Draft
Delta Wetlands Place of Use Environmental Impact Report

April 2010

Prepared for:

Semitropic Water Storage District

Prepared by:

ICF INTERNATIONAL

Sacramento, California

Draft

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Executive Summary

Approach to the Executive Summary

This executive summary is intended to provide a concise distillation of the EIR for at-a-glance convenience. As such, EIR content is used verbatim to the maximum extent possible. The heading structure and titles are consistent between the executive summary and EIR to facilitate easy reference to EIR sections. The executive summary contents are limited to Chapter 1 (Introduction), Chapter 2 (Project Description and Alternatives), and a table of environmental effects.

Introduction—Summary

Overview

This Delta Wetlands Project Place of Use Environmental Impact Report (Place of Use EIR, or EIR) has been prepared under the direction of the Semitropic Water Storage District (Semitropic) in accordance with the requirements of the California Environmental Quality Act (CEQA). This Place of Use EIR analyzes potential environmental effects associated with the diversion and storage of water by the Delta Wetlands Project (Project) and the supplying of that water to the places of use and the supplemental storage of that water in the Semitropic and Antelope Valley groundwater banks as specified in the petitions to change water right Application Nos. 29062, 29066, 30268, and 30270 filed with the State Water Resources Control Board (State Water Board). The Lead Agency has determined the Project is of statewide, regional, or area wide significance in accordance with CEQA Guidelines section 15206.

The potential environmental impacts of the Project, with the exception of the more detailed analysis of place of use and underground storage impacts analyzed in this EIR, were first analyzed in the Project 1995 Draft Environmental Impact Report/Environmental Impact Statement (1995 DEIR/EIS), the 2000 Revised Draft Environmental Impact Report/Environmental Impact Statement (2000 RDEIR/EIS), and the 2001 Final Environmental Impact Report (SCH# 1988020824) (2001 FEIR), prepared on behalf of the State Water Board to satisfy the requirements of CEQA. A Final Environmental Impact Statement (FEIS) was issued by the U.S. Army Corps of Engineers (Corps) in July 2001 (66 Federal Register [FR] 40698 [2001]) to satisfy the requirements of the National Environmental Policy Act (NEPA). The Third District Court of Appeal in *Central Delta Water Agency v. State Water Resources Control Board*, 124 Cal. App. 4th 245 (2004), set aside the water right permits and accompanying CEQA documents for failure "to specify an actual use of and the amounts of water to be appropriated." However, the underlying environmental analysis of the EIR was not overturned (nor was there any challenge to the EIS). Therefore, this Place of Use EIR incorporates the relevant portions of the 1995 DEIR/EIS, 2000 RDEIR/EIS, 2001 FEIR, and 2001 FEIS by reference, as identified in the specific sections of this EIR in accordance with State CEQA Guidelines Section 15150. The incorporated documents are included on each compact disc of the digital version of this EIR and are available for public review at the Project website, http://deltawetlandsproject.com, and at public buildings as referenced in the included distribution list.

The Project would increase the availability of high-quality water in the Sacramento–San Joaquin River Delta (Delta) for export or outflow through its six basic parts:

- diversion of water in the Delta;
- water storage on two Reservoir Islands (Bacon Island and Webb Tract);
- compensation for wetland and wildlife effects of the water storage operations on the Reservoir Islands by implementing a Habitat Management Plan on two Habitat Islands (Bouldin Island and Holland Tract);
- supplemental water storage in the Semitropic Groundwater Storage Bank and the Antelope Valley Water Bank south of the Delta;
- provision of water supply for designated south-of-Delta users; and
- release of water for water quality enhancement in the Bay-Delta Estuary in the fall as an additional beneficial water use in a designated place of use.

The first three aspects of the Project are unchanged from the Project as analyzed in the 1995 DEIR/EIS, 2000 RDEIR/EIS, and 2001 FEIR and conditioned by State Water Board Water Right Decision 1643 (D-1643), water right protest dismissal agreements between the Project proponent (Delta Wetlands Properties [DW or Project applicant]) and various parties to the State Water Board's water right hearings, and the Biological Opinions (BOs) of the National Marine Fisheries Service (NMFS), the U.S. Fish and Wildlife Service (USFWS), and the California Department of Fish and Game (DFG). The portions of the Project that remain unchanged are reviewed and updated within the document.

The integration of the in-Delta water storage element with the Semitropic Groundwater Storage Bank and the Antelope Valley Water Bank is a new element of the Project. The permitted and operational Semitropic Groundwater Storage Bank, its Stored Water Recovery Unit, and Antelope Valley Water Bank have been fully analyzed in the Semitropic Groundwater Banking Project Final EIR (SCH#1993072024), Semitropic Groundwater Banking Project Stored Water Recovery Unit Final Supplemental EIR (SCH#1999031100), and Antelope Valley Water Bank Final EIR (SCH#2005091117) and are not analyzed in this Place of Use EIR.

The location of the Project islands within the Delta is shown in Figures 1-1a and 1-1b. The places of use by county are shown in Figure 1-2, followed by place of use maps for each potential service area that may receive Project water (Figures 1-3, 1-4a through 1-4g, 1-5a through 1-5f, and 1-6).

Focus of This Environmental Impact Report

Since the 2001 FEIR, the Project applicant, the original Project proponent, has entered into a partnership with Semitropic to develop the Project, to integrate the Project into the operation of the Semitropic Groundwater Storage Bank and the Antelope Valley Water Bank, and to provide Project water for agricultural uses within Semitropic's service area.

The partnership with Semitropic allows the Project to take advantage of Semitropic's innovative and highly successful groundwater banking programs, including its Semitropic Groundwater Storage Bank and Stored Water Recovery Unit and the Antelope Valley Water Bank, managed by a joint powers authority that includes Semitropic. The addition of groundwater banking capability south of the Delta to the Project provides additional water supply reliability and operational flexibility in the provision of water to the places of use.

Changes to the Project Description

In compliance with *Central Delta Water Agency v. State Water Resources Control Board*, 124 Cal.App.4th 245 (2004), this Place of Use EIR updates the water supply portion of the Project to identify specific places of use of water. Petitions to change the Project's water rights applications to add places of use and places of underground storage have been filed with the State Water Board.

Accordingly, the scope of this CEQA analysis focuses primarily on the changes to the Project description proposed in the petitions for change regarding specific places of use for Project water, estimated diversion amounts, beneficial uses, means of transfer, and storage of water in groundwater banks. Changes to the Project description and additional information on the places of use are discussed in greater detail in Chapter 2, "Project Description and Alternatives."

Description of Updated Resource Analyses

Generally, the resource analyses in the prior documents, incorporated herein by reference, accurately describe the current environmental and regulatory settings, environmental impacts, and needed mitigation measures relevant to each resource. As needed, this Place of Use EIR updates resource analyses of the 1995 DEIR/EIS, 2000 RDEIR/EIS, and 2001 FEIR to address changed circumstances. Using the CEQA Guidelines as a reference, the Lead Agency developed criteria to determine when an update of a resource analysis was needed. Each resource was considered, and analysis updated, if any of the following were present:

- changes in the Project description resulting in new significant environmental effects or a substantial increase in the severity of previously identified significant effects;
- changes occurring with respect to the circumstances under which the Project is undertaken resulting in new significant environmental effects or a

substantial increase in the severity of previously identified significant effects; and

- new information that was not known at the time of the previous environmental analyses, that shows:
  - a change in severity of the impact; or
  - that the mitigation measures or alternatives previously analyzed and found not to be feasible would in fact be feasible and would substantially reduce one or more significant effects of the Project, but the Project applicant declines to adopt; or
  - that new mitigation measures or alternatives substantially different from those analyzed in the previous EIR would substantially reduce one or more significant effects on the environment, but the Project applicant declines to adopt.

This EIR attempts to efficiently and appropriately apply the environmental analyses of the prior CEQA and NEPA documents. However, the headings and identification coding system for impacts and mitigation measures may deviate from prior documents to facilitate the logic and structure of this EIR for readability and internal consistency.

Summary of New Information and Changed Circumstances

This Place of Use EIR will also reevaluate the Project and analyses from the 1995 DEIR/EIS, 2000 RDEIR/EIS, 2001 FEIR, and 2001 FEIS in light of regulatory changes and other developments and studies or planning efforts conducted since 2001 that may affect the existing conditions in the Delta or understanding of potential impacts from Project operations. Major new information and circumstances included in subsequent chapters and sections include, but are not limited to:

- California Department of Water Resources' (DWR's) Integrated Storage Investigation (ISI) Studies (see Chapter 2, "Project Description and Alternatives," Chapter 3, "Project Operations," and Section 4.3, Flood Control and Levee Stability);
- University of California, Davis (UC Davis)/Public Policy Institute of California (PPIC) Reports: "Envisioning Futures for the Sacramento–San Joaquin Delta" and "Comparing Futures for the Sacramento–San Joaquin Delta" (see Chapter 2, "Project Description and Alternatives");
- Delta Vision Blue Ribbon Task Force Report (see Chapter 2, "Project Description and Alternatives");
- Bay Delta Conservation Plan (BDCP) planning and evaluation efforts for water supply reliability and fish species protection in the Delta (see Chapter 2, "Project Description and Alternatives," and Section 4.5, Fish);

- Delta water legislative package (see Chapter 2, “Project Description and Alternatives);
- State Water Board review and update of the 1995 Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary (1995 WQCP) (see Section 4.1, Water Supply);
- Environmental Water Account (EWA) and the Yuba Accord (See Section 4.1, Water Supply);
- legal challenges to the USFWS and NMFS BOs on the Central Valley Project (CVP) and State Water Project (SWP) Operations Criteria and Plan (OCAP), the Interim Remedial Order issued by Judge Wanger on December 14, 2007, in *Natural Resources Defense Council, et al. v. Kempthorne*, and the December 2008 USFWS BO and the June 2009 NMFS BO (see Section 4.5, Fish);
- studies and evaluations by Interagency Ecological Program (IEP) of the pelagic organism decline (see Section 4.5, Fish);
- Delta Risk Management Strategy (DRMS) Report (see Section 4.3, Flood Control and Levee Stability);
- the Jones Tract levee failure and flooding in June 2004 as described and evaluated by DWR (See Section 4.2, Water Quality); and
- DWR 2006 Report on “Progress on Incorporating Climate Change into Management of California’s Water Resources” (see Section 4.14, Climate Change).

Project History

The Project, through private party initiative, first filed water right applications with the State Water Board and a Department of the Army permit under Clean Water Act (CWA) Section 404 for the discharge of dredged or fill material into waters of the United States and under the Rivers and Harbors Act (RHA) Section 10 for activities within navigable waters with the Corps in 1987. Through agency coordination and public review, and the recent partnerships with Semitropic and with water users, the Project has gone through several iterations. A timeline of the Project history, as described below, is provided in Table 1-2 at the end of Chapter 1.

The following major events characterize the Project history (in chronological order):

- 1990 Draft Environmental Impact Statement/ Environmental Impact Report
- 1995 Draft Environmental Impact Statement/ Environmental Impact Report
- Fisheries Consultation and Biological Opinions
- 1997 Historical Preservation Consultation

- 2000 Revised Draft Environmental Impact Report/ Environmental Impact Statement
- 2000 State Water Board Water Right Hearing
- 2001 Final Environmental Impact Report
- 2001 Final Environmental Impact Statement and Clean Water Act 404 Permit
- California Endangered Species Act Incidental Take Permit and Habitat Management Plan
- Legal Challenges to the Final Environmental Impact Report and Decision 1643

Partnership between the Project Applicant and Semitropic and Addition of Groundwater Banking

The Project applicant and Semitropic have partnered to jointly develop and implement the Project. Ownership of the Project islands and many regulatory applications will remain in the Project applicant's name, but the Project will be implemented by Semitropic for the benefit of Semitropic, the Project applicant, and the users of the Project water. Semitropic will also integrate the Project into its groundwater banking operations in the Semitropic Groundwater Bank and the Antelope Valley Water Bank. The Project applicant will continue to manage the Project islands before Project construction and assist Semitropic in regulatory permitting and financing. Accordingly, the Project is no longer a private venture but a public-private partnership.

The Project will benefit from Semitropic's expertise gained from developing and managing its highly successful groundwater banking operations. Project water users will gain more flexibility and reliability of water supplies with the addition of south-of-Delta banking. Semitropic will benefit from the Project's new source of water supply that will augment the water assets in its groundwater banks. Semitropic's landowners will benefit from the banking of Project water in the groundwater bank through higher groundwater levels and reduced overdraft, improved groundwater quality, and reduced pump lift costs. Furthermore, a portion of the water supply yield of the Project will be allocated to irrigation purposes within Semitropic's acre service area.

Project water supply that is available in excess of the immediate needs of the other places of use will be banked within the Semitropic Groundwater Storage Bank and Antelope Valley Water Bank. Through appropriate arrangements with its sister agency in Kern County, the Kern County Water Agency, Semitropic will facilitate the conveyance of Project water to the groundwater banks and the places of use. The groundwater banking and water conveyance elements of the Project are described in more detail in Chapter 2, "Project Description and Alternatives."

As the public agency carrying out the proposed Project (CEQA Guidelines Section 15051), Semitropic, in coordination with the State Water Board, assumed the role as CEQA lead agency in June 2007.Semitropic will investigate opportunities to partner through a joint powers authority or other mechanism with the other public agencies participating in the Project including the four reclamation districts responsible for the Project islands and the public agencies using Project water.

Project Purpose and Objectives

The overall purpose of the Project is to increase the availability of high-quality water in the Delta for export or outflow by storing water on two Reservoir Islands (Webb Tract and Bacon Island) and by doing so, increase the reliability of water supplies for Semitropic and other places of use including Golden State, Metropolitan, Western, and Valley District. The storage of surplus Project water in the Semitropic Groundwater Storage Bank and Antelope Valley Water Bank for later use by those users will reduce groundwater overdraft and reduce pumping lift for water users within those basins as well as provide additional dry year water supply reliability for the Project users. Further, the Project would compensate for wetland and wildlife effects of the water storage operations on the Reservoir Islands by implementing an HMP on two dedicated Habitat Islands (Bouldin Island and Holland Tract).

The Project purpose would be met by diverting Delta inflow during times of surplus Delta outflow (after all water quality or flow requirements for the San Francisco Bay/Sacramento–San Joaquin Delta [Bay-Delta] Estuary are met). The diverted water would be stored on the Reservoir Islands until released for export to south-of-Delta users, including Semitropic's service area and the other specified places of use, or for environmental benefits in the Bay-Delta estuary. No infrastructure or facilities, other than those already described in the State Water Board 2001 FEIR (SCH#1988020824), are proposed to support the Project purpose. Water would be delivered via existing and previously approved facilities operated and maintained by the SWP, CVP, and those within the proposed places of use. As noted above, the Project would provide managed wetlands and wildlife habitat areas. Additionally, the Project would accommodate recreational uses.

Responsible and Trustee Agencies

In addition to Semitropic's action as the Lead Agency, this EIR will be used by Responsible and Trustee Agencies to determine the effects of the proposed action. Likely Responsible and Trustee Agencies for the Project are presented in Table 1-1 (Chapter 1).

EIR Public Review Period

This draft EIR is being circulated for a 45-day public review period, during which the public and interested agencies are encourage to submit comments on the document. To facilitate public review, a public hearing will be conducted during the review period to solicit oral comments on this EIR. Public notice of the hearing date and location, and of the date of public comment closure, will be provided by mail, through newspaper publication, and through the Project website, http://deltawetlandsproject.com.

Comments should be sent to:

ICF International
630 K Street, Suite 400
Sacramento, CA 95814
Attn: Megan Smith, Project Manager

Once all comments have been assembled and reviewed, the lead agency will prepare responses on all notable environmental issues that have been raised. These responses to comments, combined with the draft EIR, will constitute the final EIR.

Areas of Known Controversy

Based on public and agency comments received throughout the project planning process, the Project applicant and lead agency have identified several areas of controversy related to the proposed Project raised by agencies and the public during the public scoping process:

- Delta sustainability;
- Delta fisheries;
- Water supply; and
- Other environmental effects, including:
  - Delta hydrology and water quality;
  - Levee stability;
  - Seepage; and
  - Agricultural land conversion.

These areas of known controversy are explored in more detail in Chapter 1.

Project Description and Alternatives—Summary

Introduction

Chapter 2 reviews the basic description of the Project and presents, in detail, the following changes to the Project description that have been proposed since the 2001 FEIR.

- Specific places of use have been designated for Project water to improve the reliability of the existing supplies of water for irrigation and municipal purposes. The designated places of use include Semitropic, Golden State, and Metropolitan and its member agencies' service areas.
- An operational element has been added for banking Project water in the Semitropic Groundwater Storage Bank and the Antelope Valley Water Bank for later use by Semitropic, Metropolitan, and other designated users. This allows Project water to be stored until there is a water delivery deficit (i.e., unmet existing demand) in the designated places of use.
- The levee design has been revised to improve Reservoir Island structural integrity.
- Environmental commitments have been incorporated into the Project design to avoid, minimize, and mitigate environmental impacts and are to be considered as part of the analysis.

Chapter 2 also summarizes new information and changed circumstances that may affect the existing or future conditions in the Delta or the Project description.

The operations of the Project in the Delta and the operations of the groundwater banks and the monthly deliveries to designated places of use are described in more detail in Chapter 3 "Project Operations." New specific information or changed circumstances that affect Project operations are described in Chapter 3, "Project Operations," and new specific information that may change the impact assessments are described in the respective appropriate resource sections of this Place of Use EIR.

The complete Project description providing the basis for the summary below can be found in the 1995 DEIR/DEIS (Pages 2-3 through 2-15, and Appendix 2, Supplemental Description) and the 2000 RDEIR/EIS (Pages 2-1 through 2-5).

Changes to the Project since the 2001 FEIR

The major changes in the Project description and operation are summarized and discussed below. The Project monthly operations with these changes are described in Chapter 3.

Designated Places of Use

The Project applicant's original applications filed in 1987 and new applications and petitions to change the original applications filed in 1993 identify the entire SWP and CVP service areas and the Bay-Delta estuary as the place of use for the Project water. Potential users of the Project water were assumed to be any user within this broad place of use. Potential beneficial uses for the Project water included irrigation, municipal and industrial, and fish and wildlife enhancement and water quality for the Bay-Delta estuary. The Court of Appeal decision required that designated places of use be more specifically identified.

The Project applicant has identified specific places of use for Project water, including Semitropic and four other places of use, as shown in Figures 1-3 through 1-6. Valley District has not determined whether it will participate in the Project, but it is included in this EIR as a Place of Use for assessment of potential impacts. If Valley District does not elect to participate in the Project, the Final EIR will be amended accordingly. These Places of Use require additional sources of water to improve the reliability of their existing water supplies to meet current demand, and have infrastructure in place for conveyance and transfer of the Project water. The Project water would be used to improve water supply reliability for their current water uses, which include irrigation, domestic, and municipal and industrial beneficial uses. Table 2-1 in Chapter 2 defines the annual demands and estimated maximum annual deliveries of Project water for each Place of Use. The designated places of use are:

- Golden State for municipal, industrial and domestic purposes,
- Metropolitan and its member agencies' service areas for municipal and industrial purposes,
- Western for municipal and industrial purposes, and
- Valley District for municipal and industrial purposes.

Other water service providers may enter into agreements to take Project water and become additional places of use. Additional potential places of use beyond those analyzed in this EIR were discussed in the Notice of Preparation published for this EIR. Approval of additional service areas and places of use may require further CEQA analysis and petitions to the State Water Board.

Groundwater Banks

Project water not needed for designated place of use demands in a year with relatively high deliveries may be stored in the Semitropic Groundwater Storage Bank and/or the Antelope Valley Water Bank for later delivery to the designated places of use. Project water would be conveyed to the Semitropic Groundwater Storage Bank or Antelope Valley Water Bank using existing SWP and CVP and local water conveyance facilities. No new construction would be required to convey Project water to the groundwater banks for recharge (infiltration) or for pumping and delivery from the groundwater banks.

Project Description Summary

The Project would increase the availability of high-quality water in the Delta for export or outflow by storing water on two Reservoir Islands (Bacon Island and Webb Tract, see Figures 2-1 and 2-2) and would compensate for wetland and wildlife effects of the water storage operations on the Reservoir Islands by implementing an HMP on two Habitat Islands (Bouldin Island and Holland Tract, see Figures 2-3 and 2-4). The physical description of the Project is in Chapter 2, and the monthly operations of the Project are described in Chapter 3.

Some background information about the Delta and the Project islands is included in Chapter 2 to provide a framework for understanding the existing conditions of these Project islands and the proposed conversion to in-Delta Reservoir Islands and habitat management islands. More detailed descriptions of existing conditions on the Project islands and tracts are provided in each resource impact section in Chapter 4.

Project Alternatives

The 2001 FEIR and 2001 FEIS analyzed three Project alternatives (Alternatives 1, 2, and 3) and the No-Project Alternative to represent a range of Project operations for purposes of determining environmental impacts. The proposed Project in the 2001 FEIR consists of storage of water on two Reservoir Islands and implementation of an HMP on two Habitat Islands. No changes are being made to the proposed Project other than the identification of specific places of use, incorporation of several environmental commitments, and improvement to the Reservoir Island levee design.

Therefore, the alternatives analyzed in detail in the 1995 DEIR/EIS, the 2000 RDEIR/EIS, and the 2001 FEIR represent a reasonable range of alternatives. A brief summary of the Proposed Project (Alternative 2), as well as Alternatives 1, 3, and the No-Project Alternative, follow. For a more detailed discussion of the original design and operational details of the Project alternatives, please refer to the 1995 DEIR/EIS, 2000 RDEIR/EIS, and the 2001 FEIR.

Proposed Project (Alternative 2)

Alternative 2 consists of water storage on two Reservoir Islands and implementation of an HMP on two Habitat Islands. Alternative 1 entails the potential year-round diversion and storage of water on Bacon Island and Webb Tract, and wetland and wildlife habitat creation and management on Bouldin Island and Holland Tract. To operate Alternative 2, the Project would improve levees on the perimeters of the Reservoir Islands, install additional siphons and water pumps, and construct inner dike and berm systems on all four islands for shallow-water management. Under Alternative 2, during periods of availability throughout the year, water would be diverted onto the Reservoir Islands to be stored for later sale or release and would be discharged from the islands into Delta channels for sale for beneficial uses for export or for Bay-Delta estuary needs during periods of demand. Discharges from the islands would be subject to state and federal regulatory standards, endangered species protection measures, and Delta export pumping capacities.

The Proposed Project is Alternative 2, as modified by incorporation of the BOs, FOC, WQMP, protest dismissal agreements, and other environmental commitments. In review:

- the terms and conditions of the DFG, USFWS, and NMFS BOs are based on this alternative;
- all of the revised operating criteria developed from the BOs were included in the FOC for the Project; and
- these operations were simulated and evaluated in the 2000 RDEIR/EIS.

Following the 2000 Water Rights Hearings, the WQMP was developed in the course of negotiating protest dismissal agreements with CUWA and CCWD. These water quality operations criteria are also included in the Project operations described in Chapter 3, "Project Operations," and the resulting water quality conditions for salinity and dissolved organic carbon (DOC) are evaluated as part of the water quality impact assessment in Section 4.2, Water Quality.

Revised Project operations have been simulated for this Place of Use EIR to demonstrate the likely south-of-Delta water delivery to designated water districts and associated groundwater banking. These water supply simulations are also described in Chapter 3, "Project Operations."

Alternative 1

Alternative 1 differs from Alternative 2 only with regard to operating criteria for diversion and discharge of stored water. Under Alternative 1, Project discharges would be subject to a conservative (strict) interpretation of "percent of inflow" export limits specified in the 1995 WQCP.

Alternative 3

Under Alternative 3 all four of the Project islands would be used as reservoirs with limited compensation habitat provided on a portion of Bouldin Island. Alternative 3 would be inconsistent with the FOC and BOs previously issued for the Project.

No-Project Alternative

The No-Project Alternative has not changed since publication of the 2001 FEIR and 2001 FEIS. If Corps permit applications or SWRCB water right permit applications for the Project are denied, the Project applicant would implement intensive agricultural operations on the four Project islands or sell the property to another entity that would likely implement intensive agriculture. The No-Project Alternative is based on the assumption that intensified agricultural conditions represent the most realistic scenario for the Project islands if permit applications are denied.

It is assumed that no new recreation facilities would be built. However, under the No-Project Alternative, an intensive for-fee hunting program would be operated on the Project islands, creating an additional 12,000 hunter-use days over existing conditions.

Under the No-Project Alternative, consumptive use would increase, reflecting more extensive agricultural use of the islands, but not measurably so at the scale of monthly water supply modeling. Currently existing siphon facilities on the islands, which are unscreened, would not be modified under the No-Project Alternative.

Project Environmental Commitments

Environmental commitments are measures incorporated by the project proponent as part of the project description, meaning they are proposed as elements of the proposed action and are to be considered in conducting the environmental analysis and determining effects and findings. The purpose of environmental commitments is to reflect and incorporate best practices into the project that avoid, minimize, or offset potential environmental effects. *Note: The term* mitigation *is specifically applied in this EIR only to designate measures required to reduce environmental impacts of the proposed Project, including Project environmental commitments, triggering a finding of significance.* These best practices tend to be relatively standardized and compulsory; they represent sound and proven methods to reduce the potential effects of an action. The rationale behind including environmental commitments is that the Project proponent commits to undertake and implement these measures as part of the Project in advance of impact findings and determinations in good faith to improve the quality and integrity of the Project, streamline the environmental analysis, and demonstrate responsiveness and sensitivity to environmental quality.

