	-0.1
	Alt 2	0.2	0.2	-0.2	0.2	0.1	-0.1	0.0	0.0	1.0	-0.1	-0.1	-0.1
	Alt 4	0.2	0.1	-0.2	0.3	0.1	0.1	0.0	0.0	0.9	-0.1	-0.3	-0.1

* Modeling results presented in this table have been updated based on analysis for the Final EIS/EIR.

% = percent
Alt = alternative

TABLE 4.3-16 (REVISED)*
LONG-TERM MONTHLY AVERAGE OF EXPORT TO INFLOW RATIO (%)
UNDER 2030 LEVEL OF DEVELOPMENT

		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Future Without Project		43	39	39	23	19	19	8	9	23	45	50	50
Change from Future Without Project	Alt 1	0.0	0.3	0.0	0.1	-0.2	-0.2	0.0	0.0	0.8	-0.1	0.0	-0.1
	Alt 2	0.1	0.4	-0.2	0.1	-0.2	-0.1	0.0	0.0	0.8	-0.1	0.0	-0.1
	Alt 4	0.0	0.0	0.2	0.1	-0.1	0.0	0.0	0.0	0.8	-0.1	0.0	-0.2

* Modeling results presented in this table have been updated based on analysis for the Final EIS/EIR.

% = percent
Alt = alternative

Alternatives 1 and 2 reduce the E/I ratio ~~in April~~during the Los Vaqueros Reservoir no diversion period, which is implemented in March in this analysis.~~, which could potentially benefit fishery resources. This benefit~~ This could potentially benefit Delta fishery resources ~~is created~~ by providing water supply to South Bay water agencies from storage in the expanded Los Vaqueros Reservoir during the 30-day No-Diversion Period, as described in Chapter 3, and thereby reducing total Delta diversions during this period.

Effects of changes in circulation within the Delta

Particle tracking model. The particle tracking model (PTM) estimates the probability that a parcel of water starting at one location will arrive at another location in a given time frame. The PTM tool has been used to assess the potential effects of water project operations on planktonic phytoplankton (microscopic free-floating aquatic plants) and zooplankton (free-floating aquatic invertebrates) that are important as a food resource within the estuary. Because the particles simulated in the model are neutrally buoyant (and therefore have no swimming behavior or other independent movement) results of these analyses are most relevant to the planktonic early larval stages of various organisms that do not move independently in the water column. The particles are not considered to reflect movements of juvenile or adult fish within the Delta.

For this analysis, particle releases were simulated in the model at various locations within the Delta that are either known to represent important fish habitat or important hydrologic locations. Such simulated particle releases were made in each month of the 16-year Delta hydrodynamic model study period (see discussion of the DSM2 model in the updated Section 4.2 [Vol. 4, Chapter 5, Section 5.3]). After each release, particles were tracked in the simulated Delta conditions for 120 days and counted when they entered an export facility or other diversion or when they exited the geographic extent of the model by passing Martinez downstream of Suisun Bay. One limitation of PTM is that it does not allow for consideration of fish screens. The presence of positive barrier fish screens at CCWD intakes was accounted for during post-processing. A screen efficiency factor was applied and the fate of particles determined to be screened out in this manner was then assigned proportionally based on results of particle insertions near the respective intake during the same month. The percentage of particles shown by the model to remain in Suisun Bay and Marsh and within the Delta was analyzed for each geographic region. This analysis was repeated for each simulated particle release.

In general, the following considerations should be taken into account when interpreting the particle tracking analysis (a more detailed description of PTM methodology and limitations is provided in Appendix C7 [Vol. 4]):

- The measure of changes in Delta circulation patterns provided by the analysis is most relevant for passive entities such as planktonic species and larval stage fish that have no swimming behavior or otherwise independent means of movement.

- The PTM tool does not account for fish screens. Positive barrier fish screens provide proven entrainment reductions even for larval stage fish, which are hatched at sizes at the low end of the size exclusion range of the screens. One important finding of the PTM analysis was that particles that would be excluded by the screens do have the possibility of leaving the Delta, especially in the spring, so particles that are transported to the central Delta are not necessarily trapped in the Delta. Incorporating a screen efficiency factor that reduces entrainment and leaves more particles in the flow field would effectively increase the percentage of particles traveling past Chipps Island. To address the lack of fish screen efficiency accounting within the PTM tool, a post-process method was developed to determine the proportional re-entrainment at other diversions based on the results of particle insertions near the screened intakes. This method is described in Appendix C7 (Vol. 4).

- PTM has limitations regarding the dispersion of particles (Kimmerer and Nobriga, 2008), including simplistic assumed velocity profiles that do not adjust for channel geometry or bottom roughness, and the mixing of particles at channel nodes. These factors may have a significant effect on particle dispersion, particularly in the near-field (locations close to where the particles are released). Dispersion issues in the near-field are amplified in the central and south Delta due to the DSM2 channel grid, where nodes are very close together. Additionally, because agricultural diversions are simulated at almost every DSM2 node in the central and south Delta, simulated particle releases in this region are likely to contain errors in the estimation of agricultural entrainment that are due to the near-field dispersion issue.

- The open, shallow water areas of the Delta (e.g., Franks Tract and Mildred Island) are not well represented in the particle tracking analysis. The model assumes the regions are completely mixed environments, such that a particle that enters on one side of the flooded lake has the possibility of exiting on the other side of the lake in a short time period. In reality, these environments have complicated dynamics that effectively “trap” particles within the regions or can move them in ways that the model does not capture.

To illustrate changes in Delta circulation provided by the particle tracking simulation, results are shown for a select location – Chipps Island, which represents the western boundary of the Delta – for the 2030 level of development~~ with severe fishery restrictions~~, which includes the greatest incremental change due to the project alternatives. Additional results are provided in Appendix C7 (Vol. 4). **Table 4.3-17** shows the percentage of neutrally buoyant particles that are modeled to have traveled past Chipps Island 120 days after the particles originated at the specified release locations. The three leftmost numeric columns of each table show the average percentage of particles that pass Chipps Island for the without-project condition during Winter (December through February), Spring (March through June), and Fall (September through November). The remaining columns show the change from the without project condition in percentage of particles that have traveled past Chipps Island for each season.

In general, the percentage of particles passing Chipps Island tends to be greatest for particles originating in the western Delta or upstream on the Sacramento River. Particles originating in the central and southern Delta have a lower probability of passing Chipps Island, yet, in the without-project conditions~~ under severe fishery restrictions~~, about ~~45~~49 percent of the particles originating in the spring on Old River near Holland Tract do pass Chipps Island within 120 days after release.

Changes in particle fate between the alternatives under 2030 level of development and the Future Without Project conditions were assessed. In ~~all scenarios~~ Alternatives 1 and 4, small ~~decreases~~ increases and decreases in the range of 1 to 2 percent occur in particles passing Chipps Island~~, mostly in the range of 1 to 2 percent~~; this is consistent with the small change in Delta outflow discussed above and within the level of accuracy of the CalSim II model (See Section 4.2 [Vol. 4, Chapter 5, Section 5.3]) and relatively low when compared to seasonal variability.

~~The greatest reduction in the percent of particles passing Chipps Island occurs in the spring for particles originating on Old River at Holland Tract, with a maximum decrease of 4 to 5 percent occurring in the 2030 level of development under severe fisheries restrictions for Alternatives 1 and 2. To determine whether a 4 to 5 percent reduction would significantly affect Delta fisheries and other aquatic resources, the following additional information regarding particles originating~~

TABLE 4.3-17 (REVISED)*
LONG-TERM, SEASONAL AVERAGE PERCENT OF PARTICLES TRAVELING PAST CHIPPS ISLAND 120 DAYS AFTER PARTICLES ARE RELEASED AT DESIGNATED LOCATIONS 2030 LEVEL OF DEVELOPMENT

	Future Without Project			Change from Future Without Project								
				Alt 1			Alt 2			Alt 4		
Release Location	W	S	F	W	S	F	W	S	F	W	S	F
Sacramento River at Freeport	71	71	46	0	0	0	0	0	0	0	0	0
Sacramento River above Delta Cross Channel	66	72	42	0	0	0	0	0	0	0	0	0
Cache Slough at Sac Ship Channel	31	6	10	0	0	0	0	0	0	0	0	0
Sacramento River at Rio Vista	79	82	65	2	2	2	0	0	0	0	0	0
Sacramento River at Emmaton	84	87	75	0	0	0	0	0	0	0	0	1
Sacramento River at Collinsville	89	91	84	0	0	0	0	0	0	0	0	0
San Joaquin River at Jersey Island	75	83	63	0	0	0	0	0	0	0	0	0
San Joaquin River at mouth of Old River	48	66	28	0	0	0	0	0	0	0	0	0
Old River at Holland Tract	24	49	7	0	0	0	0	0	0	0	-1	0
Middle River at Empire Cut	12	28	0	0	0	0	0	0	0	0	0	0
San Joaquin River west of Rough and Ready Island	24	40	6	0	0	0	0	0	0	0	0	0
San Joaquin River at Mossdale	13	25	3	0	0	0	0	0	0	0	-1	0
Suisun Bay at Port Chicago	-1	-1	-3	0	0	0	0	0	0	0	0	0
Montezuma Slough	-1	0	4	0	0	0	0	0	0	0	0	0

* Modeling results presented in this table have been updated based on analysis for the Final EIS/EIR.

~~on Old River at Holland Tract under the Future Without Project condition under severe fishery restrictions should be considered:~~

- ~~As indicated in Table 4.3-17, on average in the without project condition, 45 percent of particles released in the spring pass Chipps Island within 120 days. The variability around the average is characterized by the standard deviation. For the same time period, the standard deviation is 28 percent, indicating that a reduction of 4 to 5 percent in Alternatives 1 and 2 in comparison to the without project condition is a small fraction of the variability in the without project condition.~~
- ~~On average in the without project condition, 25 percent of particles originating on Old River at Holland Tract are entrained into agricultural diversions. In Alternatives 1 and 2, this increases to 30 percent – an increase of 5 percent, which corresponds to the reduction in particles passing Chipps Island. Alternatives 1 and 2 do not increase or otherwise alter agricultural diversions; the 5 percent increase in particles entrained in the agricultural diversions appears to be an artifact of the modeling, and does not directly result from the operation of the project alternatives.~~

Overall, the particle tracking results presented in Table 4.3-17 indicate no significant changes in particle behavior between the Future Without Project and each of the 2030 level of development project alternatives~~ under severe fishery restrictions~~, with respect to their movement through the Delta. These results are representative of the particle tracking studies analyzed for the project alternatives (see Appendix C7 (Vol. 4) for additional results), and they support the conclusion that the project alternatives do not create adverse impacts related to changes in hydrologic conditions in terms of Delta circulation.

Qwest. Qwest is a measure of the net flow in the lower San Joaquin River near Sherman Island. Flows in this region are strongly tidal, and the net (i.e., tidally averaged) flow is generally less than 5 percent of the peak flow rate. For instance, flows in the San Joaquin River at Jersey Point generally vary tidally between +150,000 cfs and -150,000 cfs, while net flow is generally between +10,000 cfs and -5,000 cfs.

A condition described as “reverse flows” as measured by the Qwest parameter occurs when Delta diversions and agricultural demands in the south and central Delta exceed the inflow into the central Delta, such that net flow on the lower San Joaquin River is to the east. Inflow into the central Delta is composed of San Joaquin River inflow, Sacramento River flow through the Delta Cross Channel, Georgiana Slough, and Three Mile Slough, and flows from rivers along the eastern side of the Delta, including the Mokelumne, Co~~n~~sumnes and Calaveras rivers.

Eastward flow on the lower San Joaquin River is measured as a negative value of the Qwest parameter. This condition occurs frequently during dry years with low Delta inflows and high levels of export at the SWP and CVP facilities in the south Delta. Net reverse flows are particularly common during summer and fall when nearly all exported water is drawn across the Delta from the Sacramento River (DWR and Reclamation, 1994). The Qwest parameter has been hypothesized to be correlated with fish abundance in the Delta, such that negative values of Qwest could indicate greater potential for fish entrainment at Delta export facilities. Analysis of model and historical data to date has not conclusively shown such a relationship. However, the effects of project alternatives on Qwest is provided here for reference, and to more completely describe the project effects on the aquatic environment of the Delta.

As shown in **Table 4.3-18** and **Table 4.3-19,** modeled estimates of net reverse flow conditions on the lower San Joaquin River (i.e., negative values for Qwest) occur in the existing and future without project conditions primarily from July through ~~November~~September. In dry and critical water years, net reverse flows often extend into December and January (see Appendix C7 (Vol. 4) for monthly averages by water year type).

For Alternatives 1~~ and~~, 2 and 4, the maximum incremental decreases in Qwest tend to occur in April and May, when Qwest values are generally positive and typically exceed 5,000 cfs. Thus, the effect of a decrease during that time is not significant. This is a result of the ~~focus of the project alternatives on use of surplus flows,~~coordination of the operation of the project alternatives with the modified operations of the CVP and SWP under the OCAP BOs, as described in Section 4.2 (Vol. 4, Chapter 5, Section 5.3)~~, which generally means that Qwest is positive when the use of the surplus flows (which cause the resultant Qwest decrease) occurs~~. The effect of the No-Diversion Period is evident in Alternatives 1~~ and~~, 2 and 4 in ~~April~~March, when Qwest flows are consistently made more positive. During the periods when Qwest is reversed (from July through ~~November~~September), the Qwest

TABLE 4.3-18 (REVISED)*
LONG-TERM MONTHLY AVERAGE OF QWEST UNDER 2005 LEVEL OF DEVELOPMENT

		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Existing Condition		310	139	452	5,850	7,993	7,001	9,030	7,479	3,201	-2,094	-2,350	-1,662
Change from Existing Condition	Alt 1	-22	-30	26	-66	-33	149	-151	-53	-33	-45	5	-4
	Alt 2	-26	-44	23	-78	-42	114	-154	-58	-41	-15	-3	-7
	Alt 4	-14	-4	18	-53	-22	67	-143	-41	-15	-14	7	1

* Modeling results presented in this table have been updated based on analysis for the Final EIS/EIR.

Alt = alternative
cfs = cubic foot (feet) per second
QWEST = Parameter that represents the estimated net westward flow of the San Joaquin River at Jersey Point

TABLE 4.3-19 (REVISED)*
LONG-TERM MONTHLY AVERAGE OF QWEST UNDER 2030 LEVEL OF DEVELOPMENT

		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Future Without Project		554	236	520	5,802	7,870	7,193	9,994	7,524	3,150	-1,937	-2,316	-1,631
Change from Future Without Project	Alt 1	2	-64	-2	-35	29	189	-234	-73	17	-32	1	18
	Alt 2	-3	-80	38	-37	22	150	-238	-82	9	-34	1	12
	Alt 4	-4	1	-39	-2	29	114	-215	-73	18	-16	3	14

* Modeling results presented in this table have been updated based on analysis for the Final EIS/EIR.

Alt = alternative
cfs = cubic foot (feet) per second
QWEST = Parameter that represents the estimated net westward flow of the San Joaquin River at Jersey Point

decreases caused by project operations are small and would not cause significant changes in habitat. ~~The effects of Alternative 3 on Qwest are generally smaller than those of Alternatives 1 and 2. Similar to Alternatives 1 and 2, the greatest reductions in Qwest occur during times of ample Qwest flow. Alternative 4 has the smallest effects on Qwest of all the alternatives.~~ Results of these analyses show that the impacts of changes in hydrologic conditions affecting Qwest under each of the proposed project alternatives would be less than significant.