Several changes in Project design, mitigation measures from the 1995 DEIR/EIS and the 2000 RDEIR/EIS, and many prior agreements with Delta water rights holders or agencies (such as FOC to protect fish and the WQMP) have been incorporated as Project environmental commitments. The Project environmental commitments are listed below and described in detail in Chapter 2 and in the individual resource sections:

- Two-Island Habitat Management Plan
- Reservoir Island Construction Monitoring
- Screened Diversions
- Fish Monitoring and Habitat Protection
- Conservation Easements on Habitat Islands
- Prior Agreements with Other Parties, including CUWA, CCWD, PG&E, and EBMUD
- Improved Reservoir Island Levee Design
- Seepage Monitoring and Control System

Effects Summary Table

Table ES-1. Summary of Impacts and Mitigation Measures for the Delta Wetlands Project

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
WATER SUPPLY				
WS-1: Reduction in Delta Consumptive Use	2	Beneficial and less than significant	No mitigation is required	–
WS-2: Increase in Delta Consumptive use	1	Less than significant	No mitigation is required	–
WS-2: Increase in Delta Consumptive Use	3	Significant and unavoidable	No mitigation is available	Significant and unavoidable
WATER QUALITY				
WQ-1: Salinity Increase at Chipps Island	1, 2, 3	Less than significant	No mitigation is required	–
WQ-2: Salinity Increase at Emmaton	1, 2, 3	Less than significant	No mitigation is required	–
WQ-3: Salinity Increase at Jersey Point	1, 2, 3	Less than significant	No mitigation is required	–
WQ-4: Salinity Increase at Exports	1, 2, 3	Less than significant	No mitigation is required	–
WQ-5: Beneficial Salinity Reductions at Exports	1, 2, 3	Less than significant	No mitigation is required	–
WQ-6: Elevated DOC Concentrations in Delta Exports	1, 2, 3	Less than significant	No mitigation is required	–
WQ-7: Increased Methylmercury Loading in the Delta	1, 2, 3	Significant	WQ-MM-1: Follow Guidelines from Proposed Delta TMDL for Methylmercury WQ-MM-2: Incorporate Mercury Methylation Control Measures in Wetland Design	Less than significant
WQ-8: Changes in Other Water Quality Variables in Delta Channel Receiving Waters	1, 2, 3	Less than significant	No mitigation is required	–
WQ-9: Potential Contamination of Stored Water by Contaminant Residues	1, 2, 3	Significant	WQ-MM-3: Conduct Assessments of Potential Contamination Sites and Remediate as Necessary	Less than significant
WQ-10: Water Pollution Caused by Construction Activities	1, 2, 3	Less than significant	No mitigation is required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
WQ-11: Increase in Pollutant Loading in Delta Channels Associated with Recreational Boating	1, 2, 3	Less than significant	No mitigation is required but the following will further reduce impacts: WQ-MM-4: Clearly Post Waste Discharge Requirements, Provide Waste Collection Facilities, and Educate Recreationists Regarding Illegal Discharges of Waste REC-MM-1: Reduce the Size or Number of Recreation Facilities	–
WQ-12: Reduction in Agricultural Pollutants	1, 2, 3	Beneficial and less than significant	No mitigation is required	–
FLOOD CONTROL AND LEVEE STABILITY				
FC-1: Improvement in Long-Term Levee Stability on Reservoir Islands	1, 2, 3	Less than significant	No mitigation is required	–
FC-2: Potential for Seepage from Reservoir Islands to Adjacent Islands	1, 2, 3	Less than significant	No mitigation is required	–
FC-3: Potential for Wind and Wave Erosion on Reservoir Islands	1, 2, 3	Less than significant	No mitigation is required	–
FC-4: Potential for Erosion of Levee Toe Berms at Pump Stations and Siphon Stations on Reservoir Islands	1, 2, 3	Less than significant	No mitigation is required	–
FC-5: Change in Potential for Levee Failure on Project Islands during Seismic Activity	1, 2, 3	Less than significant	No mitigation is required	–
FC-6: Increase in Long-Term Levee Stability on Habitat Islands	1, 2	Beneficial and less than significant	No mitigation is required	–
UTILITIES, PUBLIC SERVICES, AND HIGHWAYS				
UT-1: Increase in the Structural Integrity of County Roads	1, 2, 3	Beneficial and less than significant	No mitigation is required	–
UT-2: Reduction in Ferry Traffic from Jersey Island to Webb Tract	1, 2, 3	Less than significant	No mitigation is required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
UT-3: Increase in the Risk to Gas Lines Crossing Exterior Levees on Bacon Island Resulting from Levee Improvements	1, 2, 3	Less than significant	No mitigation required, but the following will monitor Project measures: UT-MM-1: Monitor Locations Where Gas Pipelines Cross Bacon Island Levees during and after Levee Construction	–
UT-4: Increase in PG&E Response Time to Repair a Gas Line Failure on Bacon Island	1, 2, 3	Less than significant	No mitigation is required	–
UT-5: Potential Interference with Pipeline Inspection Procedures	1, 2, 3	Less than significant	No mitigation is required	–
UT-6: Inundation of Electrical Distribution Utilities on the Reservoir Islands	1, 2	Significant	UT-MM-2: Relocate Electrical Distribution Lines to the Perimeter Levee around Webb Tract	Less than significant
UT-6: Inundation of Electrical Distribution Utilities on the Reservoir Islands	3	Significant	UT-MM-10: Relocate Electrical Distribution Lines to the Perimeter Levees around Webb and Holland Tracts and Bouldin Island	Less than significant
UT-7: Possible Need to Increase Capacity of the Existing Electrical Distribution Lines on the Project Islands	1, 2	Less than significant	No mitigation is required	–
UT-7: Possible Need to Increase Capacity of the Existing Electrical Distribution Lines on the Reservoir Islands	3	Less than significant	No mitigation is required	–
UT-8: Possible Need to Expand the Existing Electrical Distribution Lines on Webb Tract, Bouldin Island, and Holland Tract to Serve a Proposed Siphon Station and Recreation Facilities	1, 2	Significant	UT-MM-3: Extend Electrical Distribution Lines to Serve New Siphon and Pump Stations and Recreation Facilities	Less than significant
UT-8: Possible Need to Expand the Existing Electrical Distribution Lines on Webb Tract, Bouldin Island, and Holland Tract to Serve Proposed Siphon and Pump Stations and Recreation Facilities	3	Significant	UT-MM-3: Extend Electrical Distribution Lines to Serve New Siphon and Pump Stations and Recreation Facilities	Less than significant

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
UT-9: Increase in Demand for Police Services on the Project Islands	1, 2, 3	Significant	UT-MM-4: Provide Adequate Lighting in and around Buildings, Walkways, Parking Areas, and Boat Berths UT-MM-5: Provide Private Security Services for Recreation Facilities and Boat Docks REC-MM-1 Reduce the Size or Number of Recreation Facilities	Less than significant
UT-10: Increase in Demand for Fire Protection Services on the Project Islands	1, 2, 3	Significant	UT-MM-6: Incorporate Fire Protection Features into Recreation Facility Design UT-MM-7: Provide Fire Protection Services to Webb Tract and Bacon Island	Less than significant
UT-11: Increase in Demand for Water Supply Services	1, 2, 3	Less than significant	No mitigation required, but the following will monitor Project measures: UT-MM-8: Obtain Appropriate Local and State Permits for Recreation Facility Services and Utilities	–
UT-12: Increase in Demand for Sewage Disposal Services	1, 2, 3	Less than significant	No mitigation required, but the following will monitor Project measures: UT-MM-8: Obtain Appropriate Local and State Permits for Recreation Facility Services and Utilities	–
UT-13: Increase in Demand for Solid Waste Removal	1, 2, 3	Less than significant	No mitigation required, but the following will monitor Project measures: UT-MM-8: Obtain Appropriate Local and State Permits for Recreation Facility Services and Utilities	–
UT-14: Increase in the Risk of Structural Failure of SR 12	3	Less than significant	No mitigation required, but the following will monitor Project measures: UT-MM-9: Coordinate Design and Construction of Wilkerson Dam with Caltrans	–
UT-15: Increase in the Fog Hazard on SR 12	3	Significant and unavoidable	No mitigation available	Significant and unavoidable

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
FISH				
FISH-1: Alteration of Habitat through Construction of Project Facilities	1, 2, 3	Significant	FISH-MM-1: Conservation of Shallow-Water Vegetated Habitat REC-MM-1: Reduce the Size or Number of Recreation Facilities FISH-MM-2: Site Project Facilities to Avoid Existing Shallow-Water Vegetated Habitat FISH-MM-3: Limit Waterside Construction to Less- Sensitive Time Periods FISH-MM-4: Implement Best Management Practices for Waterside Construction	Less than significant
FISH-2: Increase in Organic Materials and Toxics and Decrease in Dissolved Oxygen of Delta Water because of Project Discharges	1, 2, 3	Less than significant	No mitigation is required	–
FISH-3: Temperature-Related Impacts on Chinook Salmon and Other Species	1, 2, 3	Less than significant	No mitigation is required	–
FISH-4: Potential Increase in Accidental Spills of Fuel and Other Materials and Boat Wake Erosion	1, 2, 3	Less than significant	No mitigation is required	–
FISH-5: Effects of the Project on Juvenile Chinook Salmon	1, 2, 3	Significant and unavoidable	FISH-MM-1: Conservation of Shallow-Water Vegetated Habitat FISH-MM-5: Implement a Fishery Improvement Mitigation Fund FISH-MM-6: Establish a Shallow-Water Aquatic Habitat Conservation Easement	Significant and unavoidable
FISH-6: Effects of the Project on Juvenile Steelhead	1, 2, 3	Significant and unavoidable	FISH-MM-1: Conservation of Shallow-Water Vegetated Habitat FISH-MM-5: Implement a Fishery Improvement Mitigation Fund FISH-MM-6: Establish a Shallow-Water Aquatic Habitat Conservation Easement	Significant and unavoidable

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
FISH-7: Effects of the Project on Delta Smelt	1, 2, 3	Significant and unavoidable	FISH-MM-1: Conservation of Shallow-Water Vegetated Habitat REC-MM-1: Reduce the Size or Number of Recreation Facilities FISH-MM-2: Site Project Facilities to Avoid Existing Shallow-Water Vegetated Habitat FISH-MM-3: Limit Waterside Construction to Less- Sensitive Time Periods FISH-MM-4: Implement Best Management Practices for Waterside Construction FISH-MM-5: Implement a Fishery Improvement Mitigation Fund FISH-MM-6: Establish a Shallow-Water Aquatic Habitat Conservation Easement	Significant and unavoidable
FISH-8: Effects of the Project on Longfin Smelt	1, 2, 3	Significant and unavoidable	FISH-MM-1: Conservation of Shallow-Water Vegetated Habitat REC-MM-1: Reduce the Size or Number of Recreation Facilities FISH-MM-2: Site Project Facilities to Avoid Existing Shallow-Water Vegetated Habitat FISH-MM-3: Limit Waterside Construction to Less- Sensitive Time Periods FISH-MM-4: Implement Best Management Practices for Waterside Construction FISH-MM-5: Implement a Fishery Improvement Mitigation Fund FISH-MM-6: Establish a Shallow-Water Aquatic Habitat Conservation Easement	Significant and unavoidable
FISH-9: Effects of the Project on Green Sturgeon	1, 2, 3	Significant and unavoidable	FISH-MM-5: Implement a Fishery Improvement Mitigation Fund	Significant and unavoidable

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
FISH-10: Effects of the Project on Sacramento Splittail	1, 2, 3	Less than significant	No mitigation required, but the following will monitor Project measures: FISH-MM-1: Conservation of Shallow-Water Vegetated Habitat REC-MM-1: Reduce the Size or Number of Recreation Facilities FISH-MM-2: Site Project Facilities to Avoid Existing Shallow-Water Vegetated Habitat FISH-MM-3: Limit Waterside Construction to Less- Sensitive Time Periods FISH-MM-4: Implement Best Management Practices for Waterside Construction FISH-MM-5: Implement a Fishery Improvement Mitigation Fund FISH-MM-6: Establish a Shallow-Water Aquatic Habitat Conservation Easement	–
FISH-11: Effects of the Project on Other Aquatic Species	1, 2, 3	Less than significant	No mitigation is required	–
VEGETATION AND WETLANDS				
VEG-1: Increase in Freshwater Marsh and Exotic Marsh Habitats	1, 2,3	Beneficial and less than significant	No mitigation is required	–
VEG-2: Loss of Riparian and Permanent Pond Habitats	1, 2,3	Less than significant	No mitigation is required	–
VEG-3: Loss of Upland and Agricultural Habitats	1, 2,3	Less than significant	No mitigation is required	–
VEG-4: Consistency with Local Policies or Ordinances Protecting Biological Resources	1, 2,3	No impact	No mitigation is required	–
VEG-5: Conflict with Provisions of an Adopted HCP/NCCP	1, 2	No impact	No mitigation is required	–
VEG-6: Introduction and Spread of Invasive Plants	1, 2	Less than significant	No mitigation is required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
VEG-7: Loss of Special-Status Plants	1, 2, 3	Significant	VEG-MM-1: Site Project Facilities to Avoid Special-Status Plant Populations VEG-MM-2: Protect Special-Status Plant Populations from Construction and Recreation Activities VEG-MM-3: Develop and Implement a Special-Status Plant Species Monitoring and Mitigation Plan	Less than significant
VEG-8: Loss of Jurisdictional Wetlands on Reservoir Islands	3	Significant	VEG-MM-4: Develop and Implement an Off-Site Mitigation Plan	Less than significant
WILDLIFE				
W-1: Potential Injury or Mortality of, and Potential Loss of Suitable Habitat for, Valley Elderberry Longhorn Beetle	1, 2	Less than significant	No mitigation is required	–
W-1: Potential Injury or Mortality of, and Potential Loss of Suitable Habitat for, Valley Elderberry Longhorn Beetle	3	Significant	W-MM-3: Avoid or Compensate for the Loss of Habitat for the Valley Elderberry Longhorn Beetle	Less than significant
W-2: Potential Injury or Mortality of Western Pond Turtle	1, 2	Less than significant	No mitigation is required	–
W-2: Potential Injury or Mortality of Western Pond Turtle	3	Significant	W-MM-4: Avoid and Minimize Injury and Mortality of Western Pond Turtle	Less than significant
W-3: Loss of Suitable Aquatic and Upland Habitat for Western Pond Turtle	1, 2	Less than significant	No mitigation is required	–
W-3: Loss of Suitable Aquatic and Upland Habitat for Western Pond Turtle	3	Significant	W-MM-5: Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan	Less than significant
W-4: Potential Injury or Mortality of Giant Garter Snake	1, 2	Less than significant	No mitigation is required	–
W-4: Potential Injury or Mortality of Giant Garter Snake	3	Significant	W-MM-6: Avoid and Minimize Injury and Mortality of Giant Garter Snake	Less than significant
W-5: Loss of Suitable Aquatic and Upland Habitat for Giant Garter Snake	1, 2	Less than significant	No mitigation is required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
W-5: Loss of Suitable Aquatic and Upland Habitat for Giant Garter Snake	3	Significant	W-MM-5: Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan	Less than significant
W-6: Loss of Upland Habitats	1, 2	Less than significant	No mitigation is required	–
W-6: Loss of Upland Habitats	3	Significant	W-MM-5: Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan	Less than significant
W-7: Increase in Suitable Wetland Habitats for Nongame Water and Wading Birds	1, 2	Beneficial and less than significant	No mitigation is required	–
W-8: Loss of Foraging Habitats for Wintering Waterfowl	1, 2	Less than significant	No mitigation is required	–
W-8: Loss of Foraging Habitats for Wintering Waterfowl	3	Significant	W-MM-5: Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan	Less than significant
W-9: Increase in Suitable Breeding Habitats for Waterfowl	1, 2, 3	Beneficial and less than significant	No mitigation is required	–
W-10: Loss of Habitats for Upland Game Species	1, 2	Less than significant	No mitigation is required	–
W-10: Loss of Habitats for Upland Game Species	3	Significant	W-MM-5: Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan	Less than significant
W-11: Loss of Suitable Foraging Habitat for Greater Sandhill Crane	1, 2	Less than significant	No mitigation is required	–
W-11: Loss of Suitable Foraging Habitat for Greater Sandhill Crane	3	Significant	W-MM-5: Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan	Less than significant
W-12: Increase in Suitable Roosting Habitat for Greater Sandhill Crane	1, 2	Beneficial and less than significant	No mitigation is required	–
W-13: Loss of Suitable Foraging Habitat for Swainson's Hawk	1, 2	Less than significant	No mitigation is required	–
W-13: Loss of Suitable Foraging Habitat for Swainson's Hawk	3	Significant	W-MM-5: Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan	Less than significant

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
W-14: Loss of Suitable Nesting Habitat for Swainson's Hawk, Cooper's Hawk, and White-Tailed Kite	1, 2	Less than significant	No mitigation is required	–
W-14: Loss of Suitable Nesting Habitat for Swainson's Hawk, Cooper's Hawk, and White-Tailed Kite	3	Significant	W-MM-5: Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan	Less than significant
W-15: Loss of Suitable Breeding/Wintering Habitat for Western Burrowing Owl	1, 2	Less than significant	No mitigation is required	–
W-15: Loss of Suitable Breeding/Wintering Habitat for Western Burrowing Owl	3	Significant	W-MM-5: Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan	Less than significant
W-16: Loss of Suitable Foraging Habitat for Cooper's Hawk, White-Tailed Kite, Western Burrowing Owl, and Loggerhead Shrike	1, 2	Less than significant	No mitigation is required	–
W-16: Loss of Suitable Foraging Habitat for Cooper's Hawk, White-Tailed Kite, Western Burrowing Owl, and Loggerhead Shrike	3	Significant	W-MM-5: Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan	Less than significant
W-17: Loss of Foraging Habitat for Cackling (Aleutian Canada) Goose	1, 2, 3	Less than significant	No mitigation is required	–
W-18: Loss of Suitable Nesting and Foraging Habitat for Northern Harrier and Short-Eared Owl	1, 2	Less than significant	No mitigation is required	–
W-18: Loss of Suitable Nesting and Foraging Habitat for Northern Harrier and Short-Eared Owl	3	Significant	W-MM-5: Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan	Less than significant
W-19: Loss of Winter Foraging Habitat for Tricolored Blackbird	1, 2	Less than significant	No mitigation is required	–
W-19: Loss of Winter Foraging Habitat for Tricolored Blackbird	3	Significant	W-MM-5: Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan	Less than significant
W-20: Change in Acreage of Suitable Nesting Habitat for Tricolored Blackbird	1, 2	Less than significant	No mitigation is required	–
W-20: Change in Acreage of Suitable Nesting Habitat for Tricolored Blackbird	3	Significant	W-MM-5: Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan	Less than significant

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
W-21: Increase in Suitable Habitats for Special-Status Bird Species	1, 2	Beneficial and less than significant	No mitigation is required	–
W-22: Potential Injury or Mortality of Northern Harrier, Cooper's Hawk, Swainson's Hawk, White-Tailed Kite, California Black Rail, Greater Sandhill Crane, Western Burrowing Owl, Short-Eared Owl, Loggerhead Shrike, and Non–Special Status Migratory Birds	1, 2	Less than significant	No mitigation is required	–
W-22: Potential Injury or Mortality of Northern Harrier, Cooper's Hawk, Swainson's Hawk, White-Tailed Kite, California Black Rail, Greater Sandhill Crane, Western Burrowing Owl, Short-Eared Owl, Loggerhead Shrike, and Non–Special Status Migratory Birds	3	Significant	W-MM-7: Prepare a Construction Implementation Plan to Avoid Impacts on Roosting and Nesting Birds	Less than significant
W-23: Disturbance to Greater Sandhill Cranes and Wintering Waterfowl from Aircraft Operations	1, 2	Significant	W-MM-1: Monitor Effects of Aircraft Flights on Greater Sandhill Cranes and Wintering Waterfowl and Implement Actions to Reduce Aircraft Disturbances of Wildlife	Less than significant
W-24: Potential for Increased Incidence of Waterfowl Diseases	1, 2, 3	Significant	W-MM-2: Monitor Waterfowl Populations for Incidence of Disease and Implement Actions to Reduce Waterfowl Mortality	Less than significant
W-25: Potential Disruption of Waterfowl Use as a Result of Increased Hunting	1, 2, 3	Less than significant	No mitigation is required	–
W-26: Potential Disruption of Greater Sandhill Crane Use of the Habitat Islands as a Result of Increased Hunting	1, 2	Less than significant	No mitigation is required	–
W-27: Increase in Waterfowl Harvest Mortality	1, 2, 3	Less than significant	No mitigation is required	–
W-28: Potential Changes in Local and Regional Waterfowl Use Patterns	1, 2, 3	Less than significant	No mitigation is required	–
W-29: Potential Impacts on Wildlife and Wildlife Habitats Resulting from Delta Outflow Changes	1, 2, 3	Less than significant	No mitigation is required	–
W-30: Loss of Roost Sites and Foraging Habitat for and Potential Injury or Mortality of Bats	1, 2	Less than significant	No mitigation is required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
W-30: Loss of Roost Sites and Foraging Habitat for and Potential Injury or Mortality of Bats	3	Significant	W-MM-5: Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan W-MM-8: Conduct Preconstruction Surveys for Roosting Bats and Compensate for Loss of Roosting Habitat If Bats Are Found	Less than significant
LAND USE AND AGRICULTURE				
LU-1: Inconsistency with Contra Costa County General Plan Policy for Agricultural Lands and Delta Protection Commission Land Use Plan Principles for Agriculture and Recreation	1, 2, 3	Significant and unavoidable	None available	Significant and unavoidable
LU-2: Direct Conversion of Agricultural Land	1, 2, 3	Significant and unavoidable	None available	Significant and unavoidable
LU-3: Displacement of Residences and Structures on Reservoir Islands	3	Less than significant	No mitigation is required	–
RECREATION AND VISUAL RESOURCES				
REC-1: Increase in Hunting on the Project Islands	1, 2, 3	Beneficial and less than significant	No mitigation is required	–
REC-2: Change in Regional Hunter Success Outside the Project Area	1, 2	Less than significant	No mitigation is required	–
REC-3: Increase in Recreation Use-Days for Boating in the Delta	1, 2, 3	Beneficial and less than significant	No mitigation is required	–
REC-4: Change in the Quality of the Recreational Boating Experience in Delta Channels	1, 2, 3	Significant	REC-MM-1: Reduce the Size or Number of Recreation Facilities	Less than significant
REC-5: Increase in Recreation Use-Days for Other Recreational Uses in the Delta	1, 2. 3	Beneficial and less than significant	No mitigation is required	–
REC-6: Reduction in the Quality of Views of Bacon Island and Webb Tract Interiors from Island Levees	1, 2, 3	Less than significant	No mitigation is required	–
REC-7: Potential Conflict with the Scenic Designation for Bacon Island Road	1, 2, 3	Less than significant	No mitigation is required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
REC-8: Reduction in the Quality of Views of Bacon Island and Webb Tract from Adjacent Waterways and from the Santa Fe Railways Amtrak Line	1, 2, 3	Significant and unavoidable	REC-MM-1: Reduce the Size or Number of Recreation Facilities REC-MM-2: Partially Screen Proposed Recreation Facilities and Pump and Siphon Stations from Important Viewing Areas REC-MM-3: Design Levee Improvements, Siphon and Pump Stations, and Recreation Facilities and Boat Docks to Be Consistent with the Surrounding Landscape	Significant and unavoidable
REC-9: Enhanced Views of Bouldin Island from SR 12	1, 2	Beneficial and less than significant	No mitigation is required	–
REC-10: Reduction in the Quality of Views of Bouldin Island and Holland Tract from Adjacent Waterways	1, 2	Significant	REC-MM-1: Reduce the Size or Number of Recreation Facilities REC-MM-2: Partially Screen Proposed Recreation Facilities and Pump and Siphon Stations from Important Viewing Areas REC-MM-3: Design Levee Improvements, Siphon and Pump Stations, and Recreation Facilities and Boat Docks to Be Consistent with the Surrounding Landscape	Less than significant
REC-10: Reduction in the Quality of Views of Bouldin Island and Holland Tract from Adjacent Waterways	3	Significant and unavoidable	REC-MM-1: Reduce the Size or Number of Recreation Facilities REC-MM-2: Partially Screen Proposed Recreation Facilities and Pump and Siphon Stations from Important Viewing Areas REC-MM-3: Design Levee Improvements, Siphon and Pump Stations, and Recreation Facilities and Boat Docks to Be Consistent with the Surrounding Landscape	Significant and unavoidable
REC-11: Increase in Opportunities for Recreation Facility Members to View Island Interiors and Other Areas in the Project Vicinity	1, 2, 3	Beneficial and less than significant	No mitigation is required	–
REC-12: Change in Views Southward from SR 12	3	Less than significant	No mitigation is required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
REC-13: Reduction in the Quality of Views of Holland Tract from the Island Levee	3	Less than significant	No mitigation is required	–
TRAFFIC AND NAVIGATION				
TRA-1: Increase of Traffic and Roadway Level of Service Impact during Construction	1, 2, 3	Less than significant	Mitigation is not required, but the following will reduce Project impacts: TRA-MM-1: Develop and Implement a Traffic Control Plan	Less than significant
TRA-2: Increase of Traffic and Roadway Level of Service Impact during Operation	1, 2, 3	Less than significant	No mitigation is required	–
TRA-3: Potential for Traffic Safety Conflicts during Construction	1, 2, 3	Significant	TRA-MM-2: Clearly Mark Intersections with Poor Visibility in the Project Vicinity	Less than significant
TRA-4: Potential for Traffic Safety Conflicts during Operation	1, 2, 3	Less than significant	No mitigation is required	–
TRA-5: Change in Circulation on or Access to Delta Roadways during Construction	1, 2, 3	Less than significant	No mitigation is required	–
TRA-6: Change in Circulation on or Access to Delta Roadways during Operation	1, 2, 3	Less than significant	No mitigation is required	–
TRA-7: Increase in Boat Traffic and Congestion on Delta Waterways during Operation	1, 2, 3	Significant	REC-MM-1: Reduce the Size or Number of Recreation Facilities	Less than significant
TRA-8: Change in Navigation Conditions on Delta Waterways Surrounding the Project Islands during Operation	1, 2, 3	Less than significant	No mitigation is required	–
TRA-9: Creation of Safety Conflicts on Delta Waterways during Construction	1, 2, 3	Significant	TRA-MM-3: Clearly Mark the Barge and Notify the U.S. Coast Guard of Construction Activities	Less than significant
TRA-10: Increase in the Potential for Safety Problem on Waterways Surrounding the Project Islands	1, 2, 3	Significant	TRA-MM-4: Clearly Post Waterway Intersections, Speed Zones, and Potential Hazards in the Project Vicinity	Less than significant

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
CULTURAL RESOURCES				
CUL-1: Destruction of Buildings and Structures from Demolition on Bacon Island	1, 2, 3	Significant	CUL-MM-1: Prepare and Implement a Historic Properties Treatment Plan CUL-MM-1a: Complete Historic Research, Measured Drawings, and Photographic Documentation of the Bacon Island Rural Historic District CUL-MM-1b: Prepare and Implement an Archaeological Resources Data Recovery Plan CUL-MM-1c: Produce a Publication to Disseminate Historical Information regarding the Bacon Island Rural Historic District to the Public CUL-MM-1d: Prepare a Video That Disseminates Historical Information and Explains the Character-Defining Features of the Bacon Island Rural Historic District to the Public	Less than significant
CUL-2: Disturbance to Archaeological Remains as a Result of Compaction, Inundation, Wave-Induced Erosion, or Habitat Development and Management	1, 2	Significant	CUL-MM-1: Prepare and Implement a Historic Properties Treatment Plan The HPTP will include the following component in addition to those described for Impact CUL-1: CUL-MM-1e: Provide Methods and Guidance for Subsurface Testing in the form of Remote Sensing and Excavation	Less than significant
CUL-2: Disturbance to Archaeological Remains as a Result of Compaction, Inundation, Wave-Induced Erosion, or Habitat Development and Management	3	Significant	CUL-MM-1: Prepare and Implement a Historic Properties Treatment Plan The HPTP will include the following components in addition to those described for Impact CUL-1: CUL-MM-1e: Provide Methods and Guidance for Subsurface Testing in the form of Remote Sensing and Excavation CUL-MM-1g: Prepare and Implement an Archaeological Resources Data Recovery Plan for Site-Specific Resources.	Less than significant