Old and Middle Rivers (OMR). The USFWS and NMFS OCAP BOs contain limits on allowable net reverse flow in Old and Middle rivers. These limits are included in the updated modeling used for this analysis, as described in Section 5.3. The reference net flow in Old and Middle Rivers is normally defined to be in the northerly direction, i.e. towards San Francisco Bay. A net reverse flow condition can occur within Old and Middle Rivers as the rate of water exported at the SWP and CVP export facilities exceeds tidal and downstream flows within the central region of the Delta. This condition would be represented by a negative value of net flow in Old and Middle rivers. There have been concerns regarding the effects of net reverse flows on fish populations and their food supply, as well as the effects of net reverse flows on delta smelt salvage (DWR and Reclamation, 1994). Net reverse flows in Old and Middle rivers, resulting from low San Joaquin River inflows and increased exports at the SWP and CVP facilities in the south Delta, have been identified as a potential cause of increased delta smelt take at the SWP and CVP fish facilities (Simi and Ruhl, 2005; Ruhl et al., 2006). Analyses of the relationship between the magnitude of net reverse flows in Old and Middle Rivers and salvage of adult delta smelt in the winter shows a substantial increase in salvage as net reverse flows exceed about -5,000 cfs (meaning the net flow is more negative than -5,000 cfs). Concerns regarding net reverse flows in Old and Middle River have also focused on planktonic egg and larval stages of striped bass, splittail, and on chinook salmon smolts, in addition to delta smelt, and while these species do not spawn to a significant extent in the southern Delta, eggs and larvae may be transported into the area. As discussed previously, these early life stages are generally entrained by the CVP and SWP export pumps, since they are too small to be effectively screened.

The most biologically sensitive period when the potential effects of net reverse flows could affect delta smelt, chinook salmon, and many other species extends from the late winter through early summer (December through June). Generally, increases in net flow during this time period may be considered beneficial while decreases to net flow indicate potential adverse effects. However, the extent of the benefit or adverse effect depends on the magnitude of the net flow. For instance, as mentioned above, salvage of delta smelt at the export facilities increases substantially as net reverse flows in Old and Middle River exceed -5,000 cfs. Therefore, an incremental decrease (relative to the without project condition) in net flow when net flow in the without project condition is near -5,000 cfs could be potentially adverse, while an incremental increase could be beneficial. On the other hand, if net flow in the without project condition is greater (meaning more northward) than -3,000 cfs, an incremental change may not have a significant effect (either beneficial or adverse).

~~Modeling for the project alternatives includes constraints on export diversions at the SWP Banks and CVP Jones pumping facilities to meet reverse flow requirements in the Old and Middle rivers that are similar to those specified in the *NRDC vs. Kempthorne* interim remedies order. Since the Common Assumptions effort has not yet developed a standard constraint equation for Old and Middle River flows, the Common Assumptions version of the CalSim II model was revised to include scenarios for moderate and severe fishery restrictions in the Delta (see Appendix C-3); net flow in Old and Middle rivers in CalSim II was estimated using the flow in the San Joaquin River at Vernalis, pumping at the SWP Banks and CVP Jones pumping facilities, and the portion of the pumping at the Los Vaqueros intakes that had been shifted from SWP and CVP facilities for the South Bay water agencies (Alternative 1 and Alternative 2). The constraints on export diversions at SWP Banks and CVP Jones pumping facilities to meet Old and Middle River flow requirements did not include the portion of pumping at the Los Vaqueros intakes that is used to meet CCWD demand and other project benefits (including Delta Supply Restoration in Alternative 1 and Dedicated Storage for Environmental Water in Alternative 2), either through direct diversion or diversion to storage.~~

To determine the effects of all project diversions, the DSM2 Delta hydrodynamics model calculates flows in Old and Middle Rivers based upon all simulated boundary flows and diversions, including all diversions at the Los Vaqueros intakes. ~~To provide context with respect to operational restrictions implemented by the *NRDC vs. Kempthorne* interim remedies order to protect delta smelt as of December 2007,~~ Old and Middle River net flow was calculated ~~using~~ from simulated tidal flows (as determined by DSM2 modeling) on Old and Middle ~~R~~rivers near the locations regulated in the OCAP BOs ~~referred to within the court documents~~. **Table 4.3-20** and **Table 4.3-21** presents a

**TABLE 4.3-20*
LONG-TERM MONTHLY AVERAGE OF OLD AND MIDDLE RIVER NET FLOW
USING DELTA FLOW MODEL (DSM2) UNDER 2005 LEVEL OF DEVELOPMENT**

**Old and Middle River Net Flow
Long-term Monthly Average of Tidally Filtered Simulated Values (cfs)
2005 Level of Development**

		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Existing Condition		-5,409	-5,312	-5,129	-3,288	-2,543	-623	1,110	651	-3,023	-8,672	-7,559	-6,752
Change from Existing Condition	Alt 1	-25	-70	29	-8	16	116	-79	-15	27	74	20	-64
	Alt 2	-44	-96	25	-40	2	86	-93	-42	19	73	21	-77
	Alt 4	54	-47	90	15	17	19	-23	-8	108	96	-31	-55

* Modeling results presented in this table have been updated based on analysis for the Final EIS/EIR.

Alt = alternative
cfs = cubic foot (feet) per second

**TABLE 4.3-21*
LONG-TERM MONTHLY AVERAGE OF OLD AND MIDDLE RIVER NET FLOW
USING DELTA FLOW MODEL (DSM2) UNDER 2030 LEVEL OF DEVELOPMENT**

**Old and Middle River Net Flow
Long-term Monthly Average of Tidally Filtered Simulated Values (cfs)
2030 Level of Development**

		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Future Without Project		-5,169	-5,037	-5,048	-3,142	-2,367	-461	1,402	677	-2,995	-8,643	-7,549	-6,923
Change from Future Without Project	Alt 1	-59	-67	-30	-47	-7	101	-71	-7	-1	-53	-7	-22
	Alt 2	-80	-85	-33	-53	-16	71	-86	-44	-11	-68	-8	-36
	Alt 4	-10	-2	8	6	3	0	-2	-11	-2	-19	-1	1

* Modeling results presented in this table have been updated based on analysis for the Final EIS/EIR.

Alt = alternative
cfs = cubic foot (feet) per second

summary of the results for the 2005 and 2030 level of development, respectively, with additional results presented in Appendix C7 (Vol. 4). Incremental changes to Old and Middle River net flow are reflective of modifications in the diversions at Delta water intakes, or changes in releases from upstream reservoirs, such as Shasta, Folsom and Oroville.

Analysis of Old and Middle River net flow indicates that the project alternatives could cause small positive and negative changes in the net flow. Under terms of the OCAP BOs, operational restrictions may be imposed from December through June to meet requirements for net OMR flow. Decreases in net OMR flow during this period would have the potential to cause fish entrainment impacts; increases in net OMR flow from December to June or changes in net OMR flow outside of the December through June period are assumed to not have effects on fish entrainment. ~~The changes attributable to the project alternatives are generally very small, rarely greater than 200 cfs. This level of change to net flow is below the level that would cause direct impacts to fish in the rivers. This conclusion is supported by comparing the resulting change in velocity in Old River from a 200 cfs change in Old and Middle River flow to the maximum approach velocity of 0.2 fps that is conservatively required at screened intakes in the Delta to avoid entrainment or impingement of~~

~~delta smelt. Assuming a cross sectional area in Old River of about 10,000 square feet, a change in velocity in Old River from a change in Old River flow of 200 cfs would be conservatively estimated at 0.02 fps, or about one tenth of the velocity that is prescribed at intakes to ensure delta smelt protection.~~

Updated operations assumptions were used in this modeling analysis, including operational coordination between CCWD, Reclamation and DWR to improve overall Delta fish protection, as described in the updated Section 4.2(Vol. 4, Section 5.3). The coordination between CCWD, CVP and SWP includes shifting filling of Los Vaqueros Reservoir into April and May, when the CVP and SWP are operating the Delta such that net OMR flow is generally positive. The coordinated operation between CCWD, Reclamation and DWR also assumes that filling of Los Vaqueros Reservoir would be limited by the conditions of the Los Vaqueros Reservoir no fill period during February, March and June, when OMR net flow regulations are typically limiting CVP and SWP water exports from the Delta. Reductions in OMR net flow in December and January are small, and are concentrated in wetter years, as indicated in the tables presented in Appendix C7 (Vol. 4), which will reduce any possible effect. None of the changes in OMR net flow are large enough to result in adverse impacts on the Delta fishery or habitat.

Alternative 1

The analysis of incremental changes in flows upstream of the Delta, including total Delta inflow, Sacramento River at Freeport, and San Joaquin River at Vernalis, in Alternative 1 relative to without project conditions, indicates a less than significant effect on the Delta fishery. Similarly, the analysis of changes to parameters currently regulated by SWRCB D-1641 for fish and wildlife beneficial use, including net Delta outflow, the location of X2, and the E/I ratio, indicates a less than significant effect on the Delta fishery. Additionally, analysis of changes in Delta circulation as indicated by particle tracking analysis, Qwest, and net flow in Old and Middle rivers, indicates a less than significant effect on the Delta fishery.

Because each of the analyses performed to evaluate indirect effects of project operations indicated a less than significant impact on the Delta fishery, the facilities and operations under Alternative 1 would not result in significant changes in Delta hydrologic conditions that affect Delta fish populations or quality and quantity of aquatic habitat within the Sacramento-San Joaquin River system, including the Delta.

Alternative 2

The analysis of incremental changes in flows upstream of the Delta, including total Delta inflow, Sacramento River at Freeport, and San Joaquin River at Vernalis, in Alternative 2 relative to without project conditions, indicates a less than significant effect on the Delta fishery. Similarly, the analysis of changes to parameters currently regulated by SWRCB D-1641 for fish and wildlife beneficial use, including net Delta outflow, the location of X2, and the E/I ratio, indicates a less than significant effect on the Delta fishery. Additionally, analysis of changes in Delta circulation as indicated by particle tracking analysis, Qwest, and net flow in Old and Middle rivers, indicates a less than significant effect on the Delta fishery.

Because each of the analyses performed to evaluate indirect effects of project operations indicated a less than significant impact on the Delta fishery, the facilities and operations under Alternative 2 will would not result in significant changes in Delta hydrologic conditions that affect Delta fish populations or quality and quantity of aquatic habitat within the Sacramento-San Joaquin River system, including the Delta.

~~*Alternative 3*~~

~~The analysis of incremental changes in flows upstream of the Delta, including total Delta inflow, Sacramento River at Freeport, and San Joaquin River at Vernalis, in Alternative 3 relative to without project conditions, indicates a less than significant effect on the Delta fishery. Similarly, the analysis of changes to parameters currently regulated by SWRCB D-1641 for fish and wildlife beneficial use, including net Delta outflow, the location of X2, and the E/I ratio, indicates a less than significant effect on the Delta fishery. Additionally, analysis of changes in Delta circulation as indicated by particle tracking analysis, Qwest, and net flow in Old and Middle rivers, indicates a less than significant effect on the Delta fishery.~~

~~Because each of the analyses performed to evaluate indirect effects of project operations indicated a less than significant impact on the Delta fishery, the facilities and operations under Alternative 3 would not result in significant changes in Delta hydrologic conditions that affect Delta fish populations or quality and quantity of aquatic habitat within the Sacramento-San Joaquin River system, including the Delta.~~

Alternative 4

The analysis of incremental changes in flows upstream of the Delta, including total Delta inflow, Sacramento River at Freeport, and San Joaquin River at Vernalis, in Alternative 4 relative to without project conditions, indicates a less than significant effect on the Delta fishery. Similarly, the analysis of changes to parameters currently regulated by SWRCB D-1641 for fish and wildlife beneficial use, including net Delta outflow, the location of X2, and the E/I ratio, indicates a less than significant effect on the Delta fishery. Additionally, analysis of changes in Delta circulation as indicated by particle tracking analysis, Qwest, and net flow in Old and Middle rivers, indicates a less than significant effect on the Delta fishery.

Because each of the analyses performed to evaluate indirect effects of project operations indicated a less than significant impact on the Delta fishery, the facilities and operations under Alternative 4 would not result in significant changes in Delta hydrologic conditions that affect Delta fish populations or quality and quantity of aquatic habitat within the Sacramento-San Joaquin River system, including the Delta.

<u>The analysis performed for the Draft EIS/EIR found no significant changes that would adversely affect Delta hydrologic conditions that in turn affect Delta fish populations or quality and quantity of aquatic habitat within the Sacramento-San Joaquin River system, including the Delta. When compared to the analysis performed for the Draft EIS/EIR, the conclusion presented above for the updated modeling analysis regarding potential impacts of Alternatives 1, 2 and 4 on Delta hydrologic conditions that affect Delta fish populations or habitat has not changed.</u>

Mitigation: None required.

Impact 4.3.7: Operation of the new screened intake, or changes to diversions at existing intakes, could affect direct entrainment or impingement of fish. (Beneficial for Alternatives 1 and 2; ~~Significant and Unavoidable for Alternative 3;~~ Less than Significant for Alternative 4)

~~Three~~Two independent types of analyses were used to evaluate changes in the potential risk of Delta fish entrainment for each of the project alternatives, which included:

- Indices for potential entrainment based on average ~~fish~~ density of adult salmonid species near Delta water intakes
- Particle tracking analysis (using the DSM2 PTM tool) to assess potential entrainment for larval fish throughout the Delta, including an evaluation of general particle fate 120 days after release from selected locations; and a determination of a higher resolution Potential Entrainment Index (PEI) that combined particle tracking results with historical CDFG survey data for delta smelt, longfin smelt and striped bass ~~to assess potential entrainment for larval fish~~
- ~~Indirect estimates of potential entrainment based on a flow index correlated with delta smelt salvage at the export facilities~~

These analyses used the same hydrologic modeling results used in evaluation of Impact 4.3.6, which describe water diversion operations over a range of environmental and hydrologic conditions (see Appendix C (Vol. 4) for full details on the modeling methodology and results). The seasonal timing and magnitude of water diversions from the Delta may affect aquatic species directly through entrainment or impingement. Hydrologic and hydrodynamic modeling results provide the technical foundation for assessing adverse effects of diversion operations on fish species and their habitats within the Bay-Delta estuary. The assessment relies on a comparative analysis of operational and resulting environmental conditions within the estuary under without-project operations and with the project alternatives (including both 2005 and 2030 levels of development).

Each of the methods presented below has specific assumptions and limitations; therefore, ~~all~~ both methods should be examined when evaluating impacts and benefits. Central Valley steelhead and chinook salmon species, which include winter run, spring run, fall run, and late fall run salmon, were analyzed using the entrainment index method based on fish salvage data. Delta smelt, longfin smelt, and striped bass were analyzed using the particle tracking/PEI analysis, due to the availability of spatial and temporal data for the larval fish. Effects on green sturgeon were evaluated using the results of the particle fate analysis. Detailed discussion of the methodology for each analysis and comprehensive results are contained in Appendix C7 (Vol. 4). Summary tables of key parameters are provided below for discussion.

Entrainment Indices Based on Average Fish Density Near Delta Water Intakes

Fish entrainment indices were developed to estimate changes in entrainment potential based on comparisons of the location, timing, volume of modeled diversions at Delta intakes (when, where, and how much pumping occurs) and ~~observed spatial and~~ temporal patterns of fish density observed at the salvage stations (when, where, and how many fish are present). The analysis used to produce the indices combined the use of intake diversion values based on hydrologic modeling with fish density estimates derived from ~~actual regional fishery surveys that CDFG conducted within the Delta and Suisun Bay, or~~ the results of fish salvage monitoring at the SWP and CVP export facilities. The presence and effectiveness of positive barrier fish screens was also incorporated into the analysis. As described in the updated Section 4.2 (Vol. 4, Chapter 5, Section 5.3), a positive barrier fish screen is not assumed to be operated in the Existing Conditions, but is assumed to be operated in the project alternatives for the existing level of development. The Future Without Project and all project alternatives in the future level of development were assumed to include operation of a positive barrier fish screen at the Rock Slough Intake.