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
CUL-3: Disturbance to Human Remains from Compaction as a Result of Inundation, Wave-Induced Erosion, or Habitat Development and Management, or Vandalism	1, 2, 3	Significant and unavoidable	CUL-MM-1: Prepare and Implement a Historic Properties Treatment Plan The HPTP will include the following component in addition to those described for Impact CUL-1: CUL-MM-1f: Negotiate, Prepare, and Implement a Preburial Agreement with the Most Likely Descendant (as Determined by the Native American Heritage Commission) of Potential Native American Interments Located in Webb Tract Piper Sands in the Project Area	Significant and unavoidable
MOSQUITOES AND PUBLIC HEALTH				
PH-1: Reduction or Elimination of Mosquito Abatement Activities during Full-Storage Periods on Reservoir Islands	1, 2, 3	Beneficial and less than significant	No mitigation is required	–
PH-2: Increase in Abatement Levels on the Habitat Islands and during Partial-Storage, Shallow-Storage, or Shallow Water–Wetland Periods on the Reservoir Islands	1, 2, 3	Significant	PH-MM-1: Develop an Integrated Pest Management Program and Coordinate Project Activities with SJCMVCD and CCCMVCD	Less than significant
PH-3: Increase in Potential Exposure of People to Wildlife Species That Transmit Diseases	1, 2	Less than significant	No mitigation is required	–
AIR QUALITY				
AIR-1. Increase in CO Emissions on the Project Islands during Construction	1, 2, 3	Less than significant	Mitigation is not required, but the following will reduce Project impacts: AIR-MM-1: Perform Routine Maintenance of Construction Equipment AIR-MM-2: Choose Borrow Sites Close to Fill Locations AIR-MM-3: Prohibit Unnecessary Idling of Construction Equipment Engines	–
AIR-2. Increase in CO Emissions on the Project Islands during Project Operation	1, 2, 3	Less than significant	No mitigation is required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
AIR-3. Increase in ROG Emissions on the Project Islands during Construction	1, 2, 3	Significant and unavoidable	REC-MM-1: Reduce the Size or Number of Recreation Facilities AIR-MM-1: Perform Routine Maintenance of Construction Equipment AIR-MM-2: Choose Borrow Sites Close to Fill Locations AIR-MM-3: Prohibit Unnecessary Idling of Construction Equipment Engines	Significant and unavoidable
AIR-4. Increase in ROG Emissions on the Project Islands during Operation	1, 2, 3	Significant	REC-MM-1: Reduce the Size or Number of Recreation Facilities AIR-MM-4: Coordinate with the SJVAPCD and BAAQMD to Reduce or Offset Emissions	Less than significant
AIR-5. Increase in NO_X Emissions on the Project Islands during Construction	1, 2, 3	Significant and unavoidable	REC-MM-1: Reduce the Size or Number of Recreation Facilities AIR-MM-1: Perform Routine Maintenance of Construction Equipment AIR-MM-2: Choose Borrow Sites Close to Fill Locations AIR-MM-3: Prohibit Unnecessary Idling of Construction Equipment Engines	Significant and unavoidable
AIR-6. Increase in NO_X Emissions on the Project Islands during Operation	1, 2, 3	Significant	Rec-MM-1: Reduce the Size or Number of Recreation Facilities AIR-MM-4: Coordinate with the SJVAPCD and BAAQMD to Reduce or Offset Emissions AIR-MM-5: Use Electrically Powered Pumps in Lieu of Diesel Powered Pumps	Less than significant
AIR-7. Increase in PM10 Emissions on the Project Islands during Construction	1, 2, 3	Significant	AIR-MM-6. Implement Construction Practices That Reduce Generation of Particulate Matter	Less than significant
AIR-8. Increase in PM10 Emissions on the Project Islands during Operation	1, 2, 3	Beneficial and less than significant	No mitigation is required	–
CLIMATE CHANGE				
CC-1: Increase in CO_2e Emissions on Project Islands during Construction	1, 2, 3	Less than significant	No mitigation is required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
CC-2: Increase in CO_2e Emissions on Project Islands during Operation	1, 2, 3	Less than significant	No mitigation is required	–
NOISE				
NOI-1: Exposure of Sensitive Receptors to Noise from Recreational Activities	1, 2, 3	Less than significant	No mitigation is required	–
NOI-2: Exposure of Sensitive Receptors to Construction-Related Noise	1, 2, 3	Significant	NOI-MM-1: Limit Construction Hours and Comply with all Applicable Local Noise Standards	Less than significant
NOI-3: Exposure of Sensitive Receptors to Operational Equipment Noise	1, 2, 3	Less than significant	No mitigation is required	–
NOI-4: Exposure of Sensitive Receptors to Noise from Ongoing Maintenance and Habitat Conservation Activities	1, 2, 3	Less than significant	No mitigation is required	–
CUMULATIVE				
CUM-1: Reduction in Delta Consumptive Use	1, 2, 3	Beneficial	No mitigation is required	–
CUM-2: Increased Water Supplies Available for Export	1, 2, 3	Beneficial	No mitigation is required	–
CUM-3: Cumulative Hydrodynamic Effects on Local Channel Velocities and Stages during Maximum Project Diversions	1, 2, 3	Not cumulatively considerable	No mitigation is required	–
CUM-4: Cumulative Hydrodynamic Effects on Local Channel Velocities and Stages during Maximum Project Discharges	1, 2, 3	Not cumulatively considerable	No mitigation is required	–
CUM-5: Cumulative Hydrodynamic Effects on Net Channel Flows	1, 2, 3	Cumulatively considerable	CUM-MM-1: Operate the Project to Prevent Unacceptable Hydrodynamic Effects in the Middle River and Old River Channels during Flows That Are Higher Than Historical Flows	Not cumulatively considerable
CUM-6: Increase in Pollutant Loading in Delta Channels Associated with Recreational Boating	1, 2, 3	Cumulatively considerable and unavoidable	CUM-MM-2: Clearly Post Waste Discharge Requirements, Provide Waste Collection Facilities, and Educate Recreationists regarding Illegal Discharges of Waste REC-MM-1: Reduce the Size or Number of Recreation Facilities	Cumulatively considerable and unavoidable

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
CUM-7: Improved CVP and SWP Water Quality Resulting from Increased Use of Sacramento River Water	1, 2, 3	Beneficial	No mitigation is required	–
CUM-8: Decrease in Cumulative Flood Hazard in the Delta	1, 2, 3	Beneficial	No mitigation is required	–
CUM-9: Decrease in the Need for Public Financing of Levee Maintenance and Repair on the Project islands	1, 2, 3	Beneficial	No mitigation is required	–
CUM-10: Cumulative Decrease in the Risk of Structural Failure of Roadways and Utilities	1, 2, 3	Beneficial	No mitigation is required	–
CUM-11: Cumulative Adverse Impacts on Listed Fish Species	1, 2, 3	Cumulatively considerable and unavoidable	FISH-MM-1: Replacement of Habitat Lost during Construction of Project Facilities FISH-MM-2: Implement a Fishery Improvement Mitigation Fund FISH-MM-3: Establish a Shallow-Water Aquatic Habitat Conservation Easement	Cumulatively considerable and unavoidable
CUM-12: Increase in Wetland and Riparian Habitats in the Delta	1, 2, 3	Beneficial	No mitigation is required	–
CUM-13: Cumulative Increase in Foraging Habitat for Wintering Waterfowl in the Delta	1, 2, 3	Beneficial	No mitigation is required	–
CUM-14: Cumulative Loss of Herbaceous Habitats in the Delta	1, 2, 3	Not cumulatively considerable	No mitigation is required	–
CUM-15: Cumulative Temporary Loss of Riparian Habitat in the Delta	1, 2, 3	Not cumulatively considerable	No mitigation is required	–
CUM-16: Cumulative Conversion of Agricultural Land	1, 2, 3	Cumulatively considerable and unavoidable	No reasonable mitigation is available	Cumulatively considerable and unavoidable
CUM-17: Increase in Recreation Opportunities in the Delta	1, 2, 3	Beneficial	No mitigation is required	–
CUM-18: Enhancement of Waterfowl Populations and Increased Hunter Success in the Delta	1, 2, 3	Beneficial	No mitigation is required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
CUM-19: Reduction in the Quality of Views of the Reservoir Islands	1, 2, 3	Cumulatively considerable and unavoidable	REC-MM-1: Reduce the Size or Number of Recreation Facilities REC-MM-2: Partially Screen Proposed Recreation Facilities and Pump and Siphon Stations from Important Viewing Areas REC-MM-3: Design Levee Improvements, Siphon and Pump Stations, and Recreation Facilities and Boat Docks to Be Consistent with the Surrounding Landscape	Cumulatively considerable and unavoidable
CUM-20: Destruction of or Damage to Prehistoric Archaeological Sites in the Delta	1, 2, 3	Not cumulatively considerable	No mitigation is required	–
CUM-21: Destruction of or Damage to Historic Districts Representing Agricultural Labor Camp Systems in the Delta	1, 2, 3	Cumulatively considerable	CUL-MM-1: Prepare and Implement a Historic Properties Treatment Plan	Not cumulatively considerable
CUM-22: Increase in Abatement Levels during Partial-Storage, Shallow-Storage, or Shallow-Water Wetland Periods on the Reservoir Islands under Cumulative Conditions	1, 2, 3	Cumulatively considerable	Mitigation Measure PH-MM-1: Develop an Integrated Pest Management Program and Coordinate Project Activities with SJCMVCD and CCCMVCD	Not cumulatively considerable
CUM-23: Cumulative Increase in Mosquito Abatement Needs Resulting from Implementation of Future Projects, Including the Project	1, 2, 3	Cumulatively considerable and unavoidable	Mitigation Measure PH-MM-1: Develop an Integrated Pest Management Program and Coordinate Project Activities with SJCMVCD and CCCMVCD	Cumulatively considerable and unavoidable
CUM-24: Increase in Cumulative Production of Ozone Precursors and CO in the Delta	1, 2, 3	Cumulatively considerable and unavoidable	REC-MM-1: Reduce the Size or Number Recreation Facilities Air-MM-4: Coordinate with the SJVAPCD and BAAQMD to Reduce or Offset Emissions	Cumulatively considerable and unavoidable

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Acronyms and Abbreviations

°F	Fahrenheit
µg/l	micrograms per liter
µg/m^3	micrograms per cubic meter
µS/cm	microSiemens per centimeter
1995 DEIR/EIS	Delta Wetlands Project 1995 Draft Environmental Impact Report/Environmental Impact Statement
1995 WQCP	1995 Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary
2000 RDEIR/EIS	2000 Revised Draft Environmental Impact Report/Environmental Impact Statement
2001 FEIR	Delta Wetlands Project 2001 Final Environmental Impact Report (SCH# 1988020824)
AB	Assembly Bill
ACHP	Advisory Council on Historic Preservation
af	acre-feet
af/day	acre-feet per day
af/yr	acre-feet per year
AG	California Attorney General
ARB	California Air Resources Board
AVEK	Antelope Valley–East Kern Water Agency
BA	Biological Assessment
BAAQMD	Bay Area Air Quality Management District
BAU	business as usual
Bay-Delta	San Francisco Bay/Sacramento–San Joaquin Delta
Bcf/day	billion cubic feet per day
BDCP	Bay Delta Conservation Plan
BMPs	best management practices
BOs	Biological Opinions
BPS	Best Performance Standards
Br^-	bromide
CAAQS	California ambient air quality standards
$CaCO_3$	calcium carbonate
CALFED	CALFED Bay-Delta Program

Cal-IPC	California Invasive Plant Council
Caltrans	California Department of Transportation
CAPCOA	California Air Pollution Control Officers Association
CBD	Central Business District
CCCMVCD	Contra Costa County Mosquito and Vector Control District
CCF	Clifton Court Forebay
CCGP	Contra Costa County General Plan 2005–2020
CCR	California Code of Regulations
CCTA	Contra Costa Transportation Authority
CCWD	Contra Costa Water District
CDC	California Department of Conservation
CDEC	California Data Exchange Center
CDFA	California Department of Food and Agriculture
CDWA	Central Delta Water Agency
CEC	California Energy Commission
CEQ	Council on Environmental Quality
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFGC	California Fish and Game Code
cfs	cubic feet per second
CH_4	methane
CIMIS	California Irrigation Management Information System
Cl_2	chlorine
CMA	Congestion Management Agency
CMP	Congestion Management Plan
CNDDB	California Natural Diversity Database
CNEL	community noise equivalent level
CNPPA	California Native Plant Protection Act
CNPS	California Native Plant Society
CO	carbon monoxide
CO_2	carbon dioxide
Corps	U.S. Army Corps of Engineers
CPUC	California Public Utilities Commission
CRHR	California Register of Historical Resources
CUWA	California Urban Water Agencies
CVFPB	Central Valley Flood Protection Board
CVOC	Central Valley Operations Center
CVP	Central Valley Project
CVP Jones	CVP Jones Pumping Plant
CVPIA	Central Valley Project Improvement Act
CWA	Clean Water Act
D-1641	State Water Board Water Right Decision 1641
D-1643	State Water Board Water Right Decision 1643

dB	decibels
dBA	A-weighted decibels
dbh	diameter at breast height
DBP	disinfection by-product
Delta	Sacramento–San Joaquin River Delta
DFG	California Department of Fish and Game
DMC-CA Intertie	Delta-Mendota Canal/California Aqueduct Intertie
DO	dissolved oxygen
DOC	dissolved organic carbon
DPC	Delta Protection Commission
DPSs	distinct population segments
DRMS	Delta Risk Management Strategy
DSOD	California Division of Safety of Dams
DW or Project applicant	Delta Wetlands Properties
DWR	California Department of Water Resources
DWSC	Deep Water Ship Channel
E/I	export/import
EBMUD	East Bay Municipal Utility District
EC	electrical conductivity
ECCCHCP/NCCP	East Contra Costa County Habitat Conservation Plan/Natural Community Conservation Plan
EFH	essential fish habitat
EPA	U.S. Environmental Protection Agency
ESA	federal Endangered Species Act
ESU	evolutionarily significant unit
ET	evapotranspiration
EWA	Environmental Water Account
FEIS	Final Environmental Impact Statement
FMMP	Important Farmland Mapping and Monitoring Program
FMWT	Fall Mid-Water Trawl
FOC	Final Operating Criteria
FR	Federal Register
FSA	Food Security Act
ft/sec	feet per second
g/m^2	grams per square meter
g/yr	grams per year
gal/day	gallons per day
$g\text{-}C/m^2/yr$	grams of DOC per square meter per year
General Construction Permit	NPDES General Permit for Construction Activities
General Dewatering Permit	General Order for Dewatering and Other Low Threat Discharges to Surface Waters
GHG	greenhouse gas

GWP	global warming potential
Habitat Islands	Bouldin Island and Holland Tract
HCM	Highway Capacity Manual
HCP	Habitat Conservation Plan
HDD	horizontal directional drillng
HEP	habitat evaluation procedures
HFCs	hydrofluorocarbons
HMAC	Habitat Management Advisory Council
HMP	Habitat Management Plan
HMP	Habitat Management Plan
HORB	head of Old River barrier
HPMP	Historic Properties Management Plan
HPTP	Historic Properties Treatment Plan
I-5	Interstate 5
IDSM	In-Delta Storage Model
IEP	Interagency Ecological Program
IFM	Integrated Farm Management
IPCC	Intergovernmental Panel on Climate Change
IPM	integrated pest management
ISAC	Invasive Species Advisory Committee
ISI	Integrated Storage Investigation
ITP	Incidental Take Permit
kV	kilovolt
LAFCO	Local Agency Formation Commission
L_{dn}	day-night sound level
L_{dn}/CNEL	day-night noise level/community noise equivalent level
L_{eq}	equivalent sound level
L_{min} and L_{max}	minimum and maximum sound levels
LOS	level of service
LURMP	Land Use and Resource Management Plan for the Primary Zone of the Delta
L_{xx}	percentile-exceeded sound levels
m	meters
maf	million acre-feet
Magnuson-Stevens Act	Magnuson-Stevens Fishery Conservation and Management Act
MBK	MBK Engineers
MBTA	federal Migratory Bird Treaty Act
MCL	maximum contaminant level
Metropolitan	The Metropolitan Water District of Southern California
mg/l	milligrams per liter

MOA	Memorandum of Agreement
MOU	memorandum of understanding
mph	miles per hour
mS/cm	milliSiemens per centimeter
msl	above mean sea level
MTAC	Monitoring Technical Advisory Committee
MVCDs	mosquito and vector control districts
N_2O	nitrous oxide
NAAQS	national ambient air quality standards
NBHA	North Bouldin Habitat Area
NCCPA	Natural Communities Conservation Planning Act
NEPA	National Environmental Policy Act
$ng/m^2/day$	nanograms per square meter per day
NGVD 29	National Geodetic Vertical Datum of 1929
NHPA	National Historic Preservation Act
NICS	National Invasive Species Council
NMFS	National Marine Fisheries Service
NO_2	nitrogen dioxide
NOI	notice of intent
NO_X	oxides of nitrogen
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NTU	nephelometric turbidity units
O_3	ozone
OCAP	Operations Criteria and Plan
OMR	Old and Middle River
OPR	California Office of Planning and Research
PA	programmatic agreement
PBS	Public Broadcasting System
PFCs	perfluorocarbons
PG&E	The Pacific Gas and Electric Company
Place of Use EIR, or EIR	Place of Use Environmental Impact Report
PM	posted mile
PM10	particulate matter 10 microns or less in diameter
PM2.5	particulate matter 2.5 microns or less in diameter
POC	particulate organic carbon
POD	pelagic organism decline
ppb	parts per billion
ppd	pounds per day
PPIC	Public Policy Institute of California

ppm	parts per million
PPMP	pollution prevention and monitoring program
ppt	parts per thousand
Project	Delta Wetlands Project
psi	pounds per square inch
RAC	rubberized asphalt concrete
RDs	Reclamation Districts
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
Reservoir Islands	Bacon Island and Webb Tract
RHA	Rivers and Harbors Act
ROD	2000 Record of Decision
ROG	reactive organic gases
RPA	Reasonable and Prudent Alternative
RPMs	reasonable and prudent measures
RWQCB	Regional Water Quality Control Board
SB	Senate Bill
SDWA	Safe Drinking Water Act
Semitropic	Semitropic Water Storage District
SF_6	sulfur hexafluoride
SFBAAB	San Francisco Bay Area Air Basin
SHPO	State Historic Preservation Officer
SIP	State Implementation Plan
SJCGP	San Joaquin County General Plan
SJCMVCD	San Joaquin County Mosquito and Vector Control District
SJCOG	San Joaquin Council of Governments
SJMSCP	San Joaquin County Multi Species Habitat Conservation and Open Space Plan
SJVAB	San Joaquin Valley Air Basin
SJVAPCD	San Joaquin Valley Air Pollution Control District
SMARA	California Surface Mining and Reclamation Act of 1975 (PRC Section 2710 et seq.)
SMARTS	Special Multipurpose Applied Research Technology Station
SO_2	sulfur dioxide
SR	State Route
State Water Board	State Water Resources Control Board
SWANCC	Solid Waste Agency of Northern Cook County v. United States Army Corps of Engineers
SWG	Smelt Working Group
SWP	State Water Project
SWP Banks	SWP Harvey O. Banks Pumping Plant
SWPPP	stormwater pollution prevention plan

taf	thousand acre-feet
TBP	Temporary Barrier Program
TCP	Traffic Control Plan
TDM	travel demand management
TDS	total dissolved solids
THM	trihalomethane
TMDL	total maximum daily load
TOC	total organic carbon
tpy	tons per year
UC Davis	University of California, Davis
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
Valley District	San Bernardino Valley Municipal Water District,
VAMP	Vernalis Adaptive Management Plan
VELB	valley elderberry longhorn beetle
VERA	voluntary emission reduction agreement
WDRs	waste discharge requirements
Western	Western Municipal Water District of Riverside County
WMAs	Weed Management Areas
WQMP	Water Quality Management Plan
YOY	young-of-the-year

Chapter 1
Introduction

Overview

This Delta Wetlands Project Place of Use Environmental Impact Report (Place of Use EIR, or EIR) has been prepared under the direction of the Semitropic Water Storage District (Semitropic) in accordance with the requirements of the California Environmental Quality Act (CEQA). This Place of Use EIR analyzes potential environmental effects associated with the diversion and storage of water by the Delta Wetlands Project (Project) and the supplying of that water to the places of use and the supplemental storage of that water in the Semitropic and Antelope Valley groundwater banks as specified in the petitions to change water right Application Nos. 29062, 29066, 30268, and 30270 filed with the State Water Resources Control Board (State Water Board). The Lead Agency has determined the Project is of statewide, regional, or area wide significance in accordance with CEQA Guidelines section 15206.

The potential environmental impacts of the Project, with the exception of the more detailed analysis of place of use and underground storage impacts analyzed in this EIR, were first analyzed in the Project 1995 Draft Environmental Impact Report/Environmental Impact Statement (1995 DEIR/EIS), the 2000 Revised Draft Environmental Impact Report/Environmental Impact Statement (2000 RDEIR/EIS), and the 2001 Final Environmental Impact Report (SCH# 1988020824) (2001 FEIR), prepared on behalf of the State Water Board to satisfy the requirements of CEQA. A Final Environmental Impact Statement (FEIS) was issued by the U.S. Army Corps of Engineers (Corps) in July 2001 (66 Federal Register [FR] 40698 [2001]) to satisfy the requirements of the National Environmental Policy Act (NEPA). As discussed in more detail below, the Third District Court of Appeal in *Central Delta Water Agency v. State Water Resources Control Board*, 124 Cal. App. 4th 245 (2004), set aside the water right permits and accompanying CEQA documents for failure “to specify an actual use of and the amounts of water to be appropriated.” However, the underlying environmental analysis of the EIR was not overturned (nor was there any challenge to the EIS). Therefore, this Place of Use EIR incorporates the relevant portions of the 1995 DEIR/EIS, 2000 RDEIR/EIS, 2001 FEIR, and 2001 FEIS by reference, as identified in the specific sections of this EIR in accordance with State CEQA Guidelines Section 15150. The incorporated documents are included on each compact disc of the digital version of this EIR and are available for public review at the Project website, http://deltawetlandsproject.com, and at public buildings as referenced in the included distribution list.

The Project would increase the availability of high-quality water in the Sacramento–San Joaquin River Delta (Delta) for export or outflow through its six basic parts:

- diversion of water in the Delta;
- water storage on two Reservoir Islands (Bacon Island and Webb Tract);
- compensation for wetland and wildlife effects of the water storage operations on the Reservoir Islands by implementing a Habitat Management Plan on two Habitat Islands (Bouldin Island and Holland Tract);
- supplemental water storage in the Semitropic Groundwater Storage Bank and the Antelope Valley Water Bank south of the Delta;
- provision of water supply for designated south-of-Delta users; and
- release of water for water quality enhancement in the Bay-Delta Estuary in the fall as an additional beneficial water use in a designated place of use.

The first three aspects of the Project are unchanged from the Project as analyzed in the 1995 DEIR/EIS, 2000 RDEIR/EIS, and 2001 FEIR and conditioned by State Water Board Water Right Decision 1643 (D-1643), water right protest dismissal agreements between the Project proponent (Delta Wetlands Properties [DW or Project applicant]) and various parties to the State Water Board's water right hearings, and the Biological Opinions (BOs) of the National Marine Fisheries Service (NMFS), the U.S. Fish and Wildlife Service (USFWS), and the California Department of Fish and Game (DFG). The portions of the Project that remain unchanged are reviewed and updated within the document.

The integration of the in-Delta water storage element with the Semitropic Groundwater Storage Bank and the Antelope Valley Water Bank is a new element of the Project. The permitted and operational Semitropic Groundwater Storage Bank, its Stored Water Recovery Unit, and Antelope Valley Water Bank have been fully analyzed in the Semitropic Groundwater Banking Project Final EIR (SCH#1993072024), Semitropic Groundwater Banking Project Stored Water Recovery Unit Final Supplemental EIR (SCH#1999031100), and Antelope Valley Water Bank Final EIR (SCH#2005091117) and are not analyzed in this Place of Use EIR.

The location of the Project islands within the Delta is shown in Figures 1-1a and 1-1b. The places of use by county are shown in Figure 1-2, followed by place of use maps for each potential service area that may receive Project water (Figures 1-3, 1-4a through 1-4g, 1-5a through 1-5f, and 1-6). All figures are included at the end of this chapter.

Focus of This Environmental Impact Report

Since the 2001 FEIR, the Project applicant, the original Project proponent, has entered into a partnership with Semitropic to develop the Project, to integrate the Project into the operation of the Semitropic Groundwater Storage Bank and the

Antelope Valley Water Bank, and to provide Project water for agricultural uses within Semitropic's service area.

The partnership with Semitropic allows the Project to take advantage of Semitropic's innovative and highly successful groundwater banking programs, including its Semitropic Groundwater Storage Bank and Stored Water Recovery Unit and the Antelope Valley Water Bank, managed by a joint powers authority that includes Semitropic. The addition of groundwater banking capability south of the Delta to the Project provides additional water supply reliability and operational flexibility in the provision of water to the places of use.

Summary of Changes to the Project Description

In compliance with *Central Delta Water Agency v. State Water Resources Control Board*, 124 Cal.App.4th 245 (2004), this Place of Use EIR updates the water supply portion of the Project to identify specific places of use of water. Petitions to change the Project's water rights applications to add places of use and places of underground storage have been filed with the State Water Board.

Accordingly, the scope of this CEQA analysis focuses primarily on the changes to the Project description proposed in the petitions for change regarding specific places of use for Project water, estimated diversion amounts, beneficial uses, means of transfer, and storage of water in groundwater banks. Specifically, this Place of Use EIR examines the environmental effects of the following changes to the Project description:

- provision of water from the Project to the following places of use as proposed in petitions to change water right Application Nos. 29062, 29066, 30268, and 30270 filed with the State Water Board:
  - Semitropic for irrigation purposes (see Figure 1-3),
  - Golden State Water Company (Golden State) for municipal and industrial purposes (see Figures 1-4a through 1-4g),
  - The Metropolitan Water District of Southern California (Metropolitan) for municipal and industrial purposes (see Figures 1-5a through 1-5f),
  - Western Municipal Water District of Riverside County (Western) for municipal and industrial purposes (see Figure 1-6), and
  - San Bernardino Valley Municipal Water District, (Valley District) for municipal and industrial purposes (see Figure 1-6).
- banking of Project water in the Semitropic Groundwater Storage Bank and Antelope Valley Water Bank for later use by Semitropic, and the other places of use to the extent such banking of water was not analyzed previously in the Semitropic Groundwater Storage Bank and Antelope Valley EIRs; and
- a revised levee design to improve Reservoir Island structural integrity.

Changes to the Project description and additional information on the places of use are discussed in greater detail in Chapter 2, "Project Description and Alternatives."

Description of Updated Resource Analyses

Generally, the resource analyses in the prior documents, incorporated herein by reference, accurately describe the current environmental and regulatory settings, environmental impacts, and needed mitigation measures relevant to each resource. As needed, this Place of Use EIR updates resource analyses of the 1995 DEIR/EIS, 2000 RDEIR/EIS, and 2001 FEIR to address changed circumstances. Using the CEQA Guidelines as a reference, the Lead Agency developed criteria to determine when an update of a resource analysis was needed. Each resource was considered, and analysis updated, if any of the following were present:

- changes in the Project description resulting in new significant environmental effects or a substantial increase in the severity of previously identified significant effects;
- changes occurring with respect to the circumstances under which the Project is undertaken resulting in new significant environmental effects or a substantial increase in the severity of previously identified significant effects; and
- new information that was not known at the time of the previous environmental analyses, that shows:
    - a change in severity of the impact; or
    - that the mitigation measures or alternatives previously analyzed and found not to be feasible would in fact be feasible and would substantially reduce one or more significant effects of the Project, but the Project applicant declines to adopt; or
    - that new mitigation measures or alternatives substantially different from those analyzed in the previous EIR would substantially reduce one or more significant effects on the environment, but the Project applicant declines to adopt.

This EIR attempts to efficiently and appropriately apply the environmental analyses of the prior CEQA and NEPA documents. However, the headings and identification coding system for impacts and mitigation measures may deviate from prior documents to facilitate the logic and structure of this EIR for readability and internal consistency.

Summary of New Information and Changed Circumstances

This Place of Use EIR will also reevaluate the Project and analyses from the 1995 DEIR/EIS, 2000 RDEIR/EIS, 2001 FEIR, and 2001 FEIS in light of regulatory changes and other developments and studies or planning efforts conducted since 2001 that may affect the existing conditions in the Delta or understanding of potential impacts from Project operations. Major new information and circumstances included in subsequent chapters and sections include, but are not limited to:

- California Department of Water Resources' (DWR's) Integrated Storage Investigation (ISI) Studies (see Chapter 2, "Project Description and Alternatives," Chapter 3, "Project Operations," and Section 4.3, Flood Control and Levee Stability);
- University of California, Davis (UC Davis)/Public Policy Institute of California (PPIC) Reports: "Envisioning Futures for the Sacramento–San Joaquin Delta" and "Comparing Futures for the Sacramento–San Joaquin Delta" (see Chapter 2, "Project Description and Alternatives");
- Delta Vision Blue Ribbon Task Force Report (see Chapter 2, "Project Description and Alternatives");
- Bay Delta Conservation Plan (BDCP) planning and evaluation efforts for water supply reliability and fish species protection in the Delta (see Chapter 2, "Project Description and Alternatives," and Section 4.5, Fish);
- State Water Board review and update of the 1995 Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary (1995 WQCP) (see Section 4.1, Water Supply);
- Environmental Water Account (EWA) and the Yuba Accord (See Section 4.1, Water Supply);
- legal challenges to the USFWS and NMFS BOs on the Central Valley Project (CVP) and State Water Project (SWP) Operations Criteria and Plan (OCAP), the Interim Remedial Order issued by Judge Wanger on December 14, 2007, in *Natural Resources Defense Council, et al. v. Kempthorne*, and the December 2008 USFWS BO and the June 2009 NMFS BO (see Section 4.5, Fish);
- studies and evaluations by Interagency Ecological Program (IEP) of the pelagic organism decline (see Section 4.5, Fish);
- Delta Risk Management Strategy (DRMS) Report (see Section 4.3, Flood Control and Levee Stability);
- the Jones Tract levee failure and flooding in June 2004 as described and evaluated by DWR (See Section 4.2, Water Quality); and
- DWR 2006 Report on "Progress on Incorporating Climate Change into Management of California's Water Resources" (see Section 4.14, Climate Change).