The analysis produced potential entrainment indices for ~~delta smelt, longfin smelt, striped bass, and~~ Central Valley steelhead, winter-run, spring-run, fall-run, and late fall-run chinook salmon for water intakes related to the Los Vaqueros Reservoir Expansion Project, including the Old River, Rock Slough and AIP intakes, the new Delta Intake, the SWP Banks Pumping Plant and the CVP Jones Pumping Plant. Flows used in fish entrainment analyses for Alternatives 1 and 2 include CCWD direct diversions, filling of Los Vaqueros Reservoir, and Delta diversions to the South Bay Agencies, which include diversions made through Los Vaqueros facilities and diversions made at CVP and SWP Delta facilities. ~~Flows used for the fish entrainment analyses in Alternative 3 include CCWD direct diversions, filling of Los Vaqueros Reservoir, and diversions made at Jones pumping plant from July through November to convey additional environmental water supply through the Delta to San Joaquin Valley refuges.~~ Flows used for the fish entrainment analyses in Alternative 4 include CCWD diversions and filling of Los Vaqueros Reservoir.

The total diversions associated with each project alternative are used in this entrainment analysis, including diversions for CCWD and diversions at the CVP and SWP export facilities that occur in the without project conditions and in each of the project alternatives. This is done to ensure that the effects of each project alternative are analyzed, including minor changes in timing or location of diversions for CCWD. This method allows the total entrainment index calculated for each of the project alternatives to be compared with the entrainment index calculated for the without project condition. The indices are calculated for each alternative to represent the combined entrainment potential for all intakes. For a detailed description of the methods and data used to develop the entrainment indices see Appendix C7 (Vol. 4).

The index values are not intended to specifically represent the actual number of fish entrained, as they are based on average fish densities calculated from the results of many surveys. As such, these index values are used for relative comparison of the effects of project alternatives. For example, a project that reduces the entrainment index value for a species of fish relative to the without project index value (reflected in a negative entrainment index) is interpreted to be creating conditions that result in less entrainment of that species. **Table 4.3-22** presents the average percent change in fish entrainment from the without project conditions (Existing Condition for 2005 level of development and Future Without Project for the 2030 level of development) for each of the project alternatives for each of these species. For additional detail, see Appendix C7 (Vol. 4).

TABLE 4.3-22 (REVISED)
PERCENT CHANGE IN ENTRAINMENT INDEX
FROM THE WITHOUT PROJECT CONDITIONS

Alternative	Winter Run Salmon	Spring Run Salmon	Fall Run Salmon	Late Fall Run Salmon	Central Valley Steelhead
2005 Level of Development					
Alt 1	0.0%	-10%	-6.5%	-4.2%	-3.6%
Alt 2	0.0%	-10%	-6.5%	-4.2%	-3.6%
Alt 4	0.0%	-3.3%	-1.6%	0.0%	-1.2%
2030 Level of Development					
Alt 1	0.0%	-6.5%	-6.5%	-4.2%	-2.4%
Alt 2	0.0%	-6.5%	-6.5%	-4.2%	-2.4%
Alt 4	0.0%	0.0%	0.0%	0.0%	0.0%

The values presented in Table 4.3-22 indicate that a net reduction in potential fish entrainment, which represents a fishery benefit, is created in Alternatives 1, and 2, and 4. In Alternatives 1 and 2, this benefit is largely the result of improved fish screening caused by shifting water deliveries to South Bay water agencies onto the expanded Los Vaqueros Reservoir system. For Alternative 4, the benefit is smaller, and is due mainly to an increase in the years that the No-Diversion Period would apply relative to without project conditions, because the increased storage available would reduce the number of exemptions (due to low reservoir conditions) from the No-Diversion Period that would occur, particularly in dry periods.

~~Alternative 3 actually increases the potential for fish entrainment, largely due to the increase in pumping at Los Vaqueros intakes in fish-sensitive months in this alternative which are not offset by a corresponding reduction in pumping at less efficiently screened SWP or CVP intakes, as in Alternatives 1 or 2. To reduce or avoid these impacts, the operating assumptions could be revised to limit diversions at times when Delta fish could be impacted. Any changes to the operational assumptions would require a reassessment of the benefits and potential impacts of Alternative 3.~~

Particle Tracking Analysis to Assess Potential Entrainment of Larval Fish

The PTM tool described in the analysis of Impact 4.3.6 was also used to evaluate potential entrainment for larval fish. As indicated in the discussion of Impact 4.3.6, PTM studies estimate the influence of modeled Delta hydrodynamics on neutrally buoyant particles. As such, the studies are only appropriate to represent the movement of organic material and organisms that would behave as passively drifting particles. The particles are not considered to reflect movements of juvenile or adult fish within the Delta. Entrainment of juvenile and adult fish is evaluated with the Entrainment Index method described in the previous section~~, above, and the Flow Surrogate method for delta smelt salvage, described below~~. The particle tracking analysis used to assess potential entrainment of larval fish consists of one evaluation of particle fate after 120 days, and another evaluation over a 30 day timeframe in which particle tracking results are weighted by historical survey information to take into account spatial and temporal variability of specific sensitive species.

Because the PTM tool does not account for fish screens, the results have been post-processed to incorporate the efficiency of positive barrier fish screens at the Rock Slough (except in the Existing Condition), Old River and AIP intakes and the new Delta Intake. The long term~~is~~ analysis assumes that larvae are 5 mm in length (the approximate size of delta smelt when they hatch) and do not grow during the ~~120-day~~ simulation periods, which results in a conservative application of a relatively low screen efficiency, independent of growth since release (or "hatch") in the Delta. This method determines what fraction of larvae will be excluded by the positive barrier fish screens. ~~, but does not determine t~~The ultimate fate of the ~~larvae~~particles considered ~~that are protected~~excluded by the screens is accounted for in post processing by determining the proportional re-entrainment at other diversions based on the results of particle insertions near the screened intakes. ~~, which is a limitation of the PTM tool.~~

~~The particle tracking analysis is not specific to any species, and therefore does not consider fish distribution information. The results are summarized seasonally to allow interpretation for seasonal variability of fish movement.~~ A more detailed description of PTM methodology and limitations is provided in Appendix C7 (Vol. 4).

The results of the 120 day analysis are shown in **Table 4.3-23**, which presents ~~shows~~ the percentage of neutrally buoyant particles that are potentially entrained at any of the relevant water intakes, including the Rock Slough, Old River, ~~Rock Slough~~ and AIP intakes, the new Delta Intake, the SWP Banks Pumping Plant and the CVP Jones Pumping Plant, and the combined set of agricultural intakes, within 120 days after the particles originated at the specified release locations. The three leftmost numeric columns of each table show the average percentage of particles that are potentially entrained for the without project condition during Winter (December through February), Spring (March through June), and Fall (September through November). The remaining columns indicated by each project alternative, show the change from the without project condition in percentage of particles that are potentially entrained for each season. Results from the future (2030) level of development ~~with severe fishery restrictions~~ are shown within this summary because the greatest incremental change due to the project Alternatives occurs under this set of conditions. Additional results are provided in Appendix C7 (Vol. 4).

~~In Alternatives 1 and 2, a reduction in the percentage of particles entrained generally reflects a benefit of reduced potential for fish entrainment in these alternatives. The benefits are related to the relocation of some South Bay water agencies' Delta diversions to the expanded Los Vaqueros system, which provides improved fish screening relative to the SWP and CVP facilities. The benefit for larval fish as determined by PTM is not as substantial as the reductions for individual species evaluated with the fish indices discussed above because the PTM analysis assumes all larvae hatch at 5mm in length and do not grow after hatching. Because positive barrier fish screens are less than 100% efficient for the smaller size classes (e.g., planktonic larvae less than about 15 mm), this assumption results in a conservative estimate for the number of larval fish protected by positive barrier fish screens.~~

TABLE 4.3-23 (REVISED)*
LONG-TERM, SEASONAL AVERAGE PERCENT OF PARTICLES POTENTIALLY ENTRAINED 120 DAYS AFTER PARTICLES ARE RELEASED AT DESIGNATED LOCATIONS 2030 LEVEL OF DEVELOPMENT

	Future Without Project			Change from Future Without Project								
				Alt 1			Alt 2			Alt 4		
Release Location	**W**	**S**	**F**	**W**	**S**	**F**	**W**	**S**	**F**	**W**	**S**	**F**
Sacramento River at Freeport	21	22	44	0	0	0	0	0	0	0	0	0
Sacramento River above Delta Cross Channel	27	21	52	0	0	0	0	0	0	0	0	0
Cache Slough at Sac Ship Channel	18	64	33	0	0	0	0	0	0	0	0	0
Sacramento River at Rio Vista	12	10	25	-1	-2	-1	0	0	0	0	0	0
Sacramento River at Emmaton	6	5	14	0	0	0	0	0	0	0	0	0
Sacramento River at Collinsville	2	2	5	0	0	0	0	0	0	0	0	0
San Joaquin River at Jersey Island	16	10	28	0	0	0	0	0	0	0	0	0
San Joaquin River at mouth of Old River	47	28	67	0	0	0	0	0	0	0	0	0
Old River at Holland Tract	73	47	92	0	0	0	0	0	0	0	1	0
Middle River at Empire Cut	88	71	100	0	-1	0	0	-1	0	0	1	0
San Joaquin River west of Rough and Ready Island	72	57	92	-1	-1	0	0	-1	0	-1	0	0
San Joaquin River at Mossdale	84	73	95	0	0	0	0	0	0	0	1	0
Suisun Bay at Port Chicago	0	0	1	0	0	0	0	0	0	0	0	0
Montezuma Slough	0	0	0	0	0	0	0	0	0	0	0	0

* Modeling results presented in this table have been updated based on analysis for the Final EIS/EIR.

PTM results for ~~Alternatives 3 and 4 show~~ all alternatives show no significant change from the without project condition, as all changes remain below 2 percent, which is within the noise of the CalSim II model (see Section 4.2 [Vol. 4, Chapter 5, Section 5.3]) and also relatively low when compared to the seasonal variability.

To incorporate the location and timing of species present within the Delta, an additional analysis was applied using PTM results during the March-June period, when larval stage fish are most vulnerable due to their presence in the Delta, and when there is a substantial record of fish survey data available. The method used was adapted from the Potential Entrainment Index (PEI) method recently developed by DWR to assess effects of operations on larval stage entrainment based on CDFG 20mm survey data (Nam, 2009). To implement the PEI method as used for the analysis in this Final EIS/EIR, particle insertions were made at points associated with 20mm survey locations. The particles were then weighted according to historical 20mm survey data for delta smelt, longfin smelt and striped bass. After 30 days (the assumed growth period after which representation by neutrally buoyant passive particles is no longer appropriate), the cumulative entrainment fate of the weighted particles was resolved by summing across all insertion points for each intake. The effectiveness of positive barrier fish screens at the CCWD intakes was incorporated in post processing, and an approximate determination of the fate of screened particles was made as described above for the indirect effects analysis. Results are combined for the March through

June time period, and normalized by the total survey population to obtain a final PEI that represents the percentage of population entrained for a given scenario. The PEI provides a metric that accounts for spatial distribution and timing of specific sensitive species within the estuary, and allows the particle tracking results to be reviewed in an appropriate biological context. Additional detail on the PEI method and results is available in Appendix C7 (Vol. 4).

The results of the PEI analysis for delta smelt, longfin smelt and striped bass are shown in **Table 4.3-24**. The PEI shown below reflects the combined entrainment occurring at the Rock Slough, Old River and AIP Intakes, the New Delta Intake, SWP Banks Pumping Plant and the CVP Jones Pumping Plant.

TABLE 4.3-24
CHANGES IN POTENTIAL ENTRAINMENT INDEX (PEI) FOR MARCH-JUNE

Species	Existing Condition	Change in PEI from Base Alt1	Alt2	Alt4
2005 Level of Development				
Delta Smelt	2.2%	-0.3%	-0.3%	-0.3%
Longfin Smelt	0.3%	0.0%	0.0%	0.0%
Striped Bass	4.3%	-0.3%	-0.3%	-0.4%
Species	**Future Without Project**	**Change in PEI from Base Alt1**	**Alt2**	**Alt4**
2030 Level of Development				
Delta Smelt	1.8%	0.0%	0.0%	0.0%
Longfin Smelt	0.3%	0.0%	0.0%	0.0%
Striped Bass	4.1%	-0.1%	-0.1%	0.0%

In both the 2005 and 2030 level of development, the PEI in the Existing Condition and the Future Without Project for delta smelt is well below the 10% level that has been deemed protective of the delta smelt population in the recent USFWS BO (USFWS, 2008).

Delta Flow Surrogate for Delta Smelt Salvage at Export Facilities

A flow surrogate for delta smelt salvage at the SWP and CVP export facilities was used as another metric for evaluating the potential effects of operations under each of the project alternatives on Delta fish species of concern. Field data show that delta smelt salvage at the SWP and CVP export facilities is related to export flow levels and San Joaquin River flow at Vernalis during the winter months. Consequently, a weighted sum of export pumping and San Joaquin flows (total exports plus one half the San Joaquin River flow at Vernalis) was found to be a valid surrogate measure for delta smelt salvaged at the SWP Banks and CVP Jones Pumping Plants, as described in Appendix C-7.

Table 4.3-24 presents the long-term monthly average values of the flow surrogate for fish salvage at the export facilities for each of the project alternatives from December through June. This time

TABLE 4.3-24
LONG-TERM MONTHLY AVERAGE AND LONG-TERM MONTHLY AVERAGE CHANGE OF FLOW SURROGATE FOR FISH SALVAGE

	December		January		February		March		April		May		June	
	Long-term Monthly Average	Average Change from Without Project Condition	Long-term Monthly Average	Average Change from Without Project Condition	Long-term Monthly Average	Average Change from Without Project Condition	Long-term Monthly Average	Average Change from Without Project Condition	Long-term Monthly Average	Average Change from Without Project Condition	Long-term Monthly Average	Average Change from Without Project Condition	Long-term Monthly Average	Average Change from Without Project Condition
2005 LEVEL OF DEVELOPMENT														
Moderate Fisheries Restrictions														
Existing Conditions	6900	--	5200	--	3500	--	2600	--	180	--	440	--	2100	--
Alternative 1	6600	-4%	4900	-5%	3200	-9%	2300	-14%	21	-89%	240	-45%	1800	-14%
Alternative 2	6600	-4%	5000	-4%	3200	-8%	2300	-12%	23	-89%	250	-43%	1800	-13%
Alternative 3	6900	1%	5400	3%	3500	1%	2800	6%	200	12%	440	0%	2100	0%
Alternative 4	6900	0%	5300	1%	3500	0%	2700	2%	190	4%	440	0%	2100	0%
Severe Fisheries Restrictions														
Existing Conditions	6800	--	5200	--	2800	--	740	--	-360	--	-170	--	270	--
Alternative 1	6500	-4%	4900	-6%	2500	-9%	380	-50%	-510	-42%	-350	-106%	34	-85%
Alternative 2	6500	-4%	4800	-7%	2500	-9%	390	-49%	-500	-42%	-350	-100%	47	-81%
Alternative 3	6900	1%	5300	2%	2700	0%	770	3%	-350	4%	-170	2%	270	0%
Alternative 4	6800	0%	5300	1%	2800	0%	750	0%	-370	-3%	-170	0%	270	0%
2030 LEVEL OF DEVELOPMENT														
Moderate Fisheries Restrictions														
Future Without Project	6900	--	5400	--	3700	--	2700	--	240	--	480	--	2100	--
Alternative 1	6600	-4%	5000	-7%	3400	-6%	2300	-12%	110	-54%	300	-38%	1900	-13%
Alternative 2	6600	-4%	5000	-7%	3400	-7%	2400	-11%	120	-50%	310	-35%	1900	-13%
Alternative 3	6900	1%	5400	1%	3800	2%	2900	7%	270	13%	490	1%	2100	0%
Alternative 4	6900	0%	5300	-1%	3700	0%	2700	1%	240	-1%	480	0%	2100	0%
Severe Fisheries Restrictions														
Future Without Project	6700	--	5300	--	2700	--	710	--	-340	--	-150	--	280	--
Alternative 1	6400	-5%	4900	-7%	2400	-8%	380	-46%	-460	-35%	-320	-113%	65	-79%
Alternative 2	6400	-4%	4900	-7%	2500	-7%	390	-45%	-460	-35%	-310	-107%	72	-75%
Alternative 3	6800	1%	5300	0%	2800	5%	870	21%	-310	11%	-160	-6%	280	1%
Alternative 4	6700	0%	5200	-2%	2700	1%	720	1%	-340	0%	-150	0%	280	1%