These documents are publicly available and are cited in full in Chapter 9, "References."

Environmental Impact Report Organization

This EIR is organized as follows:

- Chapter 1, "Introduction"
- Chapter 2, "Project Description and Alternatives"
- Chapter 3, "Project Operations"
- Chapter 4, "Analyses of Environmental Effects"
  - Section 4.1, Water Supply
  - Section 4.2, Water Quality
  - Section 4.3, Flood Control and Levee Stability
  - Section 4.4, Utilities and Highways
  - Section 4.5, Fishery Resources
  - Section 4.6, Vegetation and Wetlands
  - Section 4.7, Wildlife
  - Section 4.8, Land Use and Agriculture
  - Section 4.9, Recreation and Visual Resources
  - Section 4.10, Traffic and Navigation
  - Section 4.11, Cultural Resources
  - Section 4.12, Mosquitoes and Public Health
  - Section 4.13, Air Quality
  - Section 4.14, Climate Change
  - Section 4.15, Noise
- Chapter 5, "Cumulative Impacts"
- Chapter 6, "Growth-Inducing Impacts"
- Chapter 7, "Compliance with Applicable Laws, Policies, Plans, and Regulatory Framework"
- Chapter 8, "Report Preparers"
- Chapter 9, "References"
- Appendix A, "Delta Wetlands Project In-Delta Storage Model"
- Appendix B, "Detailed Description of Recent OCAP Biological Opinions and Delta Wetlands Fishery Resources Impact Assessment Methods and Results"
- Appendix C, "Air Quality Data"

Project Purpose and Objectives

The overall purpose of the Project is to increase the availability of high-quality water in the Delta for export or outflow by storing water on two Reservoir Islands (Webb Tract and Bacon Island) and by doing so, increase the reliability of water supplies for Semitropic and other places of use including Golden State, Metropolitan, Western, and Valley District. The storage of surplus Project water in the Semitropic Groundwater Storage Bank and Antelope Valley Water Bank for later use by those users will reduce groundwater overdraft and reduce pumping lift for water users within those basins as well as provide additional dry year water supply reliability for the Project users. Further, the Project would compensate for wetland and wildlife effects of the water storage operations on the Reservoir Islands by implementing an HMP on two dedicated Habitat Islands (Bouldin Island and Holland Tract).

The Project purpose would be met by diverting Delta inflow during times of surplus Delta outflow (after all water quality or flow requirements for the San Francisco Bay/Sacramento–San Joaquin Delta [Bay-Delta] Estuary are met). The diverted water would be stored on the Reservoir Islands until released for export to south-of-Delta users, including Semitropic's service area and the other specified places of use, or for environmental benefits in the Bay-Delta estuary. No infrastructure or facilities, other than those already described in the State Water Board 2001 FEIR (SCH#1988020824), are proposed to support the Project purpose. Water would be delivered via existing and previously approved facilities operated and maintained by the SWP, CVP, and those within the proposed places of use. As noted above, the Project would provide managed wetlands and wildlife habitat areas. Additionally, the Project would accommodate recreational uses.

EIR Public Review Period

This draft EIR is being circulated for a 45-day public review period, during which the public and interested agencies are encourage to submit comments on the document. To facilitate public review, a public hearing will be conducted during the review period to solicit oral comments on this EIR. Public notice of the hearing date and location, and of the date of public comment closure, will be provided by mail, through newspaper publication, and through the Project website, http://deltawetlandsproject.com.

Comments should be sent to:

ICF International
630 K Street, Suite 400
Sacramento, CA 95814
Attn: Megan Smith, Project Manager

Once all comments have been assembled and reviewed, the lead agency will prepare responses on all notable environmental issues that have been raised. These responses to comments, combined with the draft EIR, will constitute the final EIR.

Areas of Known Controversy

Based on public and agency comments received throughout the project planning process, the Project applicant and lead agency have identified several areas of controversy related to the proposed Project raised by agencies and the public during the public scoping process.

Delta Sustainability

The Delta is critically important to the health of California's economy and environment. Conflicts and controversy have defined water operations in the Delta for decades. Significant efforts are underway to identify plans and operations for a sustainable Delta in the future. The Project can be a near-term action to alleviate some of the conflict and controversy regarding water diversions and environmental protection. The Project can also be coordinated with the long-term solutions as they are developed.

Delta Fisheries

The health and sustainability of Delta fisheries populations and habitat has been of high concern with recent species decline. The effects of the Project for Delta fisheries and proposed mitigation and environmental commitments are described in this Place of Use EIR.

Water Supply

The export of Project water to south-of-Delta places of use is an area of controversy because of the competing demands for water for environmental, agricultural, and municipal needs throughout California, as well as in light of recent court orders and regulatory changes affecting Delta exporting pumping.

Other Environmental Effects

The potential environmental effects of the Project on the following resources, and any necessary mitigation, are of interest and concern to agencies and the public. These issues are evaluated and addressed in this Place of Use EIR:

- Delta Hydrology and Water Quality: the Project effects on Delta hydrology, water quality, and water operations, including the cumulative effects of Delta diversions and operations;
- Levee Stability: the Project effects on flood control and levee stability for the reservoir and habitat islands;
- Seepage: the potential seepage effects from Project reservoirs to neighboring islands; and
- Agricultural Land Conversion: the effects of conversion of farmland to water storage and habitat, inconsistent with Contra Costa County’s and the Delta Protection Commission’s land use goals and policies.

Many of the impacts previously found to be significant and unavoidable have been reduced to less-than-significant through levee design revisions, changes in Project operational criteria, and other mitigation and environmental commitments. The Project will result in significant direct adverse impacts that can be reduced to a less-than-significant level with implementation of environmental commitments and mitigation to water quality, utilities, public services, fish, vegetation, wildlife, recreation, visual resources, traffic and navigation, cultural resources, mosquitoes and public health, air quality, and noise. The Project will result in significant direct adverse impacts that are immitigable and are considered unavoidable on highways, fish, land use and agriculture, visual resources, cultural resources, and air quality.

Intended Uses of the EIR

In addition to Semitropic’s action as the Lead Agency, this EIR will be used by Responsible and Trustee Agencies to determine the effects of the proposed action. Responsible Agencies are those agencies subject to the jurisdiction of California that have a legal responsibility to approve the program or project. These agencies are required to rely on the Lead Agency’s environmental document in acting on whatever aspect of the program or project that requires their approval but must prepare and issue their own findings regarding the program or project approval (CEQA Guidelines Section 15096). Trustee Agencies are those that have jurisdiction over certain resources held in trust for the people of California but do not necessarily have legal authority over approving or carrying out the program or project. Likely Responsible and Trustee Agencies for the Project are presented in Table 1-1.

Table 1-1. Likely Responsible and Trustee Agencies

Agency	Jurisdiction
Bay Area Air Quality Management District	Air quality within the district
California Department of Fish and Game	Fish and wildlife Native plants designated as Rare or Endangered Game refuges Ecological reserves
California Department of Transportation	State highways
California Department of Water Resources	State Water Project
California State Lands Commission	State-owned "sovereign" lands
California State Office of Historic Preservation	Historic and cultural resources
California State Water Resources Control Board	Water rights
Central Valley Regional Water Quality Control Board	Discharges to water bodies
Contra Costa County	Land use within Contra Costa County
Delta Protection Commission	Economic sustainability within the Delta
Delta Stewardship Council	Delta Plan consistency determination
Golden State Water Company	Taking and delivery of Project water
Metropolitan Water District of Southern California	Taking and delivery of Project water
Native American Heritage Commission	Native American resources
Reclamation District 756	Project levee design and flood management of Bouldin Island
Reclamation District 2025	Project levee design and flood management of Holland Tract
Reclamation District 2026	Project levee design and flood management of Webb Tract
Reclamation District 2028	Project levee design and flood management of Bacon Island
San Bernardino Valley Municipal Water District	Taking and delivery of Project water
San Joaquin County	Land use within San Joaquin County
San Joaquin Valley Unified Air Pollution Control District	Air quality within the district
Western Municipal Water District of Riverside County	Taking and delivery of Project water

Federal agencies that may be involved in the action include the USFWS; U.S. Department of the Interior, Bureau of Reclamation (Reclamation); NMFS; U.S. Environmental Protection Agency (EPA); and the Corps.

Each likely Responsible and Trustee agency was given an opportunity to comment during the scoping period. A list of permits and other approvals required to implement the project is included in Chapter 7, "Compliance with Applicable Laws, Policies, Plans, and Regulatory Framework."

Project History

The Project, through private party initiative, first filed water right applications with the State Water Board and a Department of the Army permit under Clean Water Act (CWA) Section 404 for the discharge of dredged or fill material into waters of the United States and under the Rivers and Harbors Act (RHA) Section 10 for activities within navigable waters with the Corps in 1987. Through agency coordination and public review, and the recent partnerships with Semitropic and with water users, the Project has gone through several iterations. A timeline of the Project history, as described below, is provided in Table 1-2 at the end of this chapter.

1990 Draft Environmental Impact Statement/ Environmental Impact Report

The Project applicant originally applied to the State Water Board in 1987 for water rights to store water seasonally on all four of its Project islands—Holland Tract, Webb Tract, Bacon Island, and Bouldin Island—and to sell that water to potential users in the CVP and SWP service areas. Because the Project was proposed by a private applicant, the State Water Board, as key state regulatory agency for project approval, was deemed Lead Agency for CEQA compliance purposes. The Project applicant also applied to the Corps for a permit under Section 404 of the CWA for the discharge of dredged or fill materials into waters of the United States and under Section 10 of the RHA for project activities in navigable waters. The Corps, the key federal regulatory agency for project approval, was lead agency for NEPA compliance purposes.

In December 1990, the lead agencies released a draft EIR/EIS analyzing the Project as it was originally proposed (Jones & Stokes Associates 1990).

1995 Draft Environmental Impact Statement/ Environmental Impact Report

In 1993, the Project applicant responded to the resources agencies' mitigation requests by revising the Project description from four Reservoir Islands to two Reservoir Islands (Bacon Island and Webb Tract) and two Habitat Islands (Holland Tract and Bouldin Island). The Project applicant revised the 1987 applications to accommodate the reduction from four to two storage islands and also filed new water right applications for direct diversion to the Project Reservoir Islands.

In 1995, the Corps and State Water Board circulated for public review and comment the 1995 DEIR/EIS to assess the environmental effects of the Project based on the 1993 Project description. They also held a public meeting on October 11, 1995 to receive comments on the document. The lead agencies received numerous comment letters during the public review period, which ended on December 21, 1995.

Fisheries Consultation and Biological Opinions

In 1997, pursuant to Section 7 of the ESA, the USFWS and NMFS issued no-jeopardy BOs to the Corps regarding effects of the Project on federally listed fish species. The “reasonable and prudent measures” (RPMs) of the BOs included detailed Project operating parameters, referred to as the Project “final operations criteria” (FOC) to reduce or compensate for the incidental take of listed species. The FOC were developed by the State Water Board, the Corps, NMFS, and DFG as part of the formal consultation process for listed fish species and identify Project operational criteria, take limits, and facility design (e.g., fish screen criteria) for listed species. The FOC have been incorporated into the proposed Project.

Under the California Endangered Species Act, as it existed in 1998, DFG issued a no-jeopardy opinion to the State Water Board in 1998 on Project effects on state-listed fish, wildlife, and plant species. DFG incorporated the FOC and added requirements for the habitat management islands in the RPMs.

1997 Historical Preservation Consultation

On December 22, 1997, the California State Historic Preservation Officer, along with the Corps, the State Water Board, and the Advisory Council on Historic Preservation, issued a Programmatic Agreement Regarding Implementation of the Delta Wetlands Properties Project under Section 106 of the National Historic Preservation Act.

2000 Revised Draft Environmental Impact Report/ Environmental Impact Statement

Also in 1997, the State Water Board convened a water right hearing to consider the Project applicant’s 1993 petitions to change the 1987 applications and 1993 applications. A substantial amount of testimony was presented. Several issues remained unresolved after the proceedings concluded. The lead agencies directed that the 2000 RDEIR/EIS be prepared to clarify those issues and to present updated simulations of Project discharges and diversions that would reflect the operating restrictions included in the FOC and other BO terms.

The 2000 RDEIR/EIS supplemented information presented in the 1995 DEIR/EIS in the following resource areas:

- water supply and operations,
- water quality,

- fisheries,
- levee stability and seepage, and
- natural gas facilities and pipelines.

The 2000 RDEIR/EIS was issued for public review on May 31, 2000. Several comment letters were received during the public review period, which ended on July 31, 2000.

2000 State Water Board Water Right Hearing

The State Water Board's hearing on the Project's water right applications was resumed and completed in October 2000.

The Project applicant and California Urban Water Agencies (CUWA) submitted to the State Water Board an agreement that the Project would be operated according to the terms of the Water Quality Management Plan (WQMP). During the October 2000 hearing, CUWA stated that it would withdraw its opposition to the Project water right permits based on the inclusion of the WQMP as a permit term or condition. East Bay Municipal Utility District (EBMUD) and Contra Costa Water District (CCWD) also entered into protest dismissal agreements with the Project applicant and submitted these to the State Water Board. The agreements include programs to ensure the stability of Project island levees, protections against seepage from the Reservoir Islands to neighboring islands, and limits on the Project's water quality effects.

The Project applicant entered into an agreement with the Pacific Gas and Electric Company (PG&E) in 2006 regarding the abandonment and/or removal of natural gas transmission Line 57A and improvements to the Line 57B levee crossings on Bacon Island, and other issues. This agreement addresses PG&E's protest to the Project's water right applications.

These and other agreements have been incorporated as elements of the Project and are further discussed in Chapter 2.

2001 Final Environmental Impact Report

In January 2001, the State Water Board issued an FEIR to respond to comments on the 1995 DEIR/EIS and the 2000 RDEIR/EIS. In February 2001, the State Water Board issued D-1643 approving the Project applicant's water right permit applications and Resolution 2001-25 certifying the FEIR. In D-1643, the State Water Board approved, subject to terms and conditions, water right applications 29062, 29066, 30268, and 30270 and the petitions to change these applications. Furthermore, the State Water Board made the following findings in D-1643 in response to issues raised in the 2000 State Water Board water right hearing.

- The terms and conditions of the Project applicant's protest dismissal agreements with Amador County, City of Stockton, North Delta Water Agency, EBMUD, CCWD, CUWA, DWR, and the Reclamation, resolved many issues raised in 1997, such as the amount and effect of dissolved organic carbon compounds produced in the Project reservoirs, possible effects on levee stability and seepage in the Delta, and impacts on fish in the Delta.
- The various modeling studies showed that water was available for appropriation.
- Storage of water on Project reservoirs and subsequent releases of water into the Delta would not adversely affect the quality of water in the Delta channels when it was released, or any reduction in water quality would be consistent with maximum benefit to the people of the State and would not unreasonably affect present and anticipated beneficial use of such water.
- DOC concentration in Delta water exports and direct and cumulative increases in trihalomethane concentrations in treated drinking water were reduced to less-than-significant levels.
- The FOC, the settlement agreement with CCWD and CUWA, X2/outflow requirements, and the 1998 DFG BO ensure that the salinity impacts of the Project are less than significant.
- The FOC, in addition to the 1995 WQCP, would reduce any impacts in receiving water dissolved oxygen concentrations caused by Project operations to a less-than-significant level.
- A general liability insurance policy for the life of the Project would serve to protect the public from potential property damage resulting from potential effects of the Project on levee stability, seepage, public utilities, and current uses of the Delta.
- Project changes under the agreement between the Project applicant and EBMUD avoided or reduced seepage impacts to a less-than-significant level.
- Regulations by other permitting agencies as well as the general liability insurance were sufficient to find that the levee construction plans met satisfactory safety standards.

D-1643 contained terms and conditions to implement a mitigation and monitoring plan for identified significant environmental effects that were within the State Water Board's responsibility. All significant effects were either mitigated to a less-than-significant level, or were identified as unavoidable but acceptable due to overriding considerations.

D-1643 also included additional terms and conditions to ensure that the Project was technically and economically feasible. A more detailed discussion of the mitigation measures implemented by D-1643 is contained within corresponding resource chapters as needed.

Pursuant to the approvals in D-1643, the State Water Board issued water right permits 21103, 21104, 21105, and 21106 to the Project applicant. In Resolution

No. 2001-025, the State Water Board certified that the FEIR for the Project complies with the requirements of CEQA.

2001 Final Environmental Impact Statement and Clean Water Act 404 Permit

The Corps issued an FEIS in July 2001 to respond to agency and public comments received on the 1995 DEIR/EIS and 2000 RDEIR/EIS.

The Corps issued a Department of the Army Permit under CWA Section 404 and RHA Section 10 (Permit 190109804) to the Project on June 26, 2002. Permit 190109804 required that construction be completed by December 31, 2007. The Project has requested reissuance of the permit with a new construction date.

California Endangered Species Act Incidental Take Permit and Habitat Management Plan

On June 6, 2001, DFG issued Incidental Take Permit (ITP) 2081-2000-061-2 to the Project pursuant to the California Endangered Species Act, Fish and Game Code Section 2050 *et seq.*, for the proposed Project. The ITP requires, among other things:

- operation of the Project in accordance with the FOC developed by the State Water Board, the Corps, NMFS, and DFG in 1997 and discussed above;
- development of a comprehensive terrestrial resources Habitat Management Plan (HMP) on Bouldin Island and Holland Tract; and
- granting of a conservation easement to DFG to ensure the Project's long-term commitment to the HMP.

The HMP articulates very specific habitat and recreational criteria, including:

- habitat design criteria;
- habitat type and location;
- hunting zones limiting the location, game type, and season of hunting;
- hunting guidelines;
- submittal of annual operating plans to the State Water Board describing pesticide use, hunting program, water and levee management, etc.;
- maintenance requirements; and
- monitoring requirements.

The HMP is summarized in Chapter 2 as one of the Project environmental commitments.

Legal Challenges to the Final Environmental Impact Report and Decision 1643

Central Delta Water Agency (CDWA) brought a petition for a writ of mandate challenging the State Water Board's issuance of D-1643 and certification of the FEIR (SCH#1988020824) in Sacramento County Superior Court (Superior Court of Sacramento County, Nos. 01CS00345 and 01CS00824, Gail D. Ohanesian, Judge). In April 2002, the Sacramento County Superior Court rejected each cause of action brought by CDWA, summarized below.

- CDWA contended that D-1643 was not supported by the evidence in the record. The Superior Court rejected this argument, finding that the State Water Board had sufficiently weighed the potential impacts and benefits, D-1643 was in the public interest, and there was no need for the identification of an end user of the water in order to support a finding of public interest.
- CDWA alleged that D-1643, by allowing a private entity to sell water, which was the property of the people, to public agencies of the state would result in developer speculation and unlawful profiteering from public agencies in violation of California Constitution, Article XVI, Section 6. The Superior Court found that this argument was without merit because there is a public purpose for the use of Project water.
- CDWA contended that there was no evidence to support the State Water Board's finding of maximum benefit to the people of the State of California to justify an exception to State Water Board Resolution No. 68-18 entitled "Statement of Policy with Respect to Maintaining High Quality of Waters in California," commonly referred to as the "Anti-Degradation Policy." The Superior Court found that D-1643 correctly concluded that there was a need for additional water supplies and the effects of the Project on water quality were minor given the extensive terms and conditions of D-1643.
- CDWA contended that the State Water Board failed to make a finding that the Project was financially feasible. The Superior Court found that the State Water Board specifically considered the issue of financial feasibility and the surrounding circumstances regarding the need for the Project that would ensure that the Project was financially feasible. Additionally, CDWA failed to cite authority requiring an explicit finding of financial feasibility.
- CDWA claimed that there was insufficient evidence in the administrative record to support the State Water Board's finding that levee design and stability and seepage control were adequate to protect the public, adjoining landowners and districts, and the surrounding lands and levees. The Superior Court found that there was substantial evidence in the administrative record.
- CDWA contended that the evidence did not support the finding that liability insurance would protect surrounding landowners and districts against damage from the Project attributable to evacuation or flooding. Additionally, CDWA argued that liability insurance was not a financial surety and that a performance bond or a security deposit should be required. The Superior Court found no merit to these claims and found that the Project's liability

insurance and levee stability and seepage provisions of the stipulated agreement with EBMUD provided were adequate financial assurances.

- CDWA contended that there was no evidence in the record to support the finding that the value of the Project for water supply outweighed and overrode the importance of maintaining agriculture on the Project islands and made the impact acceptable. The Superior Court stated that the administrative record contained evidence of the need for the Project and the benefits of the Project, as well as consideration of the economic effects of the Project.
- CDWA challenged the State Water Board finding that the counties could condition construction permits issued for the Project to mitigate any adverse effects on Delta island roadways. The Superior Court found this claim lacked merit.
- CDWA contended that there was no substantial evidence in the record to support the substitution of less protective temperature criteria than those provided in the DEIR/EIS. The Superior Court found that the criteria imposed were supported by substantial evidence.
- CDWA alleged that State Water Board's adoption and certification of the FEIR for the Project was in violation of CEQA because of its failure to investigate, discuss, and analyze potential environmental impacts resulting from the ultimate use of Project water. The Superior Court found that there was no abuse of discretion in the State Water Board's failure to further analyze the impacts of the ultimate use of the water and the EIR had discussed other potential impacts sufficiently.
- CDWA alleged that State Water Board's adoption and certification of the 2001 FEIR for the Project was in violation of CEQA because of its failure to identify, discuss, and adopt feasible mitigation measures that would minimize the Project's potentially significant impacts on agricultural lands. The Superior Court found that these issues were not timely (not raised during the comment period or by the end of the public hearing on the Project) and the State Water Board had considered impacts on agricultural lands in the EIR and concluded no reasonable mitigation was available to reduce the potential impacts to a less-than-significant level.
- CDWA challenged the State Water Board's findings that the Project's impacts on neighboring islands and property would be less than significant. The Superior Court found that the State Water Board had sufficiently analyzed and modeled seepage control for the Project and had sufficiently imposed terms and conditions on the permits to ensure that the effects would be less than significant.
- CDWA claimed that the State Water Board abused its discretion by failing to identify, discuss, and consider out-of-Delta reservoir alternatives. The Superior Court found that in light of the unique operational flexibility offered by the Project, and the discussion and rejection of out-of-Delta alternatives in the 1995 DEIR, the State Water Board had fulfilled its duty.

The Third District Court of Appeal in *Central Delta Water Agency v. State Water Resources Control Board*, 124 Cal. App. 4th 245 (2004), affirmed the Superior Court decision in most respects, but set aside the water right permits for failure "to specify an actual use of and the amounts of water to be appropriated."

The Court held that the State Water Board cannot issue water right permits to generally provide water to potential water users within the SWP and CVP service areas. The Court required that the "actual, intended" buyers of the water, and not potential users, be identified in amended water right applications before the State Water Board could issue revised permits.

The Court of Appeal upheld the trial court's determinations that the 2001 FEIR adequately assessed and described appropriate mitigation for all potential environmental effects including but not limited to levee stability, seepage control, roadways and transportation, and loss of agricultural land. The Court however required that the 2001 FEIR be revised to include an analysis of impacts associated with the provision of water to the place of use: "the CEQA determination is reversed subject to the inclusion of an environmental analysis … when the end users are provided in an amended permits [*sic*]."

In accordance with the Court of Appeal decision, the State Water Board in Order WR 2005-0023-EXEC set aside Resolution 2001-25 certifying the 2001 FEIR and D-1643 issuing water right permits.

Partnership between the Project Applicant and Semitropic and Addition of Groundwater Banking

The Project applicant and Semitropic have partnered to jointly develop and implement the Project. Ownership of the Project islands and many regulatory applications will remain in the Project applicant's name, but the Project will be implemented by Semitropic for the benefit of Semitropic, the Project applicant, and the users of the Project water. Semitropic will also integrate the Project into its groundwater banking operations in the Semitropic Groundwater Bank and the Antelope Valley Water Bank. The Project applicant will continue to manage the Project islands before Project construction and assist Semitropic in regulatory permitting and financing. Accordingly, the Project is no longer a private venture but a public-private partnership.

The Project will benefit from Semitropic's expertise gained from developing and managing its highly successful groundwater banking operations. Project water users will gain more flexibility and reliability of water supplies with the addition of south-of-Delta banking. Semitropic will benefit from the Project's new source of water supply that will augment the water assets in its groundwater banks. Semitropic's landowners will benefit from the banking of Project water in the groundwater bank through higher groundwater levels and reduced overdraft, improved groundwater quality, and reduced pump lift costs. Furthermore, a portion of the water supply yield of the Project will be allocated to irrigation purposes within Semitropic's acre service area.

Project water supply that is available in excess of the immediate needs of the other places of use will be banked within the Semitropic Groundwater Storage Bank and Antelope Valley Water Bank. Through appropriate arrangements with its sister agency in Kern County, the Kern County Water Agency, Semitropic will facilitate the conveyance of Project water to the groundwater banks and the places of use. The groundwater banking and water conveyance elements of the Project are described in more detail in Chapter 2, “Project Description and Alternatives.”

As the public agency carrying out the proposed Project (CEQA Guidelines Section 15051), Semitropic, in coordination with the State Water Board, assumed the role as CEQA lead agency in June 2007.Semitropic will investigate opportunities to partner through a joint powers authority or other mechanism with the other public agencies participating in the Project including the four reclamation districts responsible for the Project islands and the public agencies using Project water.

New Places of Use

As introduced earlier in this chapter, the specified places of use extend beyond Semitropic. Additional information on the places of use is provided in Chapter 2, “Project Description and Alternatives,” and is summarized below:

- Semitropic for irrigation purposes,
- Golden State for municipal, industrial and domestic purposes,
- Metropolitan and its member agencies’ service areas for municipal and industrial purposes,
- Western for municipal and industrial purposes, and
- Valley District for municipal and industrial purposes.

Other water service providers may enter into agreements to take Project water and become additional places of use. Additional potential places of use beyond those analyzed in this EIR were discussed in the Notice of Preparation published for this EIR. Approval of additional service areas and places of use may require further CEQA analysis and petitions to the State Water Board.

Basic Operational Approach of Project Unchanged

The Project water diversion, storage, and export operating parameters are essentially unchanged from the 2001 FEIR, except that the Project will incorporate a revised levee design to improve Reservoir Island structural integrity and will be operated in conjunction with the Semitropic Groundwater Storage Bank and Antelope Valley Water Bank to maximize export of water to Semitropic, Golden State, and other likely places of use. These new water delivery and groundwater banking operations are discussed in more detail in Chapter 3, “Project Operations.”

The place of use agreements and groundwater banking agreements are in addition to and in conjunction with all other applicable Delta regulatory requirements which the Project will operate in accordance with, including, but not limited to, the Bay-Delta Water Quality Control Plan and Water Right Decision 1641 (Revised), the FOC, and other terms and conditions imposed by water right protest dismissal agreements and D-1643. The Delta operations are discussed in more detail in Chapter 3.

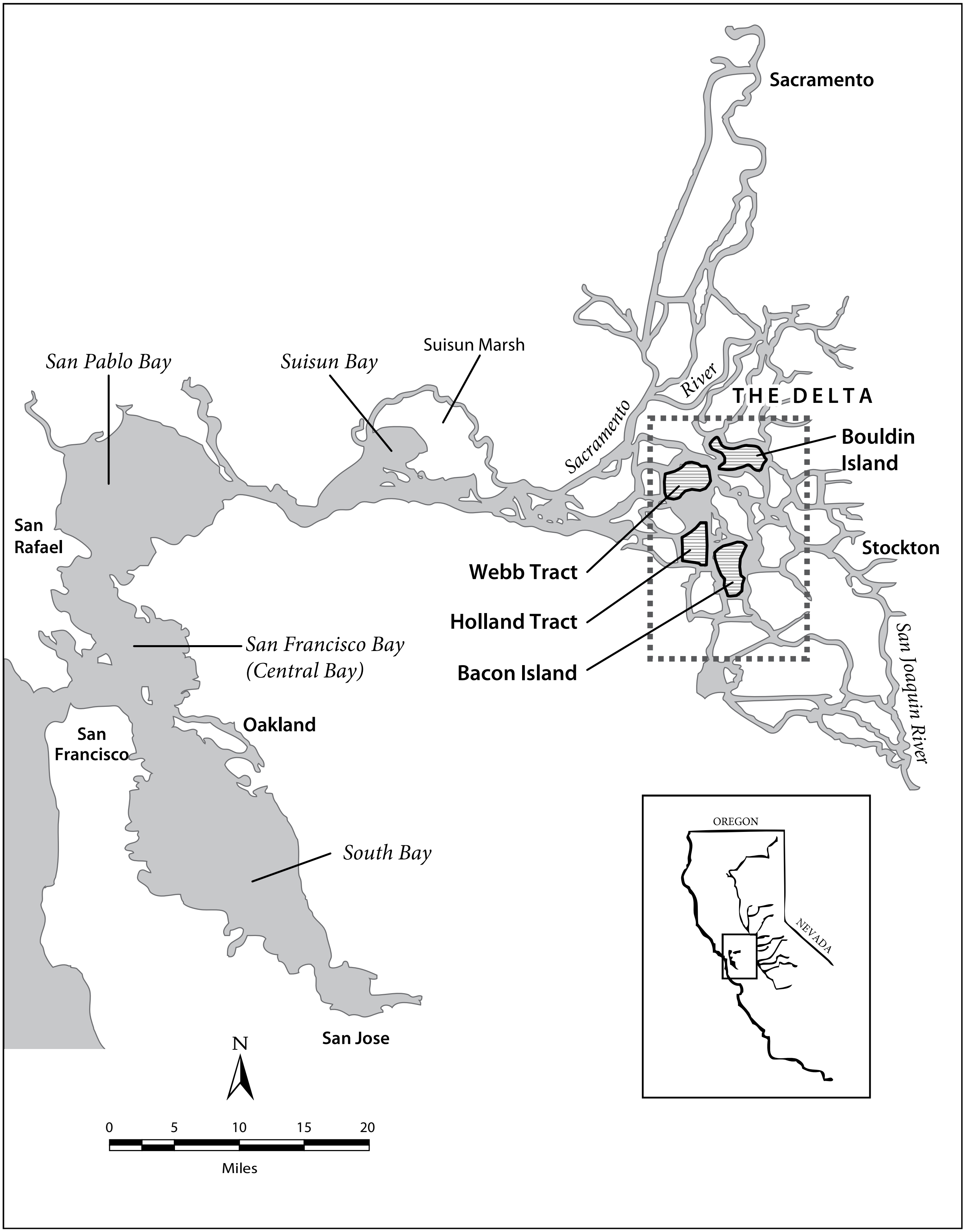
The facilities, operations, and environmental effects of the groundwater banking components are separately described and analyzed in the respective environmental impact reports for those projects, specifically, Antelope Valley Water Bank Final EIR (SCH#2005091117), Semitropic Groundwater Banking Project Final EIR (SCH#1993072024), and Semitropic Groundwater Banking Project Stored Water Recovery Unit Final Supplemental EIR (SCH#1999031100). The Semitropic Groundwater Storage Bank is approved and currently in operation. The Antelope Valley Water Bank is fully permitted. The first phase of the Bank has been constructed.

Project History Timeline

Table 1-2. Project History

Month/Year	Milestone
May 2010	Semitropic releases *Draft Delta Wetlands Place of Use Environmental Impact Report*, solicits public input.
February 2010	Petitions filed with the State Water Board to add additional places of use to Project water right applications.
July 2009	Semitropic publishes a Supplemental NOP for this *Delta Wetlands Project Place of Use Environmental Impact Report*.
March 2009	Petitions filed with the State Water Board to add places of use and places of underground storage to Project water right applications.
November 2008	Semitropic publishes an NOP for this *Delta Wetlands Project Place of Use Environmental Impact Report*.
June 2007 through November 2008	Semitropic Water Storage District, Golden State Water Company service areas, The Metropolitan Water District of Southern California, San Bernardino Valley Municipal Water District, and Western Municipal Water District of Riverside County are identified as places of use for the Project.
June 2007	Semitropic partners with the Delta Wetlands Project. Semitropic will operate the Project in conjunction with the Semitropic Groundwater Storage Bank to maximize Project flexibility and yield. Project water will be provided to Semitropic landowners for irrigation purposes and to other places of use. Semitropic assumes the role of CEQA lead agency.
November 2004	Third District Court of Appeal in *Central Delta Water Agency v. State Water Resources Control Board* sets aside the water right permits for failure “to specify an actual use of and the amounts of water to be appropriated.” The Court requires that the “actual, intended” buyers of the water, and not potential users, be identified in amended water rights applications.

Month/Year	Milestone
June 2002	The Corps issues Section 404 and Section 10 permits. These permits are the final step in a 15-year federal and state approval process, and would allow the Project to proceed once basic local construction permits are issued.
April 2002	Sacramento County Superior Court reaffirms the Project's water rights, technical feasibility, environmental soundness, and value to the State of California, unilaterally rejecting all submitted challenges.
April 2002	A coalition of leading, statewide business organizations endorses the Project.
September 2001	The State Water Board issues CWA Section 401 Water Quality Certification, verifying that the Project will comply with federal and state water quality requirements.
July 2001	The Corps issues the 2001 FEIS, in accordance with NEPA.
February 2001	The State Water Board grants water right permits, entitling the Project to capture and release surplus Delta water flows.
February 2001	The State Water Board certifies the 2001 FEIR in accordance with CEQA, confirming that the Project will not adversely impact local wildlife or other natural resources, or disrupt the Delta system.
June 2001	DFG grants biological permits, concluding Project will fully comply with CESA.
January 2001	The State Water Board issues the 2001 FEIR.
October 2000	The State Water Board continues water rights hearings for the Project prior to issuing permits to ensure that local stakeholders and neighbors have an ongoing opportunity to participate in the approval process.
October 2000	The Project applicant, CUWA, and CCWD reach agreement on Project operating procedures to protect water quality.
August 2000	The Project is officially incorporated in the CALFED Bay-Delta Program's Record of Decision, identified as the surface water storage project that can be operational before all others.
May 2000	The State Water Board and the Corps issue the 2000 Revised Draft EIR/EIS and begin a third public environmental review process.
May/June 2000	NMFS and the USFWS issue updated no-jeopardy biological opinions to reflect new federal listings, concluding the Project will fully comply with the federal Endangered Species Act.
July/August 1997	State Water Board conducts initial water rights hearing for the Project to review all water rights and water supply issues associated with the Project.
April/May 1997	NMFS and USFWS issue no-jeopardy biological opinions, concluding the Project will fully comply with the federal Endangered Species Act.
September 1995	Reflecting overall changes to the Project, State Water Board and the Corps issue new Draft EIR/EIS and solicit additional public input.
December 1990	State Water Board and the Corps issue Draft EIR/EIS, a comprehensive study of the proposed Project, potential Project alternatives, potential impacts to surrounding natural resources and mitigation required.
February 1988	State Water Board and the Corps hold public scoping sessions to ensure that plans for the Project do not conflict with other local uses and that local stakeholders and neighbors have an opportunity to comment on the Project.
July 1987	The Project applicant takes the first step in the approval process by filing water right applications with State Water Board and Section 404 applications with the Corps. State Water Board and the Corps serve as co-lead agencies for the environmental review process for the Project.



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ICF INTERNATIONAL

Figure 1-1a
Delta Wetlands Project Islands
(California context)

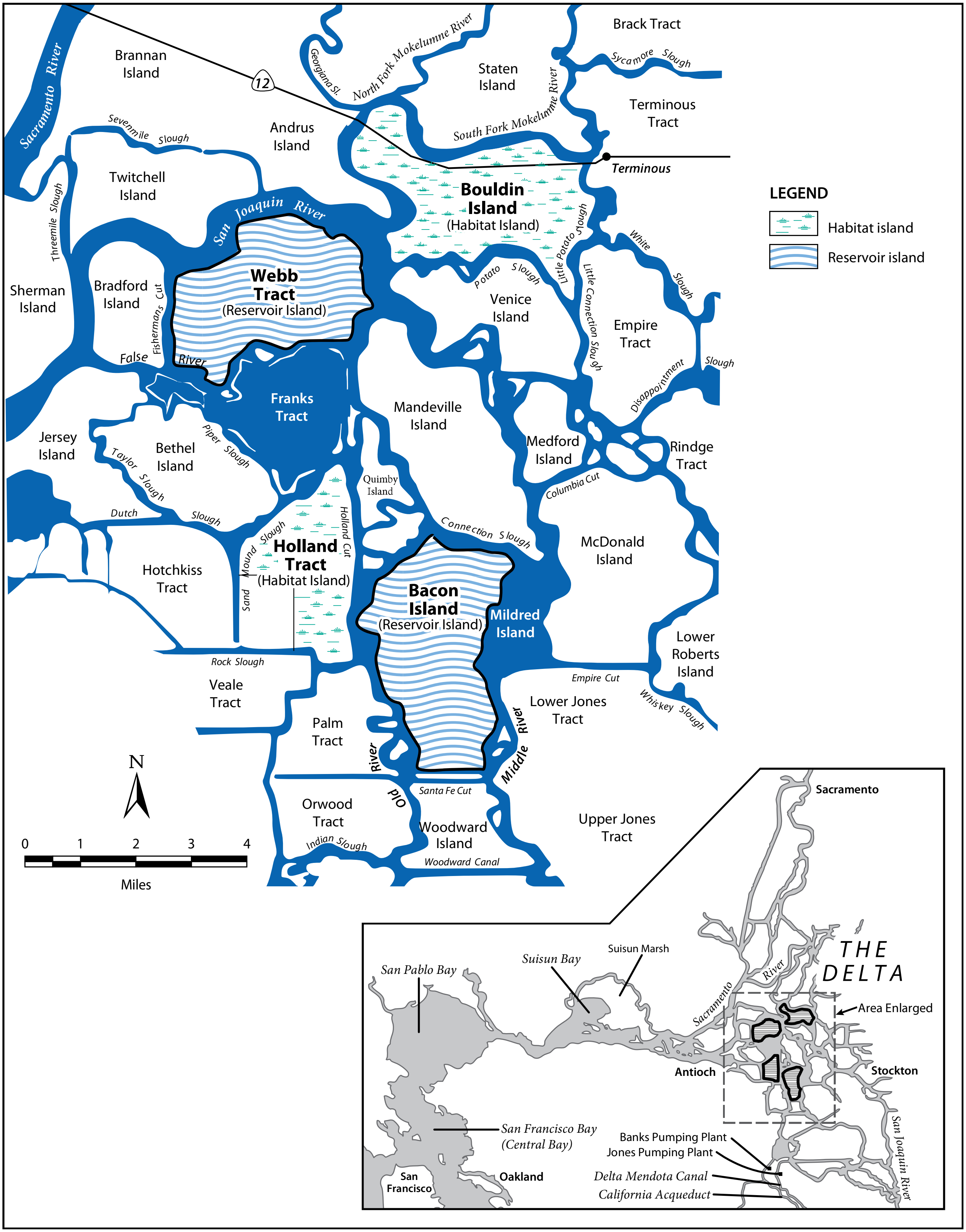

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Figure 1-1b
Delta Wetlands Project Islands
(Delta context)

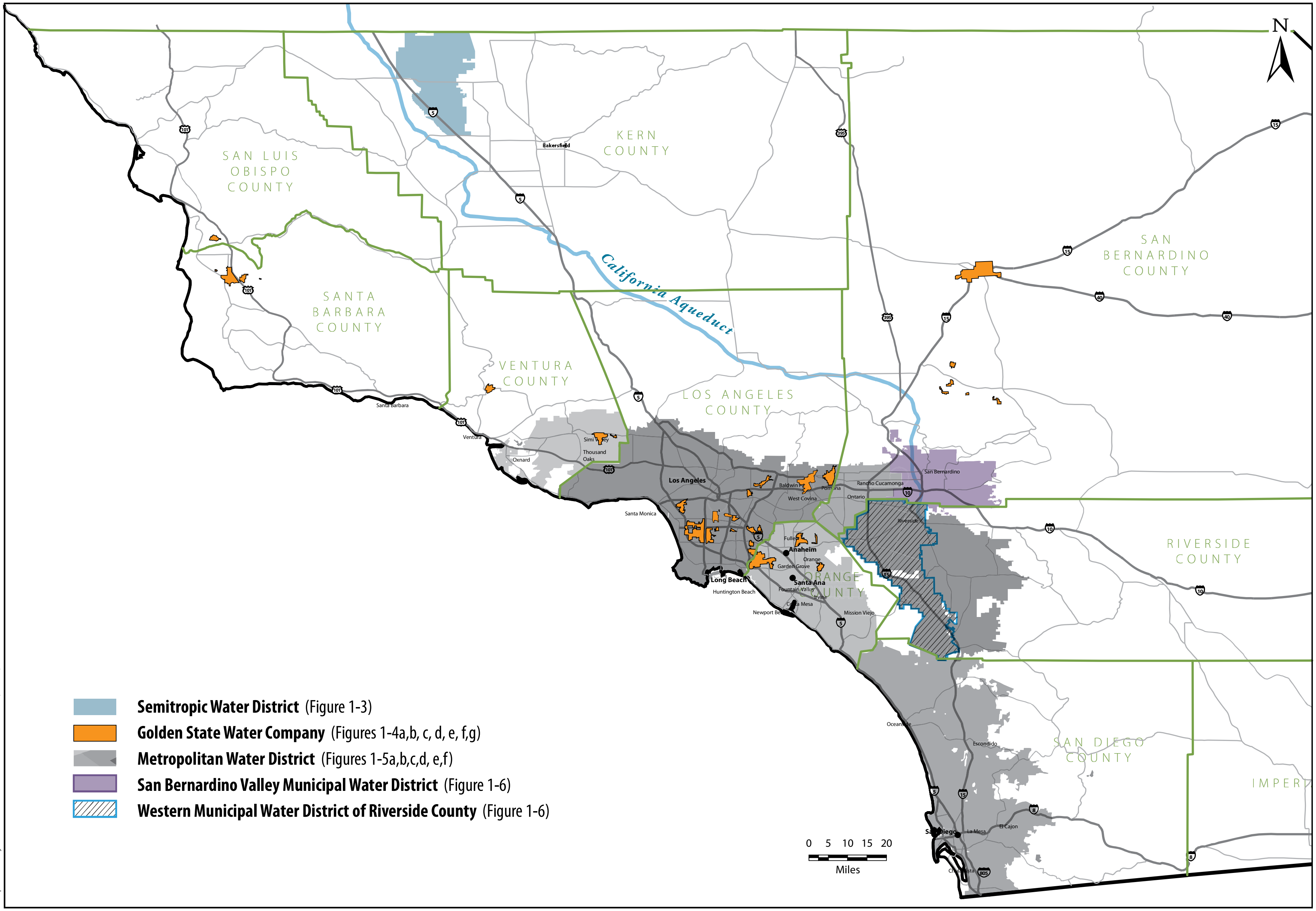

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Figure 1-2
Delta Wetlands Project Places of Use
(overview by county)

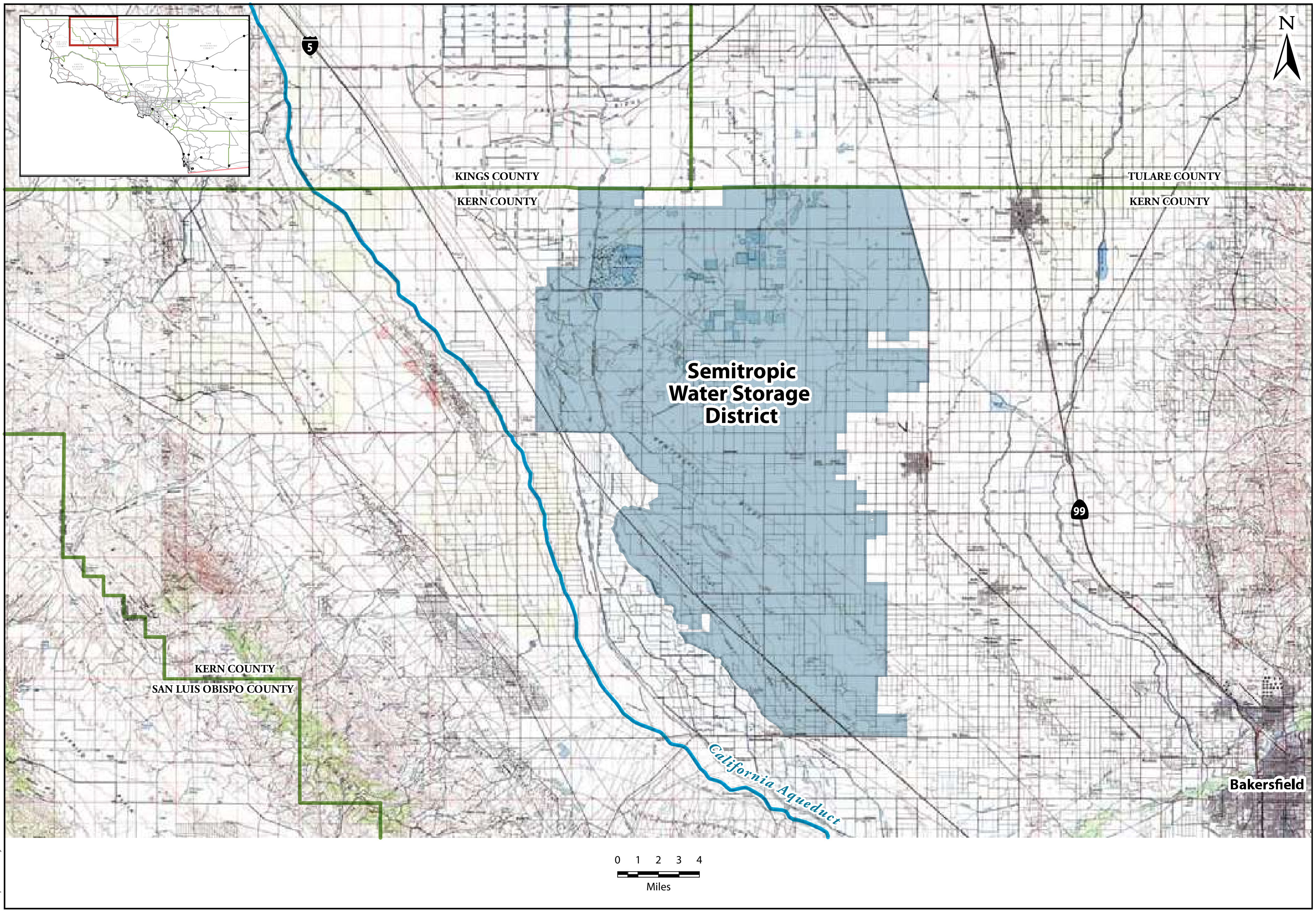

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Figure 1-3
Semitropic Water Storage District Place of Use

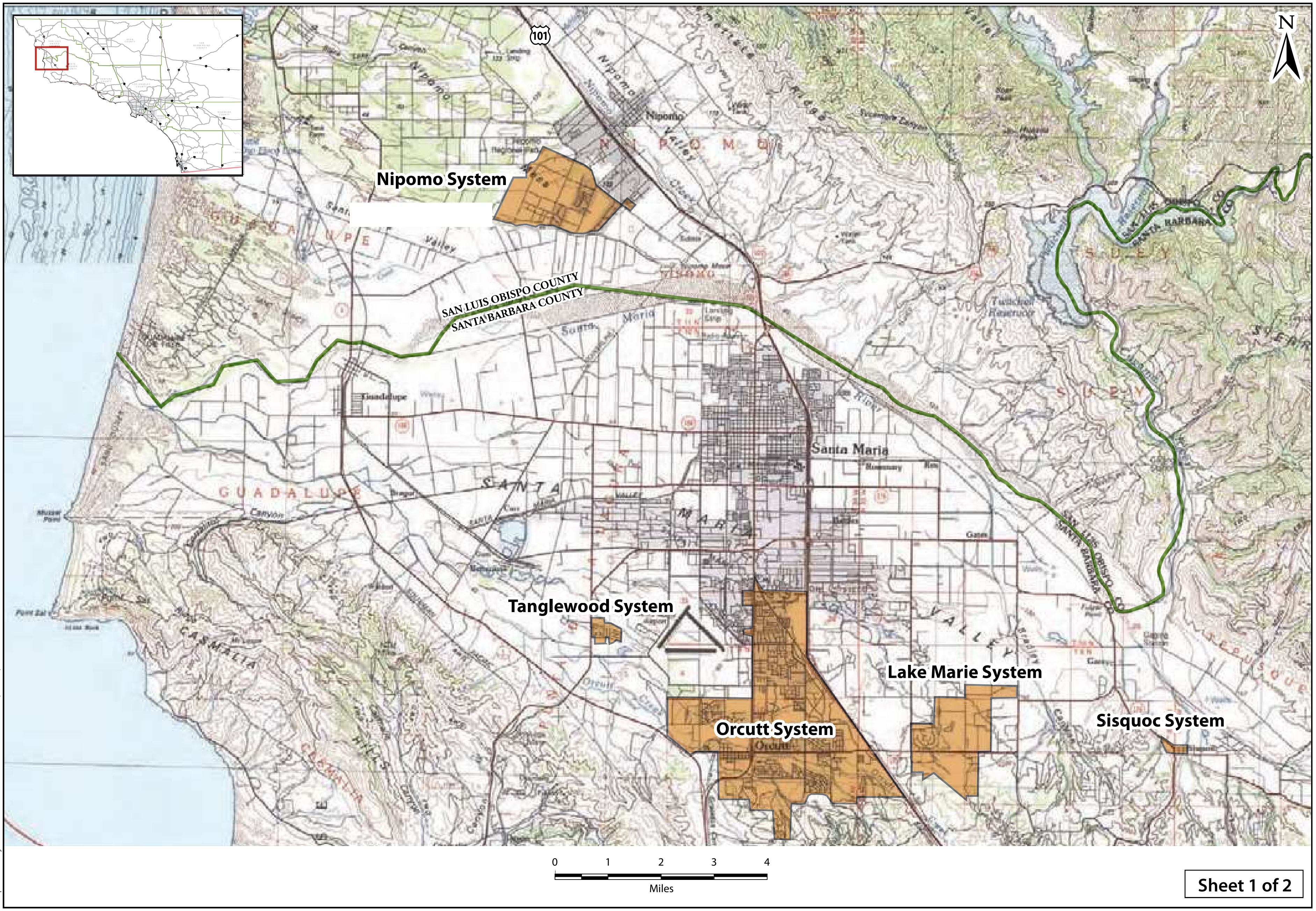

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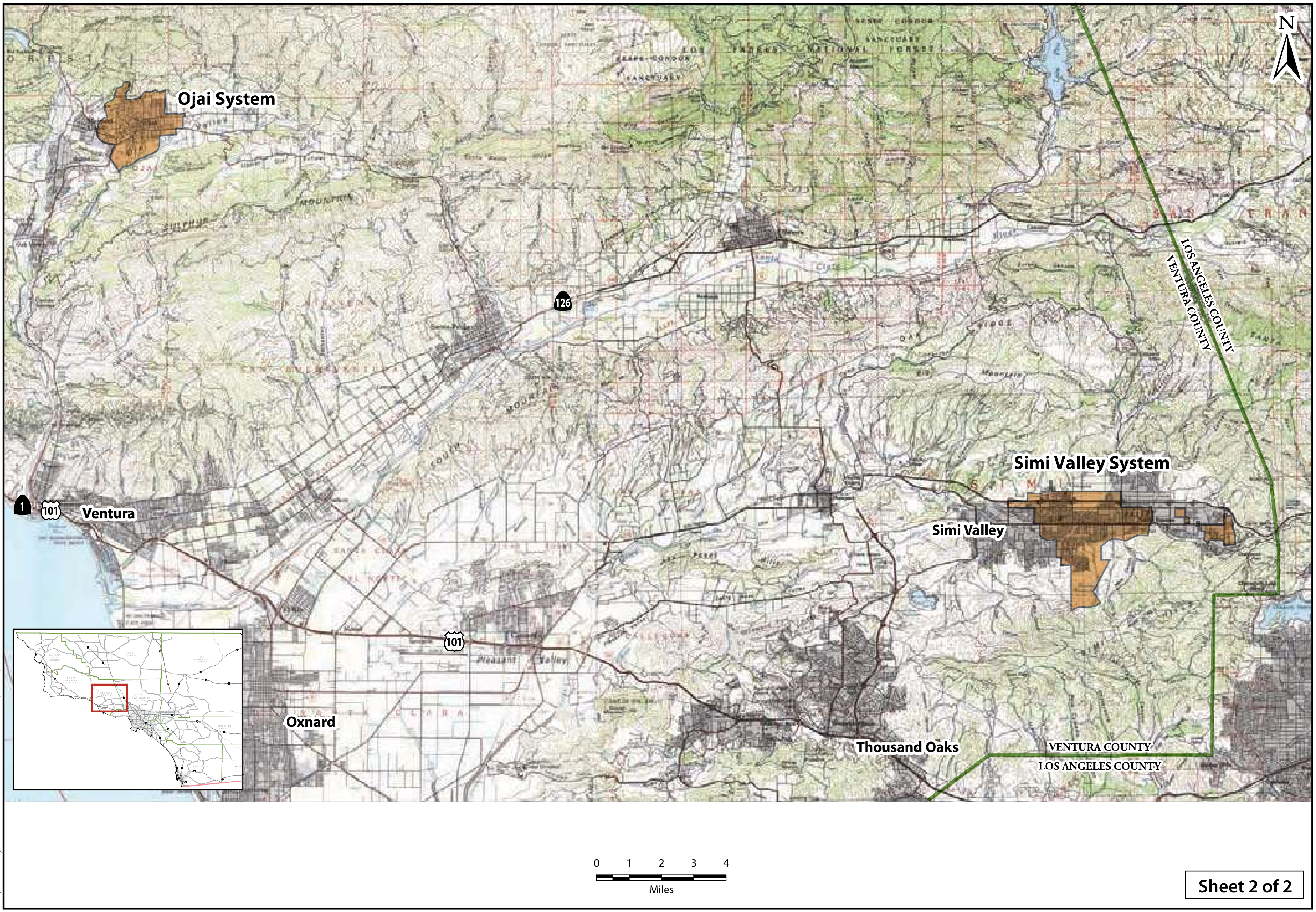
Figure 1-4a
Golden State Water Company, Region 1
Place of Use