% = percent

~~period is presented because it captures the period in which delta smelt are typically susceptible to entrainment at the export facilities. This time period is also when the fishery restrictions included in the Existing Condition and Future Without Project are assumed to be implemented at the Banks and Jones facilities (see Appendix C-3).~~

~~As shown in Table 4.3-24, the flow surrogate values tend to be generally highest in December (within the months evaluated), and generally decrease until April, and then increase slightly in May and June. This pattern reflects the fishery restrictions that are imposed on the operation of the Banks and Jones facilities, in which export limitations are typically imposed beginning in December or January, and then generally become more restrictive in the spring. The lowest values in April and May also reflect changes in export rates under the VAMP operations, which can further decrease export pumping at Banks and Jones and increase San Joaquin River flows. The flow surrogate values are also generally lower in the severe restrictions cases than in the moderate restrictions cases, reflecting the difference in maximum allowed export levels under each set of assumptions. Alternatives 1 and 2 generally reduce the value of the flow surrogate, reflecting a fishery benefit due to potential reduction in delta smelt salvage at the SWP and CVP export facilities. This benefit is due to the reduction of diversions at the SWP and CVP Delta export facilities made possible by shifting South Bay water agencies' Delta diversions to the expanded Los Vaqueros system, through improved fish screening facilities. Alternatives 3 and 4 generally have less of an effect on the flow surrogate, as they do not shift any of the South Bay water agency diversions away from the SWP and CVP export facilities. Small changes in the average surrogate values between Alternatives 3 and 4 and the without project conditions reflect the threshold sensitivity of the CalSim II model (discussed in Section 4.2).~~

Alternative 1

Alternative 1 shows ~~significant~~ reductions in estimated potential entrainment ~~across all species using the fish entrainment index analysis, which is based on the fish monitoring data near Delta water intakes~~ for salmonid species, based on the salmonid salvage data collected at the CVP and SWP export facilities. Additionally, for larval fish originating within the ~~central~~ Delta, particle tracking analysis indicates ~~a reduction in potential entrainment; for larval fish originating in other areas of the Delta,~~ Alternative 1 would not cause impacts related to direct entrainment, and ~~would not significantly affect entrainment~~ could offer benefits.~~ Finally, using the flow surrogate analysis, Alternative 1 would generally reduce delta smelt salvage at the export facilities.~~

Upon comprehensive review, the individual analyses of direct entrainment for Alternative 1 indicate a net fishery benefit. For salmonids, ~~T~~this benefit is largely due to the fact that a portion of South Bay water agencies' Delta diversions would be shifted to the Los Vaqueros system, which provides improved fish screening relative to the SWP and CVP export facilities. The benefit could conceivably extend to adult stages of other species, such as delta smelt. As analyzed in this EIS/EIR, this reduction takes place at the same time as the shift to Los Vaqueros Reservoir system intakes;~~, but~~ the timing of the reduction in potential entrainment could be adaptively managed to further benefit fish as described in Chapter 3.

Alternative 2

Similar to Alternative 1, Alternative 2 shows ~~significant~~ reductions in estimated potential net entrainment losses across the salmonid ~~all~~ species using~~for~~ the entrainment index analysis. For larval fish originating in the Delta, particle tracking analysis confirms that Alternative 2 would not cause impacts related to direct entrainment, and could offer benefits. ~~a reduction in potential entrainment of larval fish originating in the Central Delta using the particle tracking analysis, no effect on larval fish originating at other areas of the Delta using the particle tracking analysis, and a reduction in potential delta smelt entrainment at the SWP Banks and CVP Jones export facilities from the flow surrogate analysis.~~

As with Alternative 1, the benefit to salmonids in Alternative 2 is largely due to shifting a portion of South Bay water agencies' Delta diversions to the Los Vaqueros system, which provides improved fish screening relative to the SWP and CVP export facilities; this operation could be adaptively managed to further benefit fish.

As with Alternative 1, a comprehensive review of the individual analyses of direct entrainment for Alternative 2 indicates a net fishery benefit.

~~*Alternative 3*~~

~~Alternative 3 shows a significant increase in potential entrainment losses compared to without project conditions using the entrainment index method, which is based on the fish monitoring data near Delta water intakes. This is a significant impact, which is caused by the operating rules assumed for these facilities in the hydrologic modeling.~~

~~Although the other two methods used to evaluate potential entrainment (PTM and flow surrogate) do not indicate conclusive changes to the risk of entrainment, the significant impacts illustrated with the entrainment index method are substantial. To reduce or avoid these impacts, the operating assumptions could be revised to limit diversions at times when Delta fish could be impacted. Any changes to the operational assumptions would require a reassessment of the benefits and potential impacts of Alternative 3. Therefore, Alternative 3 is determined to have a significant and unavoidable impact.~~

Alternative 4

Alternative 4 generally provides no change or, under 2005 level of development conditions, slight reductions in estimated potential entrainment using the entrainment index based on fish salvage monitoring ~~near the water intakes~~. Alternative 4 effectively increases available storage in Los Vaqueros Reservoir, so it reduces the number of instances in which the No Diversion Period is waived due to insufficient stored water in Los Vaqueros Reservoir.

~~As evident in~~Review of the particle tracking results~~,~~ indicates that Alternative 4 does not ~~produce a significant change in~~ cause impacts related to potential entrainment of larval fish at Delta water intakes, and may provide some benefits.

<u>The analysis performed for the Draft EIS/EIR found no significant changes that would adversely affect the direct entrainment or impingement of fish. When compared to the analysis preformed for the Draft EIS/EIR, the conclusion presented above for the updated modeling analysis regarding potential impacts of Alternatives 2 and 4 on entrainment or impingement of fish has not changed.</u>

~~The effects of Alternative 4 on the flow surrogate for delta smelt salvage are generally neutral. Small changes in the average surrogate values between this alternative and the without project condition reflect the threshold sensitivity of the CalSim II model (discussed in Section 4.2), and do not indicate any actual difference in Delta circulation or impact on Delta fisheries. The impacts of Alternative 4 would be less than significant.~~

Mitigation: None required for Alternatives 1, 2 and 4.~~ Alternative 3 has significant and unavoidable impacts.~~

Impact 4.3.8: Fish screen maintenance activities would not significantly increase fish entrainment at the new Delta Intake or the expanded Old River Intake. (Less than Significant for Alternatives 1, 2 and 3; No Impact for Alternative 4)

Alternative 1

As part of intake operation, routine maintenance would include fish screen cleaning as well as periodic screen panel removal for inspection, cleaning, and repairs if needed. Fish screen cleaning and debris removal, as part of routine screen operations, is typically accomplished using an automated mechanical brush and/or rake system. Debris removal is intended to maintain the uniformity of approach velocities across the fish screen surface within the design criteria (e.g., 0.2 fps). As part of routine screen maintenance, CCWD would maintain the screen cleaning mechanisms (e.g., replacement brushes) and would curtail diversion operations in the event that the screen cleaners are not operating in accordance with design criteria to avoid potentially significant adverse impacts (e.g., velocity hot spots that could result in increased vulnerability of fish to impingement on the screen surface) until the screen cleaners have been returned to routine operations.