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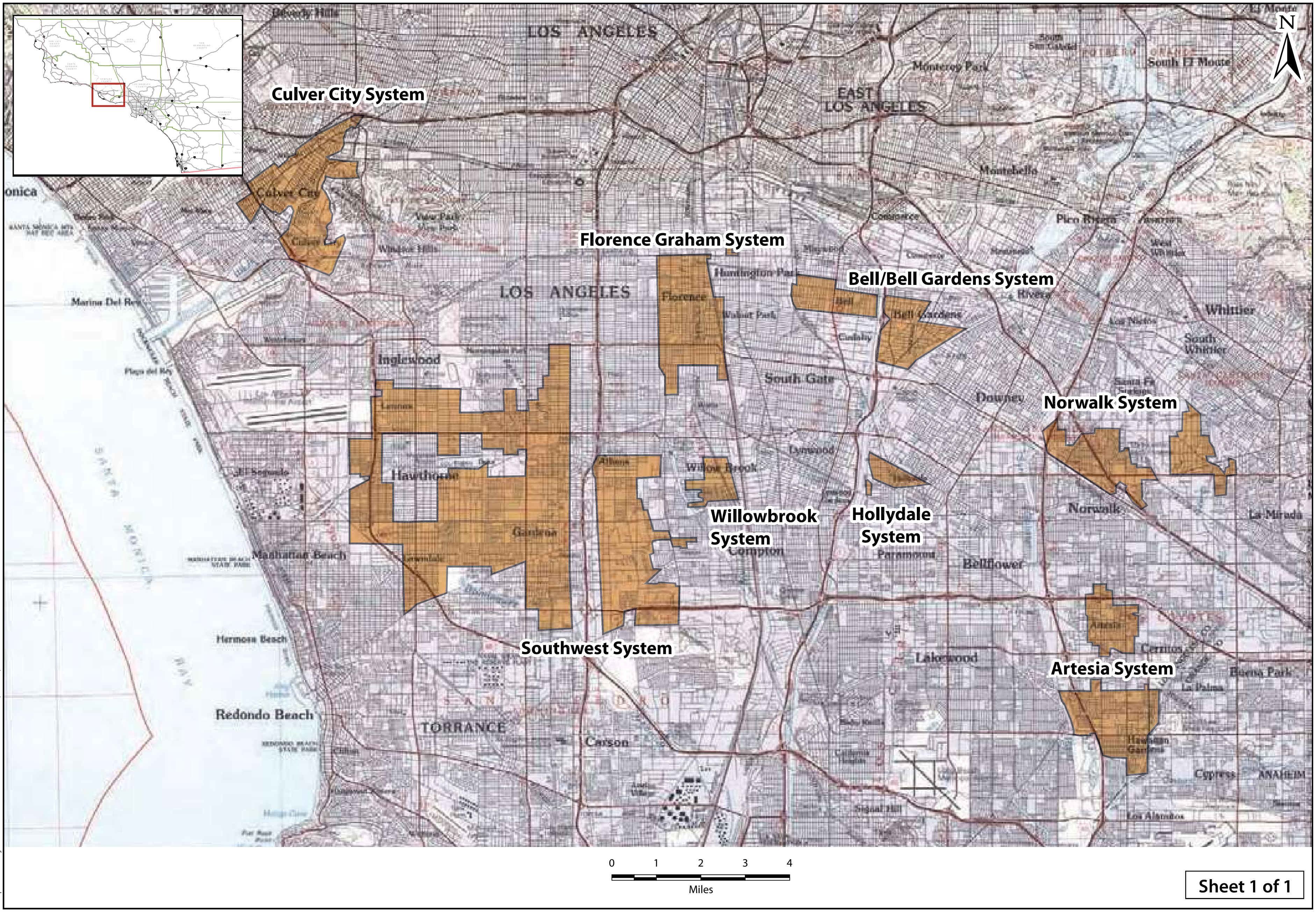
ICF INTERNATIONAL

Figure 1-4b
Golden State Water Company, Region 1
Place of Use



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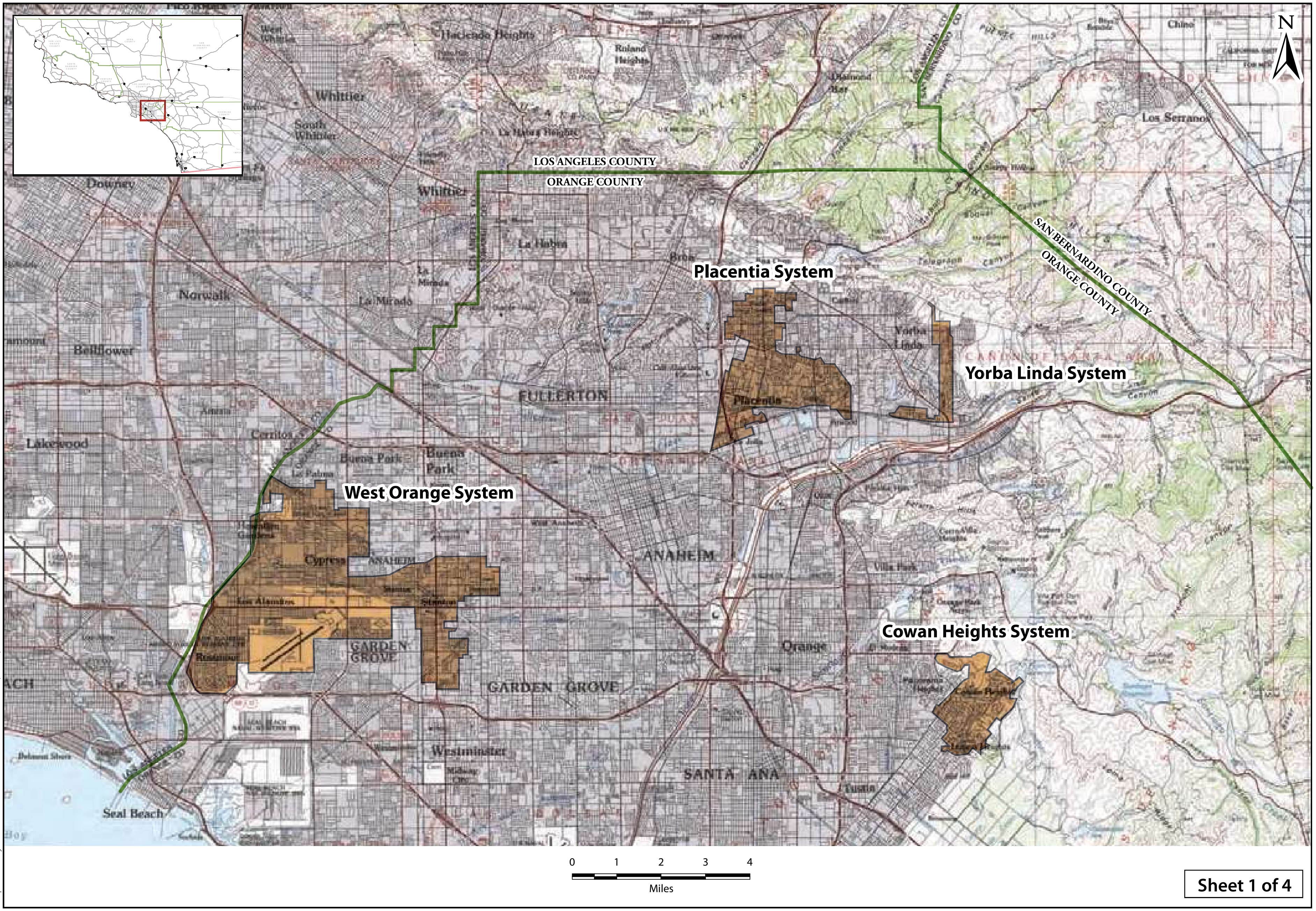
ICF INTERNATIONAL

Figure 1-4c
Golden State Water Company, Region 2
Place of Use



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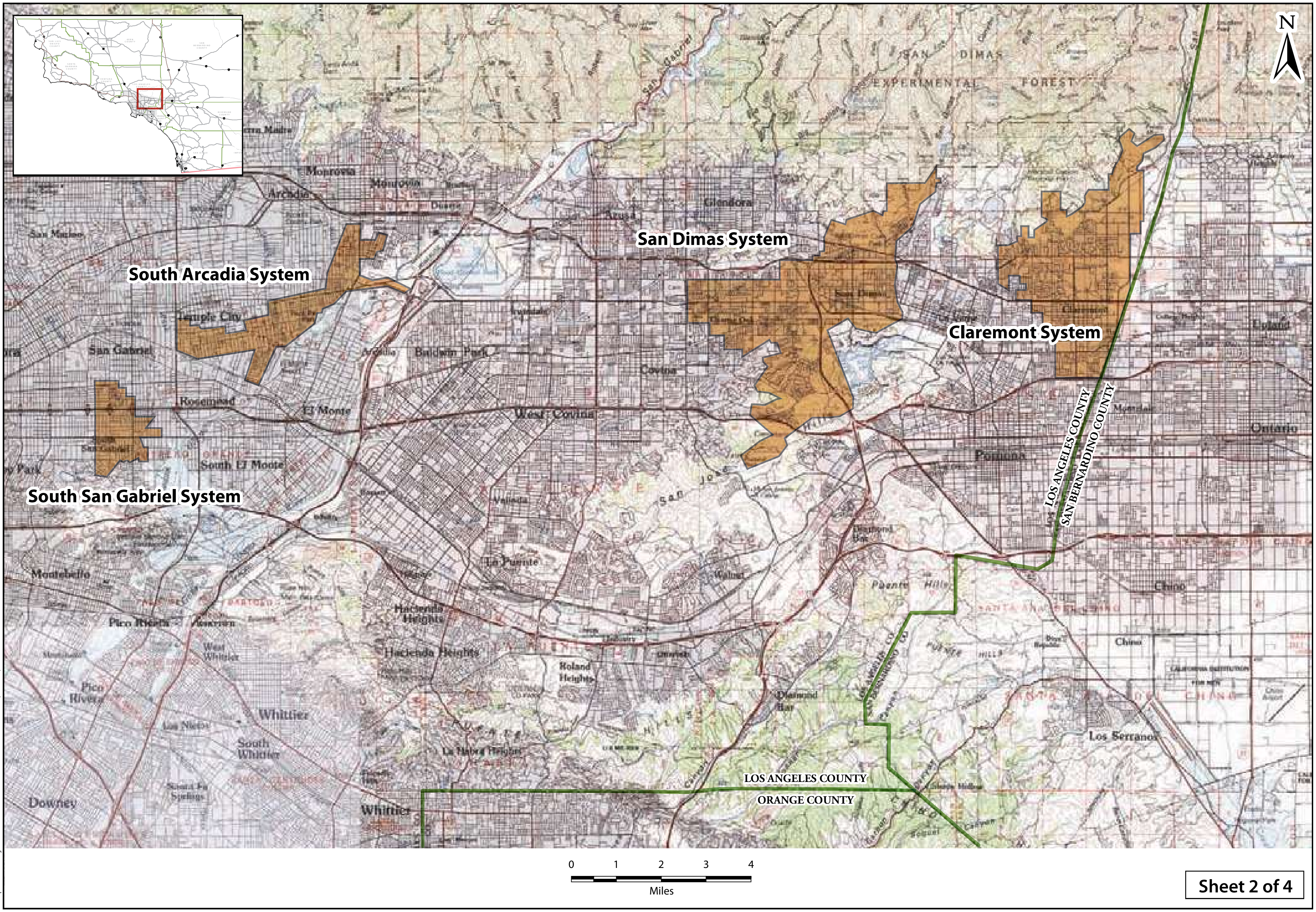
ICF INTERNATIONAL

Figure 1-4d
Golden State Water Company, Region 3
Place of Use



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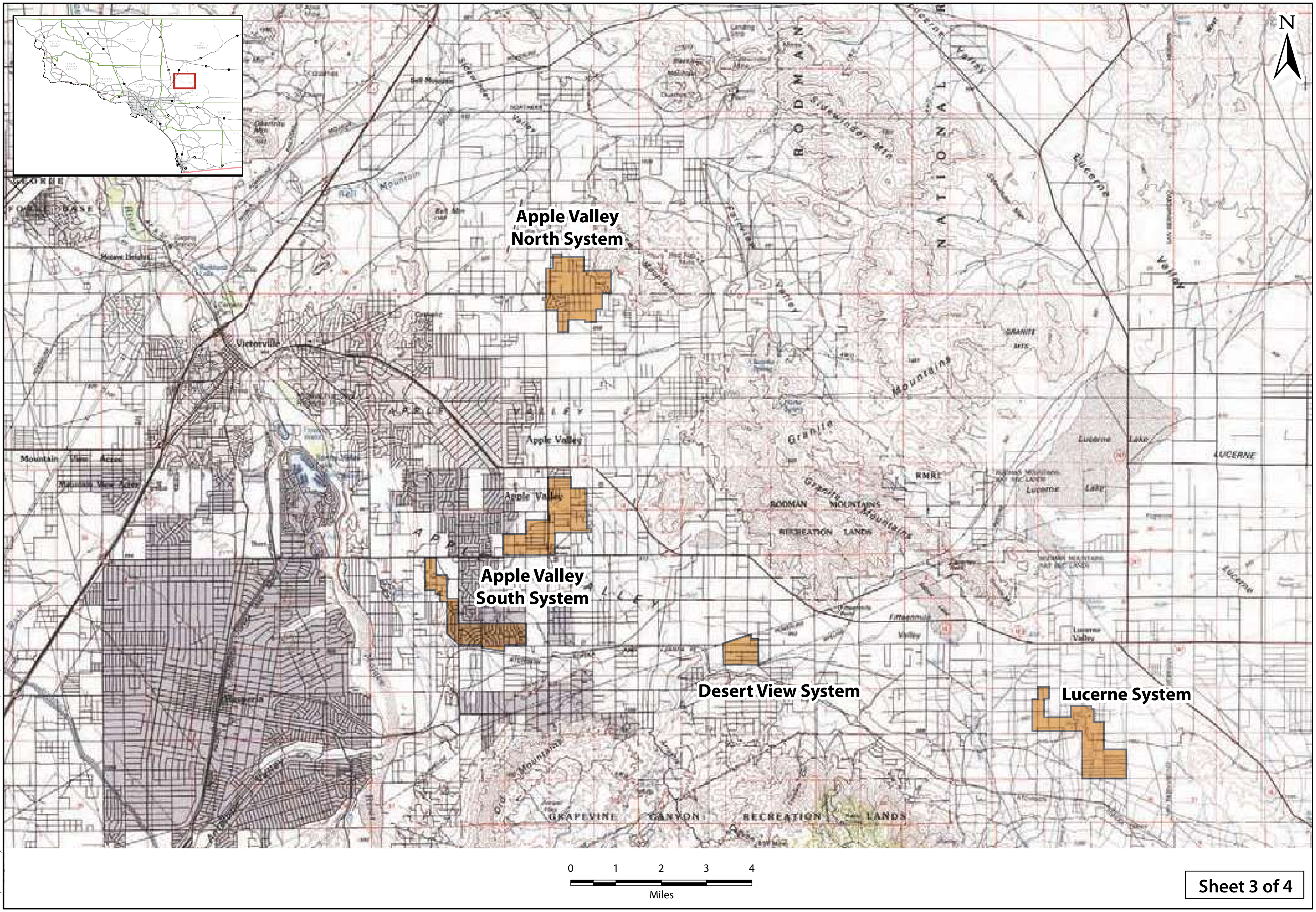
ICF INTERNATIONAL

Figure 1-4e
Golden State Water Company, Region 3
Place of Use



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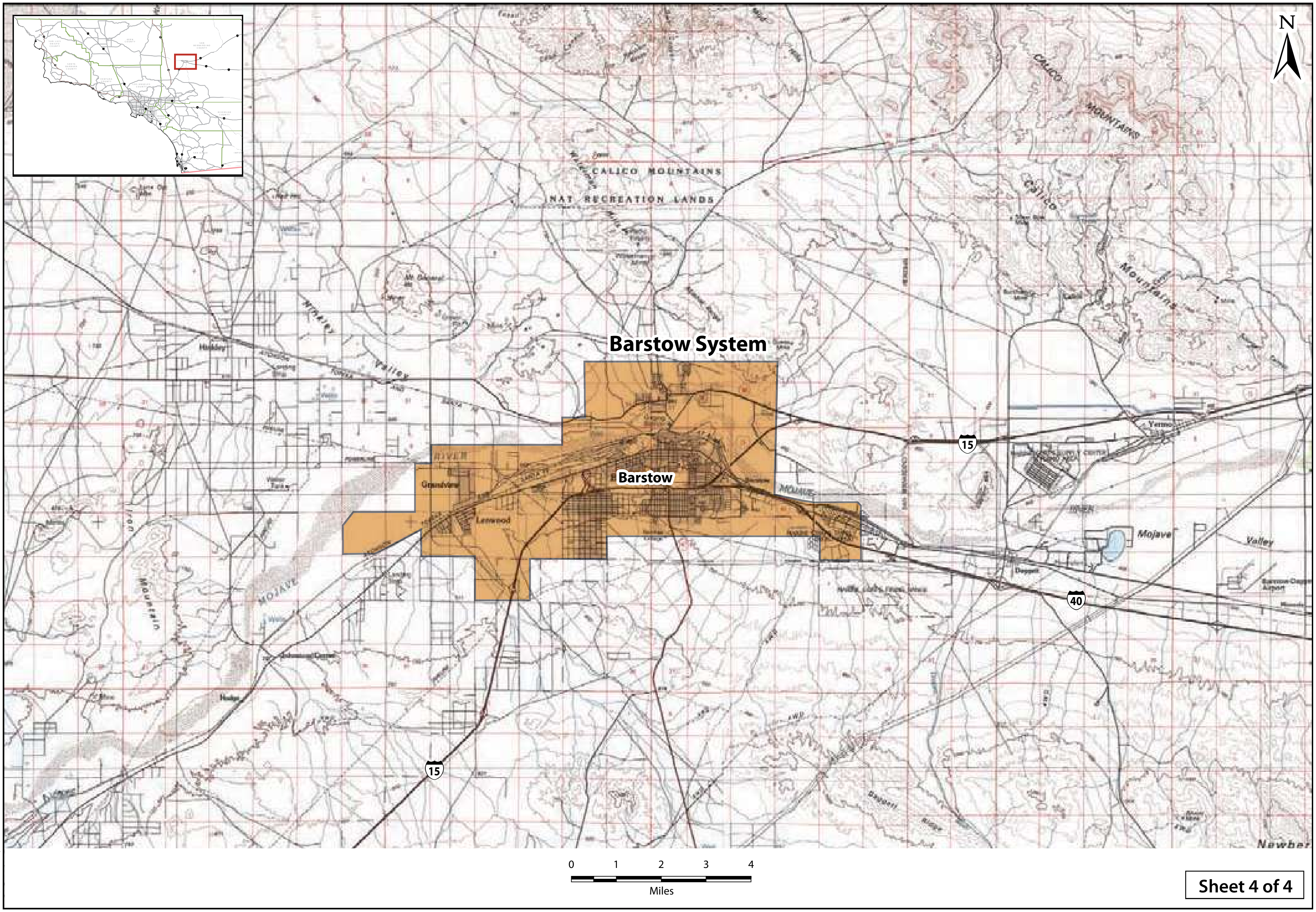
ICF INTERNATIONAL

Figure 1-4f
Golden State Water Company, Region 3
Place of Use



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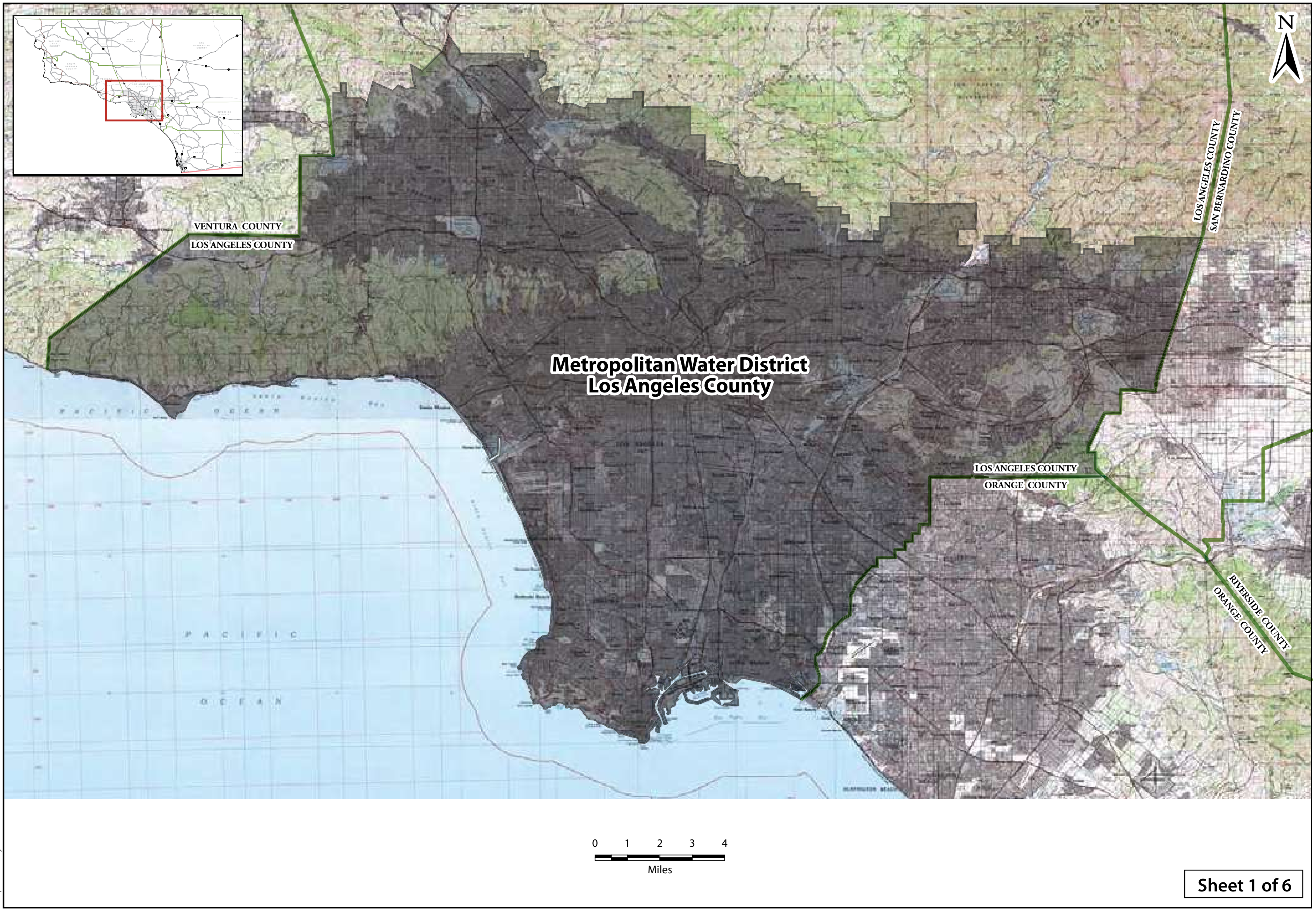
ICF INTERNATIONAL

Figure 1-4g
Golden State Water Company, Region 3
Place of Use



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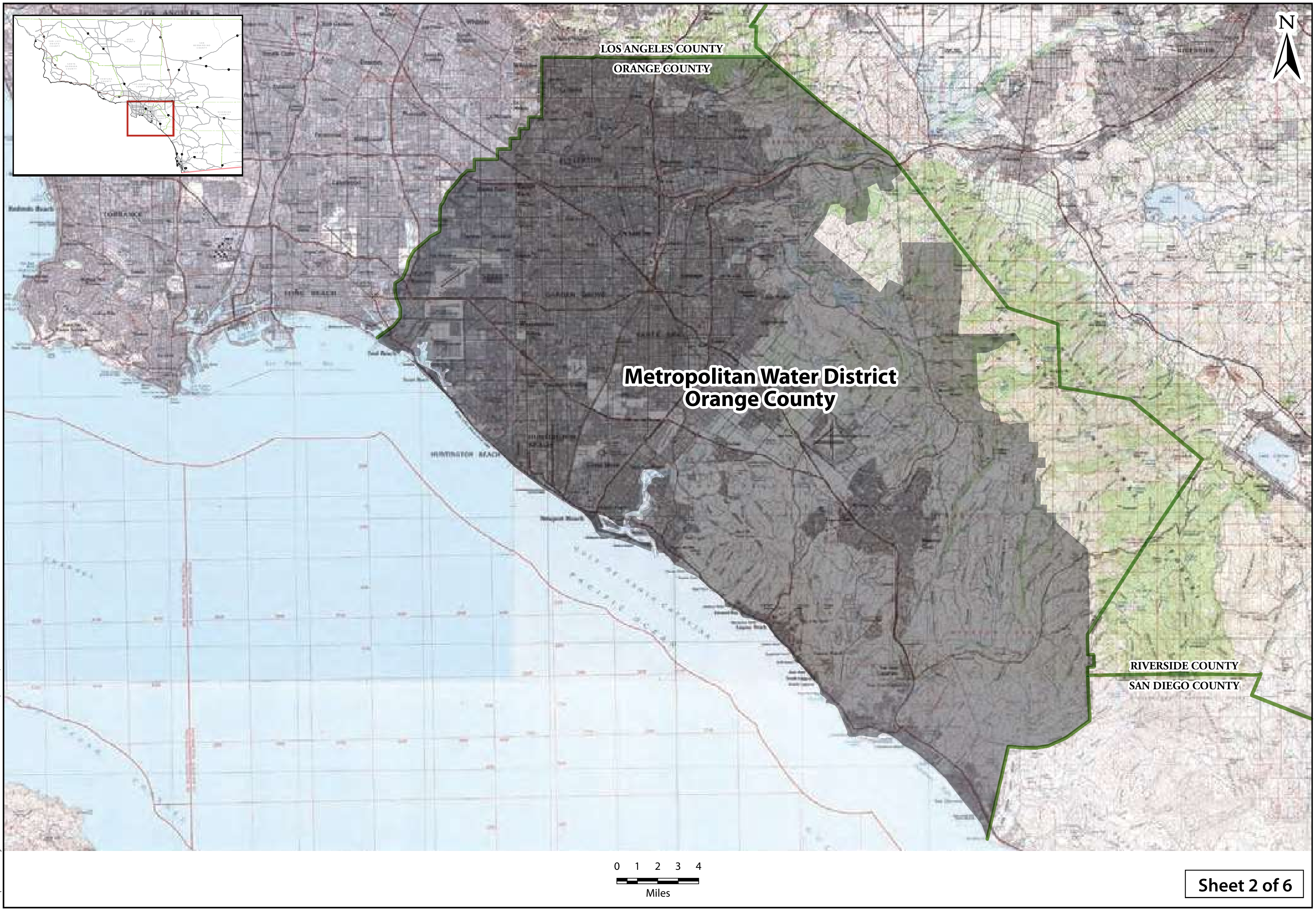
ICF INTERNATIONAL

Figure 1-5a
Metropolitan Water District, Los Angeles County
Place of Use



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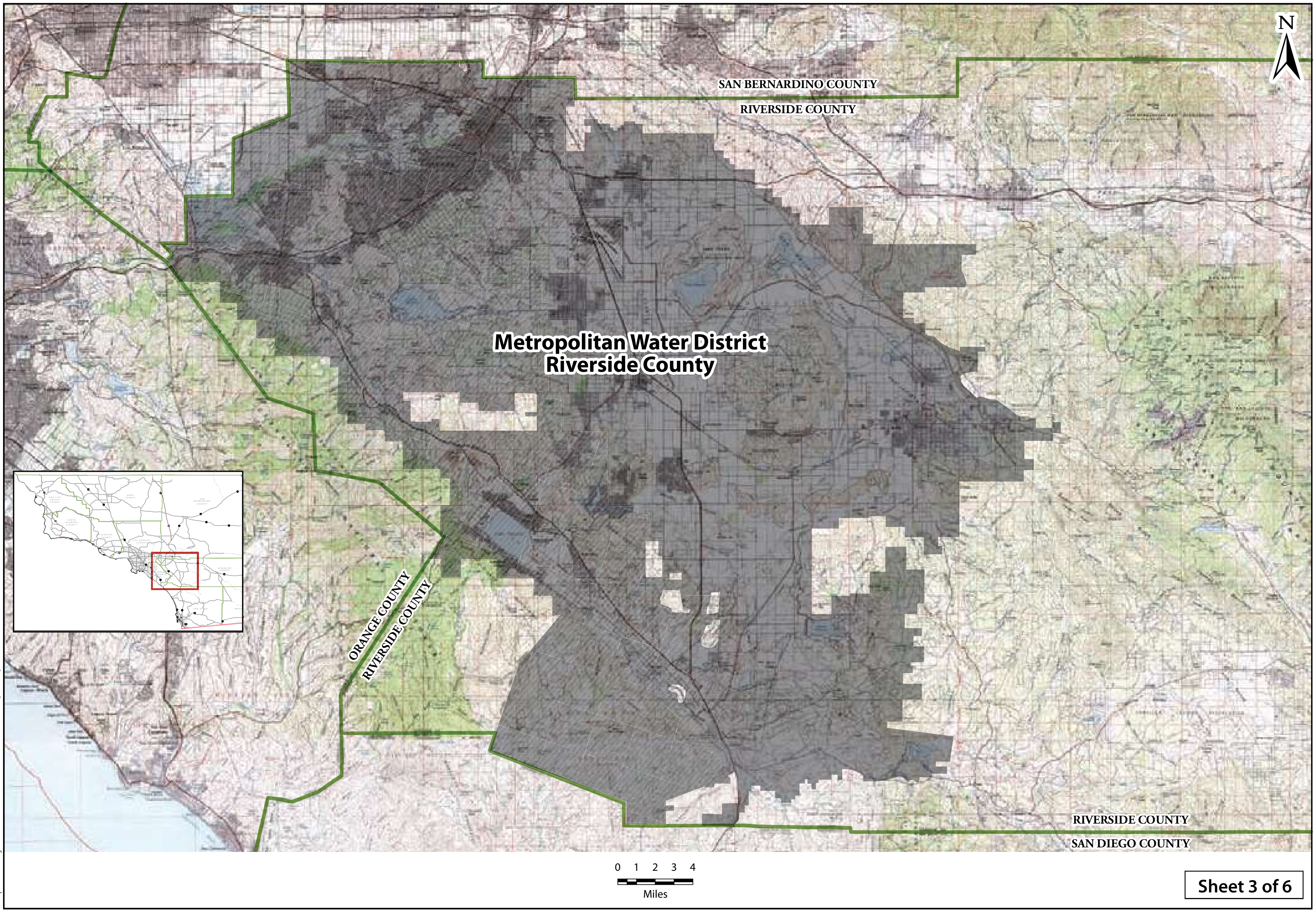
ICF INTERNATIONAL

Figure 1-5b
Metropolitan Water District, Orange County
Place of Use



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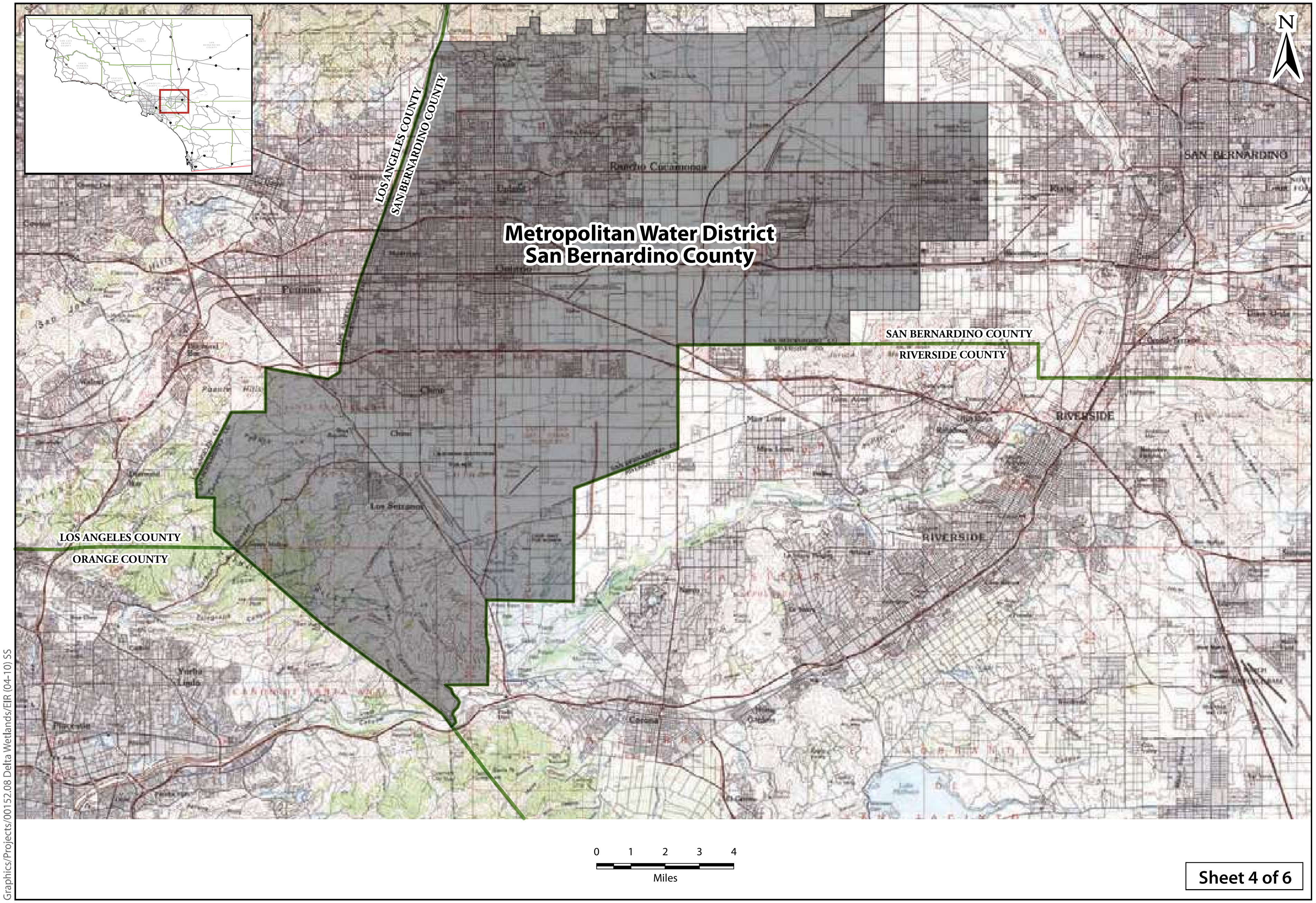
ICF INTERNATIONAL

Figure 1-5c
Metropolitan Water District, Riverside County
Place of Use



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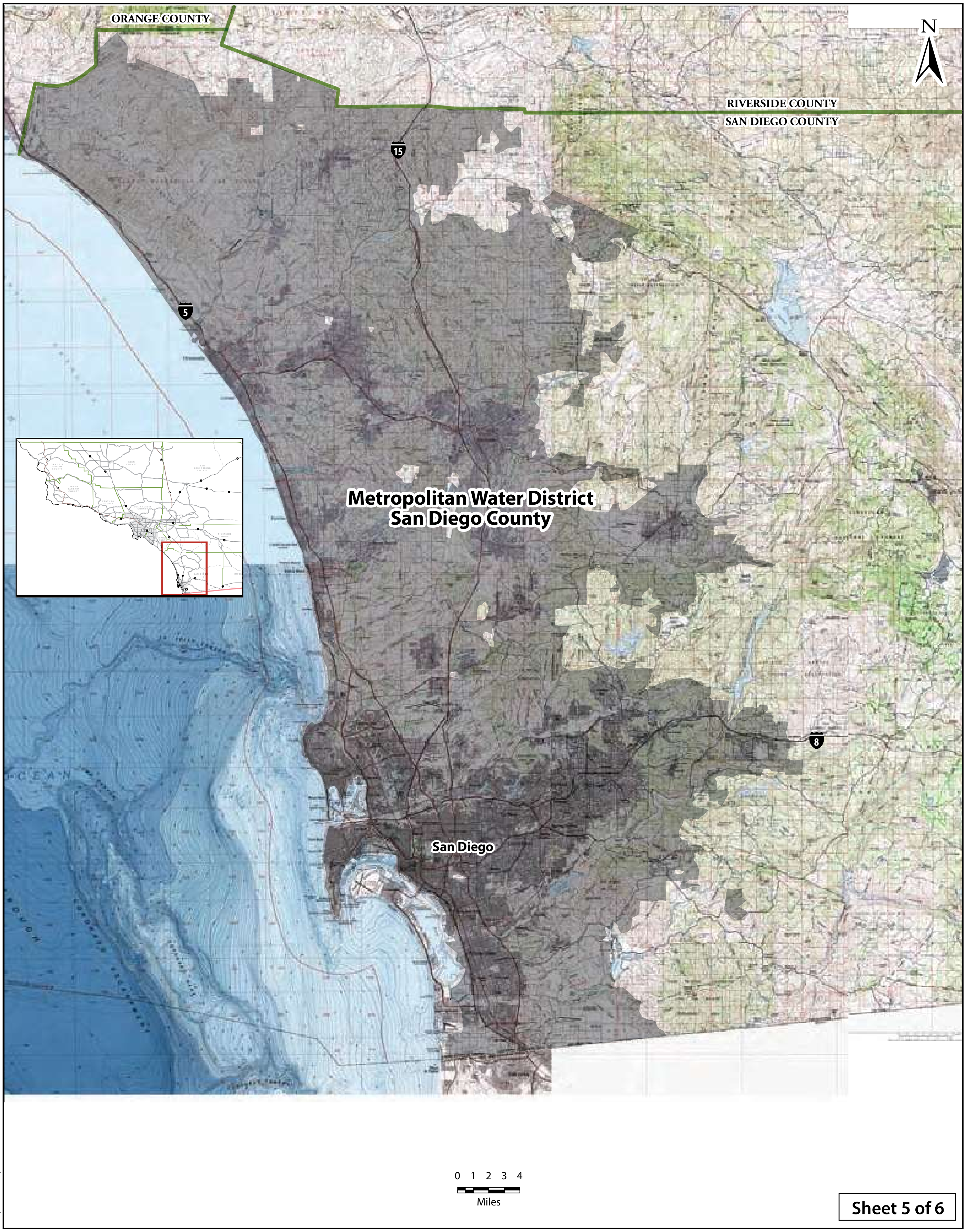
ICF INTERNATIONAL

Figure 1-5d
Metropolitan Water District, San Bernardino County
Place of Use



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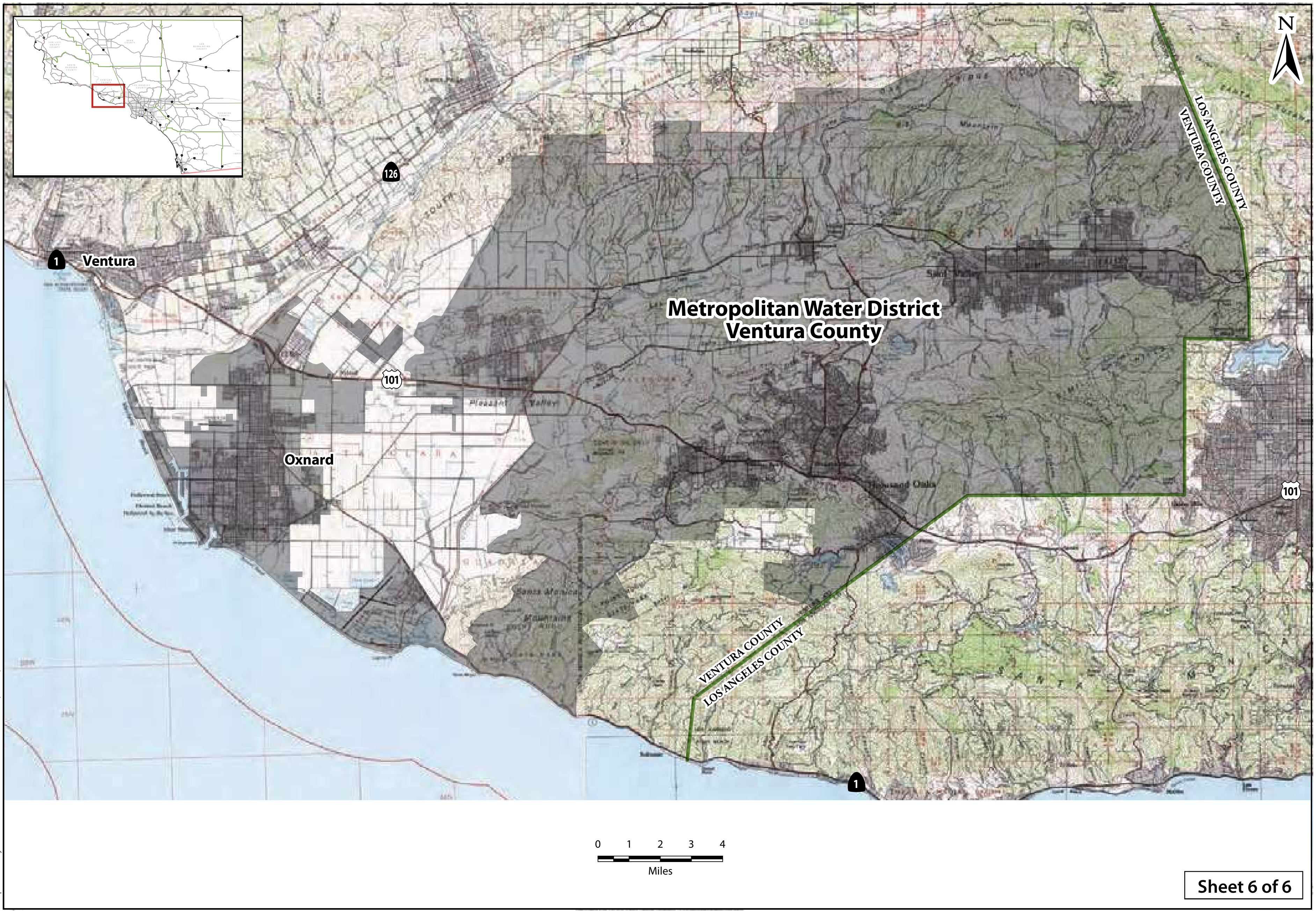
ICF INTERNATIONAL

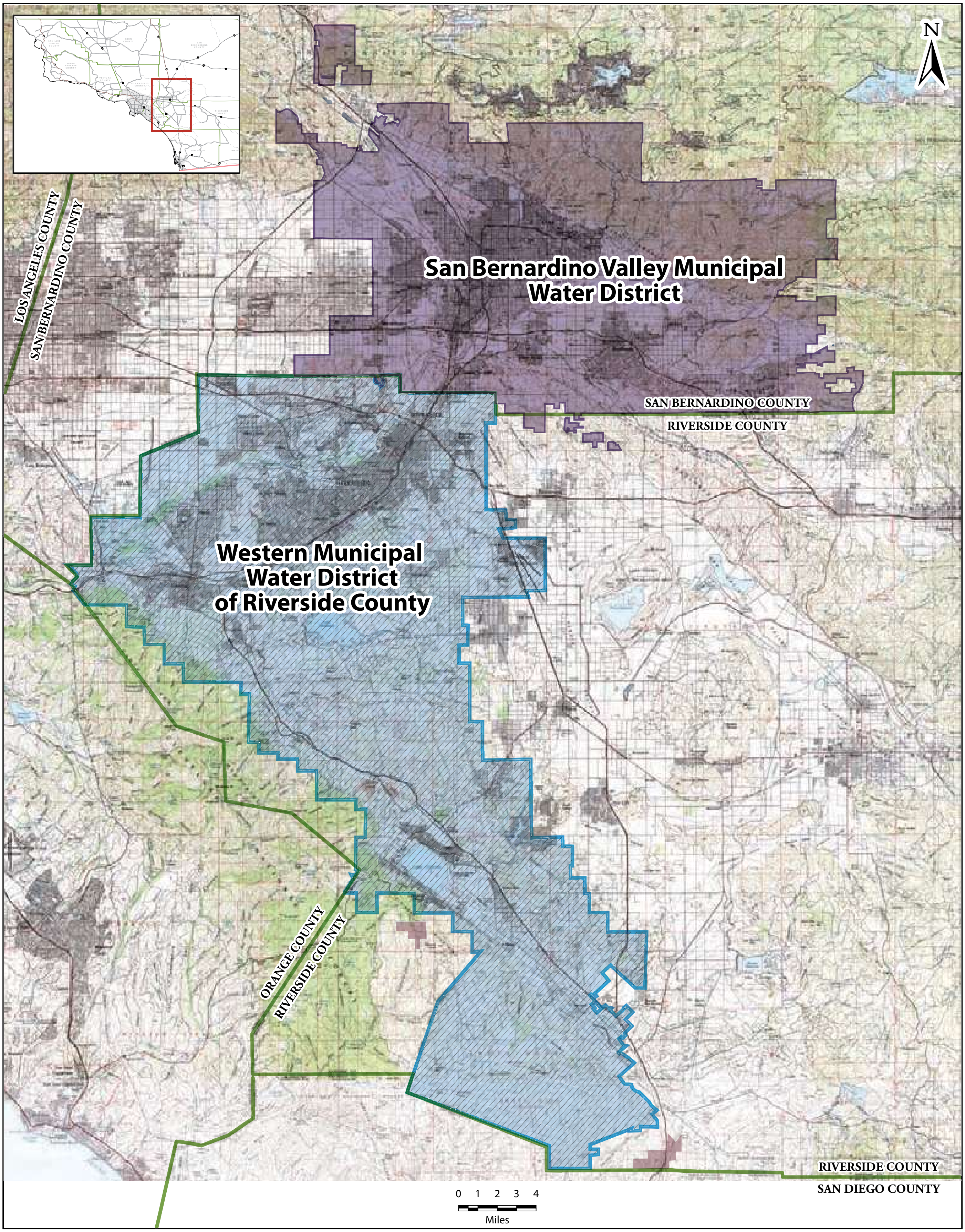
Figure 1-5e
Metropolitan Water District, San Diego County
Place of Use



Graphics/Projects/00152.08 Delta Wetlands/EIR (04-10) SS

ICF INTERNATIONAL

Figure 1-5f
Metropolitan Water District, Ventura County
Place of Use



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ICF INTERNATIONAL

Figure 1-6
San Bernardino Valley Municipal Water District and Western Municipal District of Riverside County

Chapter 2

Project Description and Alternatives

Introduction

This chapter reviews the basic description of the Project and presents, in detail, the following changes to the Project description that have been proposed since the 2001 FEIR.

- Specific places of use have been designated for Project water to improve the reliability of the existing supplies of water for irrigation and municipal purposes. The designated places of use include Semitropic, Golden State, and Metropolitan and its member agencies' service areas.
- An operational element has been added for banking Project water in the Semitropic Groundwater Storage Bank and the Antelope Valley Water Bank for later use by Semitropic, Metropolitan, and other designated users. This allows Project water to be stored until there is a water delivery deficit (i.e., unmet existing demand) in the designated places of use.
- The levee design has been revised to improve Reservoir Island structural integrity.
- Environmental commitments have been incorporated into the Project design to avoid, minimize, and mitigate environmental impacts and are to be considered as part of the analysis.

This chapter also summarizes new information and changed circumstances that may affect the existing or future conditions in the Delta or the Project description.

The operations of the Project in the Delta and the operations of the groundwater banks and the monthly deliveries to designated places of use are described in more detail in Chapter 3 "Project Operations." New specific information or changed circumstances that affect Project operations are described in Chapter 3, "Project Operations," and new specific information that may change the impact assessments are described in the respective appropriate resource sections of this Place of Use EIR.

The complete Project description providing the basis for the summary in this chapter can be found in the 1995 DEIR/DEIS (Pages 2-3 through 2-15, and Appendix 2, Supplemental Description) and the 2000 RDEIR/EIS (Pages 2-1 through 2-5).

Changes to the Project since the 2001 FEIR

The major changes in the Project description and operation are summarized and discussed below. The Project monthly operations with these changes are described in Chapter 3.

Designated Places of Use

The Project applicant's original applications filed in 1987 and new applications and petitions to change the original applications filed in 1993 identify the entire SWP and CVP service areas and the Bay-Delta estuary as the place of use for the Project water. Potential users of the Project water were assumed to be any user within this broad place of use. Potential beneficial uses for the Project water included irrigation, municipal and industrial, and fish and wildlife enhancement and water quality for the Bay-Delta estuary. The Court of Appeal decision required that designated places of use be more specifically identified.

The Project applicant has identified specific places of use for Project water, including Semitropic and four other places of use, as shown in Figures 1-3 through 1-6. Valley District has not determined whether it will participate in the Project, but it is included in this EIR as a Place of Use for assessment of potential impacts. If Valley District does not elect to participate in the Project, the Final EIR will be amended accordingly. These Places of Use require additional sources of water to improve the reliability of their existing water supplies to meet current demand, and have infrastructure in place for conveyance and transfer of the Project water. The Project water would be used to improve water supply reliability for their current water uses, which include irrigation, domestic, and municipal and industrial beneficial uses. Table 2-1 defines the annual demands and estimated maximum annual deliveries of Project water for each Place of Use.

Table 2-1. Overview of Place of Use Demands and Project Deliveries

Place of Use	Estimated Total Annual Demand (taf)	Population	Agricultural Acreage/ Annual Demand	Estimated Max. Annual Delivery from Project (taf)[1]
Semitropic Water Storage District	420	Ag. only	140,000 acres/ 420 taf	45
Metropolitan Water District of Southern California[2]	2,100	19,000,000	135 taf	215
San Bernardino Valley Municipal Water District	103[3]	600,000	Not available	15
Golden State Water Company	240	1,000,000	Not available	20
Total	2,863	20,600,000	>140,000 acres/ >555 taf	295

[1] Denotes estimates of the maximum annual deliveries of Project water to each Place of Use, and not average deliveries. The sum of the estimated maximum annual deliveries exceeds anticipated Project yield. Maximum annual deliveries are used to conservatively assess the growth-inducing impacts of the Project as discussed in Chapter Six, "Growth-Inducing Impacts."

[2] Metropolitan Water District of Southern California includes Western Municipal Water District of Riverside County.

[3] SWP Table A quantity.

The Project water would be delivered to these south-of-Delta users via existing and previously approved facilities operated and maintained by the SWP and CVP (and/or contractors) and those within the proposed places of use (designated water districts). No new facilities would be required to convey the Project water to the designated places of use.

As described and evaluated in the 2000 RDEIR/EIS and the 2001 FEIR, the Project water also may be released to benefit outflow, water quality, and fish and wildlife resources in the Bay-Delta estuary.

Semitropic Water Storage District

Water exported to Semitropic from the Project would augment Semitropic's overlying groundwater and SWP water supplies. Semitropic is a public water agency located in Kern County and provides water to irrigate approximately 140,000 acres for agricultural uses. Established in 1958, Semitropic began as an irrigation district for the purpose of securing SWP supplies to reduce groundwater overdraft. The full water supply needs are about 420,000 acre-feet per year (af/yr) (about 3 feet of applied water). The Project would support Semitropic's objectives to increase water supply reliability, reduce groundwater overdraft, raise groundwater levels and reduce pump lift, and maximize the use of its estimated 1.65 million acre-feet (maf) of groundwater storage.

As stated in Chapter 1, additional information about Semitropic's operations is covered under Semitropic Groundwater Banking Project Final EIR

(SCH#1993072024), and Semitopic Groundwater Banking Project Stored Water Recovery Unit Final Supplemental EIR (SCH#1999031100).

Golden State Water Company

Water exported to Golden State from the Project would increase the reliability of existing municipal and industrial deliveries for areas currently served. Golden State is a private water company that provides water service to more than 255,000 customers located within 75 communities throughout ten counties in northern, coastal, and southern California. Golden State delivers approximately 42 thousand acre-feet (taf) throughout its service area, based on a conservative (low) assumed customer use of 150 gallons per day (gal/day). The Project water would be supplied to Golden State users in 33 water systems and 53 communities in coastal and southern California in portions of Los Angeles, Orange, San Bernardino, San Luis Obispo, Santa Barbara, and Ventura Counties as discussed Chapter 6, "Growth Inducing Impacts," and Table 6-1.

The Metropolitan Water District of Southern California

Metropolitan is a wholesale water agency supplying water to 17 million consumers through 26 member public agencies. Metropolitan's two primary sources of supply are the Colorado River and the SWP. The percentage of supplies from these sources varies from year to year. The Colorado River Aqueduct has a maximum annual delivery capacity of about 1.2 maf. The Metropolitan contract for SWP water calls for a maximum of about 1.9 maf, but maximum annual SWP delivery so far has been about 1.5 maf. Metropolitan supplies about two-thirds of the total water deliveries made by its member agencies.

Water exported to Metropolitan would help augment the agricultural, industrial, and municipal water supply distributed within the 5,200 square miles serviced by Metropolitan. Encompassing Los Angeles, Orange, San Diego, Riverside, San Bernardino, and Ventura Counties, Metropolitan includes a population of approximately 18 million customers served through the state-chartered cooperative's 26 member agencies. Metropolitan's member agencies are identified in Chapter 6, "Growth Inducing Impacts," Table 6-2, and include Western Municipal Water District of Riverside County, discussed below. The Project water deliveries would support Metropolitan's objectives of increasing municipal and industrial water supply reliability in the face of past and anticipated future supply shortages.

Project water provided to Metropolitan will improve the reliability of Metropolitan's existing SWP and Colorado River supplies that have been reduced due to regulatory and climactic factors. The Project water will be blended with Metropolitan's existing supplies and distributed across the Metropolitan service area. Project water may also be provided to specific Metropolitan member agencies that contract with the Project.

Additional information about Metropolitan's service area, operations, use, deliveries, and planning objectives can be found in its Regional Urban Water Management Plan, dated November 2005.

Western Municipal Water District of Riverside County

Western, a Metropolitan member agency, was formed in 1954. It provides supplemental water to the cities of Corona, Norco, and Riverside and the water agencies of Box Springs Mutual, Eagle Valley Mutual, Elsinore Valley, Lee Lake and Rancho California. Western serves customers in the unincorporated areas of El Sobrante, Eagle Valley, Temescal Creek, Woodcrest, Lake Mathews, and March Air Reserve Base. Western's general district consists of a 527-square mile area of western Riverside County, with a population of approximately 853,000 people. Western currently sells approximately 125,000 acre-feet of water annually, obtained from the Colorado River, State Water Project and groundwater pumping. Additional information about Western's service area, operations, use, deliveries, and planning objectives can be found in Metropolitan's Regional Urban Water Management Plan, dated November 2005.

San Bernardino Valley Municipal Water District

Valley District was incorporated on February 17, 1954. It serves a 325 square mile area and includes the cities and communities of Bloomington, Colton, East Highlands, Grand Terrace, Highland, Loma Linda, Mentone, Redlands, Rialto, Yucaipa, San Bernardino and portions of Fontana and Riverside County. The approximate population within Valley District's service area is 600,000 people.

Valley District was organized to provide supplemental water to the San Bernardino Valley. Valley District is the fifth largest of 29 contractors who are part of the SWP. Valley District's maximum annual entitlement to State Project Water is 102,600 acre-feet.

Valley District supplies both local and State Water Project water for direct delivery to retail water agencies. In addition, Valley District is responsible for recharging certain groundwater basins to ensure that the basins have adequate water supplies to meet the needs of the retail water agencies and residents within Valley District.