Screen panels are periodically removed from an intake structure for inspection and repair. Typically panels are removed and inspected annually, or more frequently, in the event of damage to a screen panel. When a screen panel is removed from the intake fish and macroinvertebrates would be vulnerable to entrainment into the water diversion. CCWD would curtail diversion operations whenever a screen panel was removed from the intake. In the event that a screen panel is replaced by a stop-log or blank panel (solid panel with no screen mesh) the maximum diversion rate would be reduced proportionally to the reduction in screen area to maintain acceptable approach velocities across the remaining screen panels.

The new Delta Intake and/or expanded Old River intake is not anticipated to require maintenance dredging. The existing Old River intake and fish screen have not required any maintenance dredging since their operations were initiated in 1998. While it is possible that a new intake on a different location in Old River could experience different sedimentation conditions, the intake structure would be designed to minimize the likelihood of sediment accumulation. Maintenance dredging in the river channel outside the new Delta Intake structure, if necessary, would not be part of routine maintenance, and would be permitted separately.

Based on standard operating requirements, potential impacts to Delta fishery resources resulting from routine operations and maintenance of the fish screen would be less than significant.

Alternative 2

Potential impacts on Delta fisheries and aquatic resources resulting from periodic fish screen maintenance activities under Alternative 2 would be the same as those discussed for Alternative 1. As mentioned in the Alternative 1 discussion, routine maintenance dredging is not anticipated to be necessary. The impact associated with fish screen maintenance is expected to be less than significant.

Alternative 3

Alternative 3 does not include construction of a new Delta Intake on Old River, but does include enlargement of the existing intake structure on Old River. This enlargement would increase the fish screen maintenance cleaning, because of the enlarged screen surface area. However, as mentioned in the Alternative 1 discussion, the screen cleaning maintenance activities do not create impacts. Maintenance dredging is not anticipated for this alternative. This impact would therefore be less than significant, and no mitigation is required.

Alternative 4

Alternative 4 does not include construction of a new Delta intake on Old River, so would not increase the potential need for maintenance dredging or fish screen maintenance. No impact would occur and no mitigation is required.

<u>The updates to the modeling analysis of potential operational impacts of the project alternatives did not require re-analyzing Impact 4.3.8. The conclusions regarding this potential impact have not changed from those presented in the Draft EIS/EIR.</u>

Mitigation: None required.

Impact 4.3.9: The project alternatives, when combined with other planned projects or projects under construction in the area, could cumulatively contribute to substantial adverse impacts to Delta fisheries and aquatic resources. (Less than Significant with Mitigation for Alternatives 1, 2 and 4~~; Significant and Unavoidable for Alternative 3~~)

All Alternatives

Construction of Alternative 1 or 2 would result in impacts that would be mitigated to less-than-significant levels. No projects are known to be ongoing or planned in the direct vicinity of the in-channel work related to Alternatives 1 and 2 at the same time that the in-channel work would occur. (See list of water-side cumulative projects in subsection 4.1.3 (Vol. 1), supra.) Therefore, no localized cumulative construction impacts would occur. The construction of Alternatives 3 and 4 would not impact Delta fisheries or aquatic resources.

The new intake structure and fish screen under Alternatives 1 and 2 would modify existing aquatic habitat by replacement and addition of riprap and would physically exclude fish from a small area of existing aquatic habitat. Although the impact to aquatic habitat characteristics resulting from use of riprap under Alternatives 1 and 2 is less than significant, it could incrementally contribute to cumulative adverse impacts to the quality and availability of aquatic habitat within the Bay-Delta estuary. Construction of the fish screen would exclude fish from about 180 feet of shoreline along the channel margin of Old River. Mitigation Measure 4.6.2b (described in Vol. 2, Section 4.6, Biological Resources) calls for compensatory mitigation for the permanent loss of wetlands and open water habitat related to construction of the new Delta Intake and fish screens at a ratio of 2:1 for restoration and 3:1 for creation of wetland habitat. Implementation of this mitigation measure reduces the project contribution to this cumulative impact to a less than cumulatively considerable level.

Because the linear shoreline habitat where exclusion by the fish screen would occur represents only a fraction of the available habitat in the south Delta and is of low quality for rearing salmon, steelhead, and other species, this loss of aquatic habitat is not likely to adversely affect chinook salmon or steelhead populations, critical habitat for delta smelt or steelhead, or EFH for Pacific salmon within Old River and the Bay-Delta. The aquatic habitat is currently disturbed and is not unique. These factors, in conjunction with implementation of Mitigation Measure 4.6.2b, result in a less than cumulatively considerable effect on fish and their habitats.

As a result of the low design approach velocities (0.2 fps) for a water intake in the Delta, and the design of the intake to avoid hydraulic turbulence and disruption of local current patterns, long-term operation of Alternatives 1 and 2 would not be anticipated to modify hydraulic conditions next to the intake structures to a degree that would be cumulatively considerable, and no mitigation is proposed.

The analysis of Impact 4.3.6 and Impact 4.3.7 is a cumulative impact analysis, because the modeling takes into account other projects affecting Delta hydrologic conditions. As also discussed above, operation of Alternatives 1 and 2 would provide net benefits to the Delta fishery, so they would actually reduce cumulative impacts occurring in the Delta. ~~Alternative 3 would contribute to fishery impacts as evaluated herein.~~ Alternative 4 would generally provide small benefits to the Delta fishery and would not contribute to cumulative adverse impacts on Delta fisheries.

As described in the updated Section 4.2 (Vol. 4, Chapter 5, Section 5.3), the Delta Wetlands Project (DWP) was not included in modeling analysis for cumulative impacts because current modeling analysis of that project has not been provided by DWP. As described in the updated Section 4.2 (Vol. 4, Chapter 5, Section 5.3), qualitative analysis indicates that future operation of the Los Vaqueros Reservoir Expansion Project and the DWP is not likely to result in cumulative impacts to Delta hydrology or water quality. The DWP does have the potential to affect flows in the Delta, such that a cumulative impact on Delta fisheries or aquatic resources could be possible. However, it is assumed that environmental analysis performed for the DWP will limit their operations to those that are safe for the Delta ecosystem. Therefore, no cumulative impact on Delta fisheries or aquatic resources based on future operation of Los Vaqueros Reservoir Expansion Project and the DWP is anticipated.

The analysis performed for the Draft EIS/EIR found no cumulative impacts on Delta fisheries when considering the effects of the Los Vaqueros Reservoir Expansion Project along with the effects of other reasonably foreseeable projects. When compared to the analysis performed for the Draft EIS/EIR, the conclusion presented above for the updated modeling analysis regarding potential cumulative impacts of Alternatives 1, 2 and 4 with other reasonably foreseeable projects has not changed.

Mitigation for Cumulative Impacts: Implementation of Delta Fisheries and Aquatic Resources mitigation measures (measures 4.3.1, 4.3.2 and 4.3.3), together with Hazardous Materials Mitigation Measure 4.13.2, Hydrology mitigation measures 4.5-1a and Biological Resources Mitigation Measure 4.6.2b, will reduce potential impacts to less-than-significant levels. No additional measures will be required.

Impact Significance after Mitigation: Less than significant for Alternatives 1, 2 and 4. The cumulative entrainment impacts of Alternative 3 would be significant and unavoidable.