Bay-Delta Estuary Releases

Project water may be released to benefit outflow, water quality, and fish and wildlife resources in the San Francisco Bay/Sacramento–San Joaquin Delta Estuary. The water supply modeling describes how Project water would be used to supplement Delta outflow in the fall season of years when there is no capacity to export Project water during the water supply (or groundwater banking) transfer period of July–November. These releases would benefit all CVP and SWP contractors by reducing the salinity of the exports during these periods of low Delta outflow. See Chapter 3, "Project Operations," for additional information.

Groundwater Banks

Project water not needed for designated place of use demands in a year with relatively high deliveries may be stored in the Semitropic Groundwater Storage Bank and/or the Antelope Valley Water Bank for later delivery to the designated places of use. Project water would be conveyed to the Semitropic Groundwater Storage Bank or Antelope Valley Water Bank using existing SWP and CVP and local water conveyance facilities. No new construction would be required to convey Project water to the groundwater banks for recharge (infiltration) or for pumping and delivery from the groundwater banks.

This integration with these approved and operational groundwater banks would allow Project water to be available in subsequent years to meet water supply needs for the overlying designated places of use, and contribute to the California Water Plan objectives for regional conjunctive (i.e., integrated groundwater and surface supply) water management. The Project water that is delivered to these groundwater recharge and storage facilities would be stored twice prior to delivery to the designated places of use:

- first, Project water would be stored seasonally on the Project Reservoir Islands from the time of diversion during high Delta inflow periods until the summer or fall when the Project water is discharged for export; and
- second, Project water would be stored for a year or more in the groundwater bank facilities and then pumped to the overlying places of use or to the other designated places of use to meet water supply needs in a relatively dry year.

Semitropic Groundwater Storage Bank

The Semitropic Groundwater Storage Bank has been operating since the early 1990s. Project water banked in the Semitropic Groundwater Storage Bank would use pipelines currently being used for agricultural irrigation. Semitropic has a recharge capacity of 140,000 af/yr and a pumping capacity of 290,000 af/yr. Semitropic Groundwater Storage Bank operates through cooperative agreements with six banking partners who have delivered approximately 700,000 af of surplus water to Semitropic. Whenever necessary, Semitropic returns the stored water to the California Aqueduct (SWP) for use by its partners by either entitlement exchange or pumpback, with a maximum pumpback capacity into the California Aqueduct of 90,000 af/yr. Current Semitropic Groundwater Storage Bank Project storage capabilities are 1.65 maf.

As introduced in Chapter 1 and referenced previously in this chapter, additional information about Semitropic's operations is covered under Semitropic Groundwater Banking Project Final EIR (SCH#1993072024), and Semitopic

Groundwater Banking Project Stored Water Recovery Unit Final Supplemental EIR (SCH#1999031100).

Antelope Valley Water Bank

The Antelope Valley Water Bank is being developed by a Joint Powers Authority comprised of Semitropic, Rosamond Community Services District, and Valley Mutual Water Company.

Construction and operation of the Antelope Valley Water Bank recharge and pumping facilities have been approved and is under construction. In Phase 1 of the Antelope Valley Water Bank, a new 4-mile pipeline would be constructed to distribute water between the Antelope Valley–East Kern Water Agency (AVEK) West Feeder and the recharge and recovery facilities; in Phase 2, a new 8.75-mile pipeline would be constructed between the California Aqueduct East Branch and the recharge and recovery facilities. The Antelope Valley Water Bank has a turnout from the AVEK West Feeder and piping that feeds a series of recharge basins.

Project water banked in the Antelope Valley Water Bank would use existing agricultural irrigation pipelines and new pipelines that are fully approved for construction. Water would be delivered to the recharge basins via the East Branch of the California Aqueduct, the AVEK West Feeder, and the distribution/recovery pipeline installed from the Van Dam Turnout to the northwest corner of the recharge basin area. Three earthen canals extending southward from the distribution pipeline would deliver water to the recharge basins. The Antelope Valley Water Bank is designed to receive water at a rate of up to 350 cubic feet per second (cfs) and to recharge up to 100,000 af/yr. Surface water recharged into the basins would percolate through the subsurface for storage into dewatered portions of the underlying aquifer. The total storage capacity of the Antelope Valley Water Bank is estimated at 500,000 af.

As introduced in Chapter 1, additional information about the Antelope Valley Water Bank can be found in the Antelope Valley Water Bank Final EIR (SCH#2005091117).

Project Description Summary

The Project would increase the availability of high-quality water in the Delta for export or outflow by storing water on two Reservoir Islands (Bacon Island and Webb Tract, see Figures 2-1 and 2-2) and would compensate for wetland and wildlife effects of the water storage operations on the Reservoir Islands by implementing an HMP on two Habitat Islands (Bouldin Island and Holland Tract, see Figures 2-3 and 2-4). The physical description of the Project is in this chapter, and the monthly operations of the Project are described in Chapter 3.

Some background information about the Delta and the Project islands is included to provide a framework for understanding the existing conditions of these Project islands and the proposed conversion to in-Delta Reservoir Islands and habitat management islands. More detailed descriptions of existing conditions on the Project islands and tracts are provided in each resource impact section in Chapter 4.

Project Island Characteristics

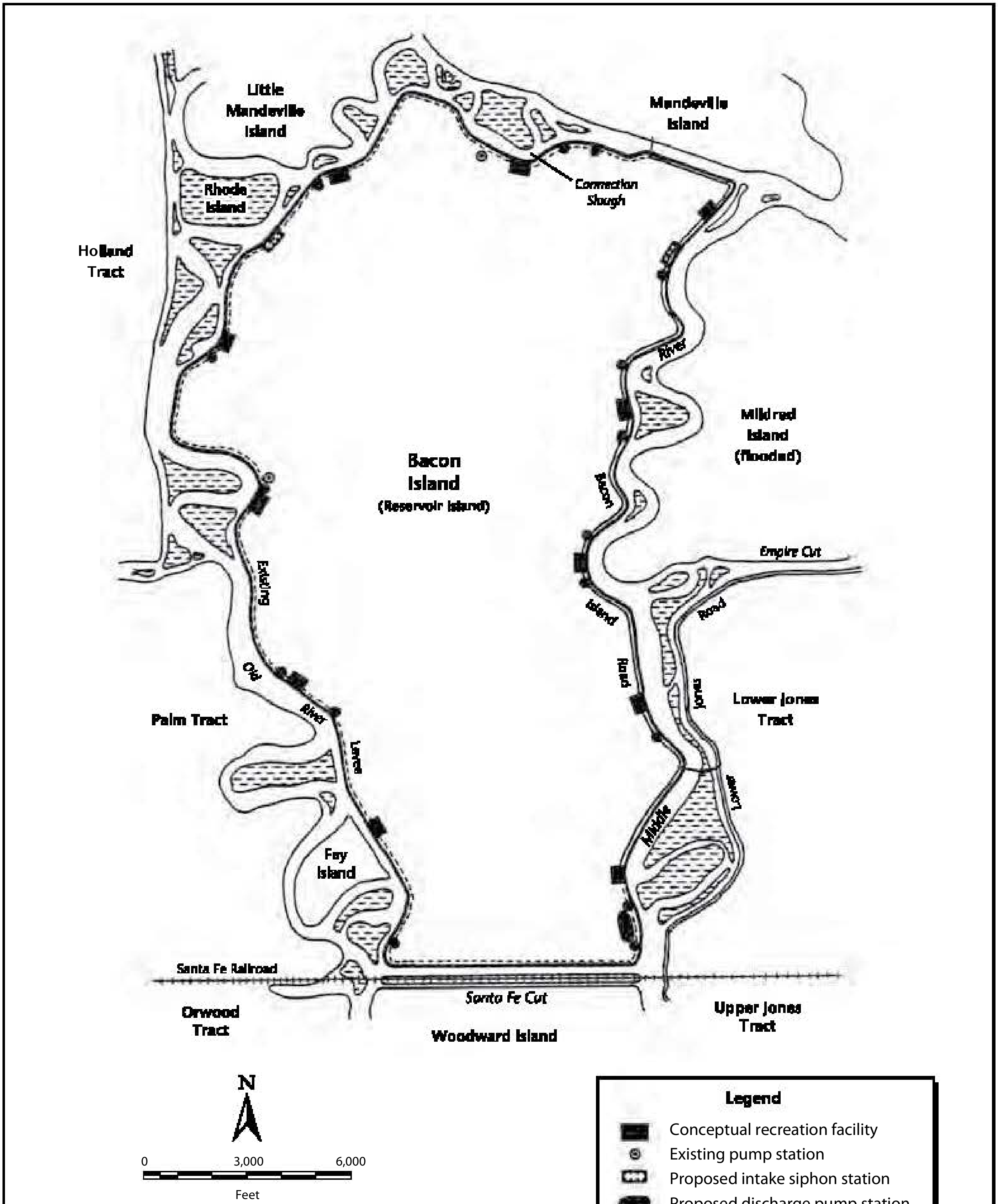
The Delta generally can be best depicted with a series of maps and tables in the Delta Atlas (California Department of Water Resources 1995). The total area within the legal Delta boundary is about 738,000 acres (1,503 square miles). The Delta is primarily agricultural lands (538,000 acres) and tidal water channels (61,000 acres), with about 65,000 acres in towns and cities and 75,000 acres undeveloped (California Department of Water Resources 1995: Table 7). Because Liberty Island in the north Delta flooded in 1997, water now covers about 65,000 acres, and the agricultural land is reduced by about 4,000 acres, slightly modifying the values as stated in the Delta Atlas.

The Delta land areas are protected with levees, and the Delta Atlas indicates that there are about 1,100 miles of levees in the Delta. The levee system is primarily maintained by local reclamation and levee districts. The levees for the Project islands are in this category and are maintained by four reclamation districts (one for each island or tract).

Bouldin Island levees are maintained by Reclamation District 756. Bouldin Island has 18 miles of levees with an area of 6,006 acres, bisected by State Route (SR) 12 (about 80% of the island is south of SR 12). Holland Tract levees are maintained by Reclamation District 2025, with 11 miles of levees and 4,060 acres. Webb Tract levees are maintained by Reclamation District 2026, with 13 miles of levees and 5,490 acres. Bacon Island is maintained by Reclamation District 2028, with 14.3 miles of levees and 5,625 acres (California Department of Water Resources 1995: Table 1). Figure 1-1b shows a map of the Delta with the location of the Project islands and tracts.

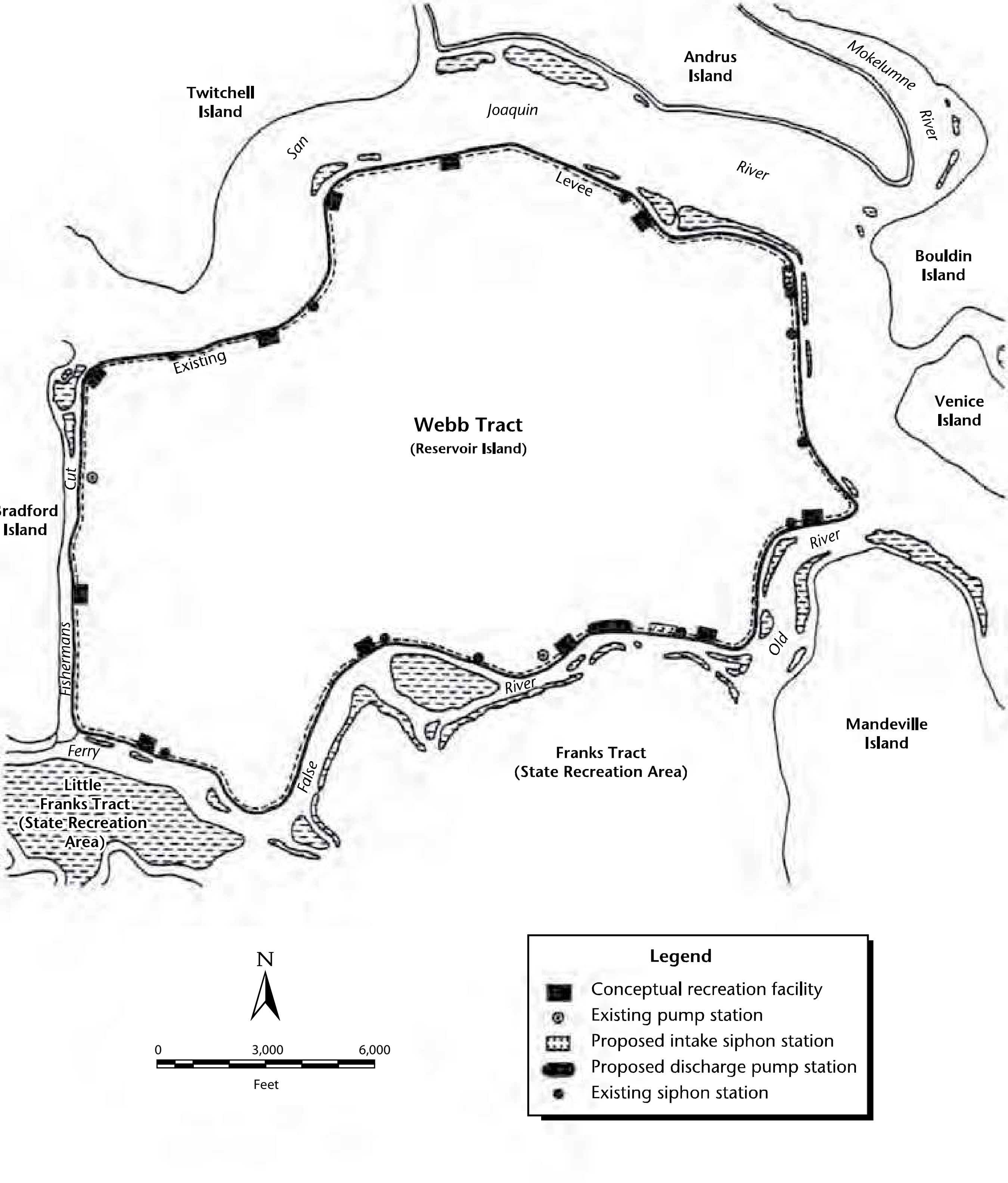
The Project islands and tracts cover a total of about 21,180 acres, which is about 4% of the Delta agricultural land. The levees on the Project islands and tracts total 56 miles which is about 7% of the Delta levees not part of the federal flood control project. Flooding has occurred regularly in the Delta, caused by high water overtopping levees during major flood events and other levee failures (like the Jones Tract June 2004 flooding). Since 1930, Bouldin and Bacon islands have not flooded. However, Webb Tract levees failed in the flood of 1950, and both Webb and Holland Tract levees failed in the flood of 1980 (California Department of Water Resources 1995: 46–48).

Land surface elevation has subsided during agricultural uses since the Delta islands and tracts were reclaimed with levees in the 1870–1920 period. The general depth of subsidence on Bacon Island and Webb Tract (Reservoir Islands)



Note: Features are shown for conceptual purposes.
Location and size are subject to detailed design.

Figure 2-1
Proposed Project Facilities on Bacon Island



Note: Features are shown for conceptual purposes. Location and size are subject to detailed design.

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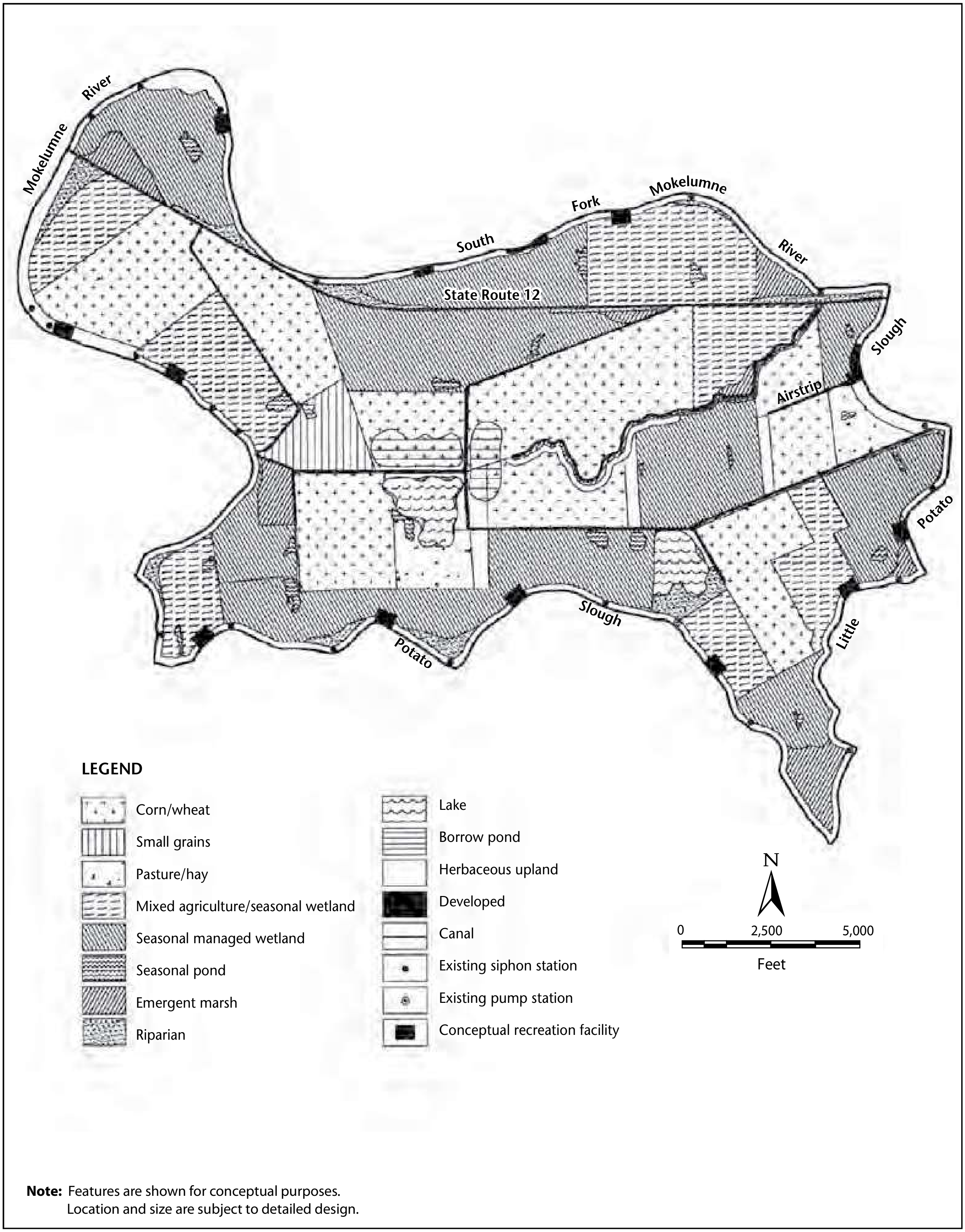
Figure 2-2
Proposed Project Facilities on Webb Tract



Note: Features are shown for conceptual purposes.
Location and size are subject to detailed design.

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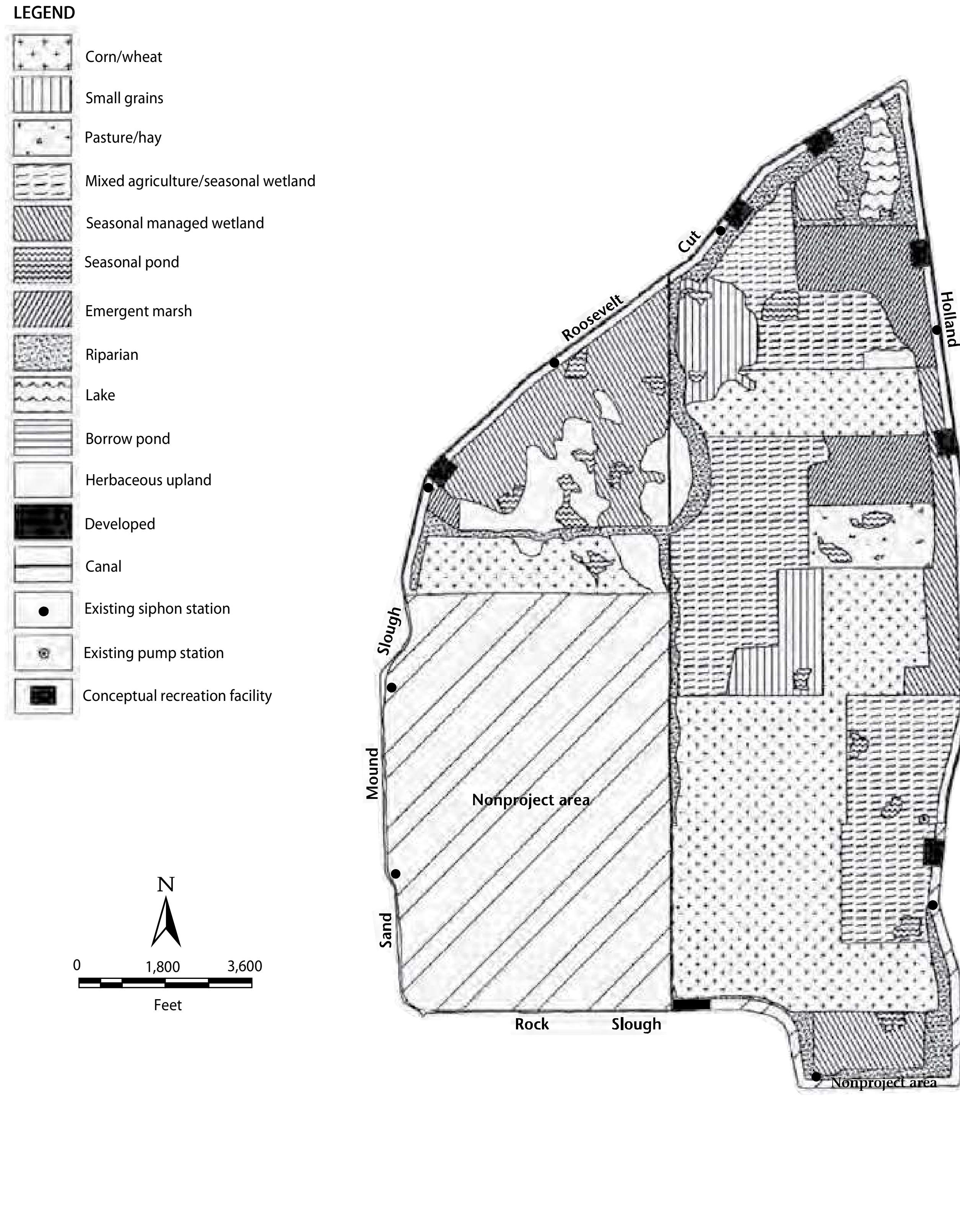
Figure 2-3
Habitat Management Plan Habitats and Proposed Project Facilities on Bouldin Island



Note: Features are shown for conceptual purposes.
Location and size are subject to detailed design.

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Figure 2-4
Habitat Management Plan Habitats and Proposed Project Facilities on Holland Tract

is about -15 feet above mean sea level (msl), with minimum elevations of -18 feet msl (California Department of Water Resources 1995: 30). The subsidence on Bouldin Island is also about -15 feet msl (minimum elevations of -17 feet) while the subsidence on Holland Tract is -10 to -15 feet msl (minimum elevations of -16 feet msl). With Project levee improvements to store water to +4 feet above mean sea level, Bacon Island and Webb Tract would have a combined storage capacity of 215 taf.

Reservoir Islands

Bacon Island and Webb Tract would be managed as Reservoir Islands for water diversion, storage, and discharge. The Project life-cycle for this use is planned for 50 years. Facilities needed for water storage operations include intake siphon stations with auxiliary pumps to divert water onto the Reservoir Islands and pump stations to discharge stored water from the islands.

The maximum water storage elevation analyzed in the 2001 FEIR was +6 feet msl (National Geodetic Vertical Datum 1929 [NGVD 29]). The Reservoir Islands are now are designed for water storage levels up to a maximum elevation of +4 feet (NGVD 29), providing a total estimated storage capacity of 215 taf, with 115 taf on Bacon Island and 100 taf on Webb Tract.

Diversion Facilities

Two diversion stations with 16 siphons per station would be constructed on both Webb Tract and Bacon Island. Each siphon would have 36 inch diameter pipes diverting water from the adjacent channel. State-of-the-art, positive barrier fish screens to prevent entrainment of fish in Project diversions would be installed around the intake end of each siphon pipe as specified in the FOC and the BOs, as described in detail in Chapter 4.5, Fishery Resources. Siphons would also include flow control valves, inline booster pumps, and expansion chambers at the discharge end of the siphon pipe. The individual siphons would be spaced at least 40 feet apart to incorporate fish screen requirements. The proposed locations of diversion stations are shown in Figure 2-1 for Bacon Island and in Figure 2-2 for Webb Tract.

Diversion rates of water onto the Reservoir Islands would vary with pool elevation and water availability. The maximum daily diversion onto either Webb Tract or Bacon Island would be about 3,000 cfs (6 taf per day). The diversion rate would be reduced as the reservoirs fill, and booster pumps would be used to complete the filling process. The combined maximum monthly diversion rate would be about 3,500 cfs, provided that all terms and conditions set forth by the Project applicant's water rights, the FOC, BOs, and stipulated agreements with other parties to the State Water Board's water right hearing are satisfied.

Discharge Facilities

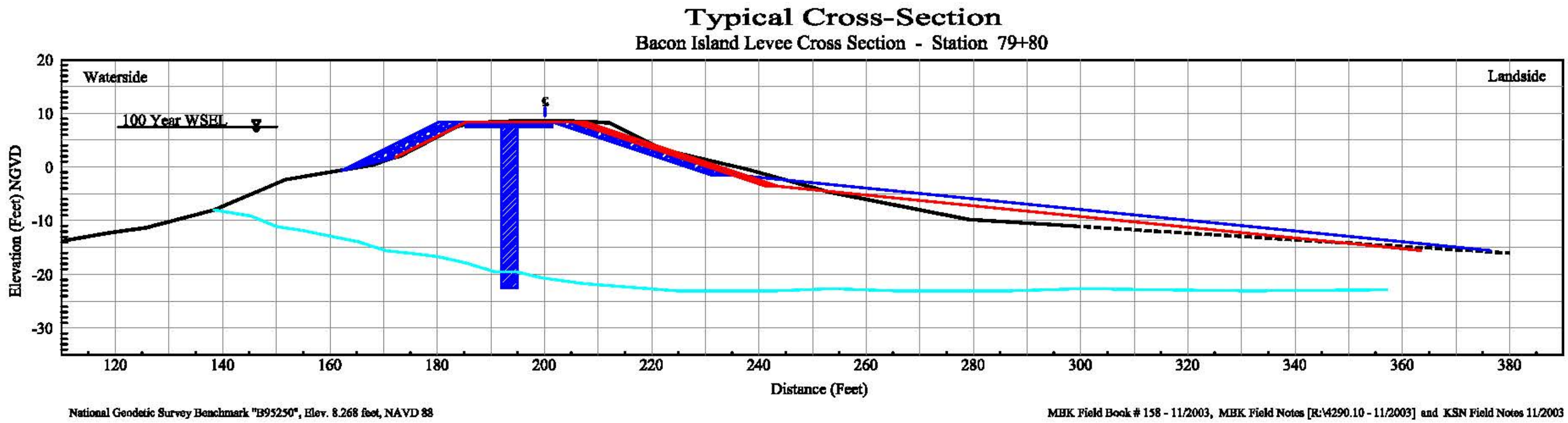
One discharge pump station with up to 32 new pumps would be constructed on Webb Tract, and a pump station with 32 pumps would be constructed on Bacon Island, for a total of 64 discharge pumps. Pumps would be either electrically-powered or diesel-powered. Each pump would have 36-inch-diameter pipes discharging to adjacent Delta channels. An assortment of axial-flow and mixed-flow pumps would be used to accommodate a variety of head conditions throughout drawdown. As water levels decrease on the Reservoir Islands, the discharge rate of each pump also would decrease. The pump station pipes would discharge underwater to adjacent Delta channels. The proposed locations of discharge stations are shown in Figure 2-1 for Bacon Island and in Figure 2-2 for Webb Tract.

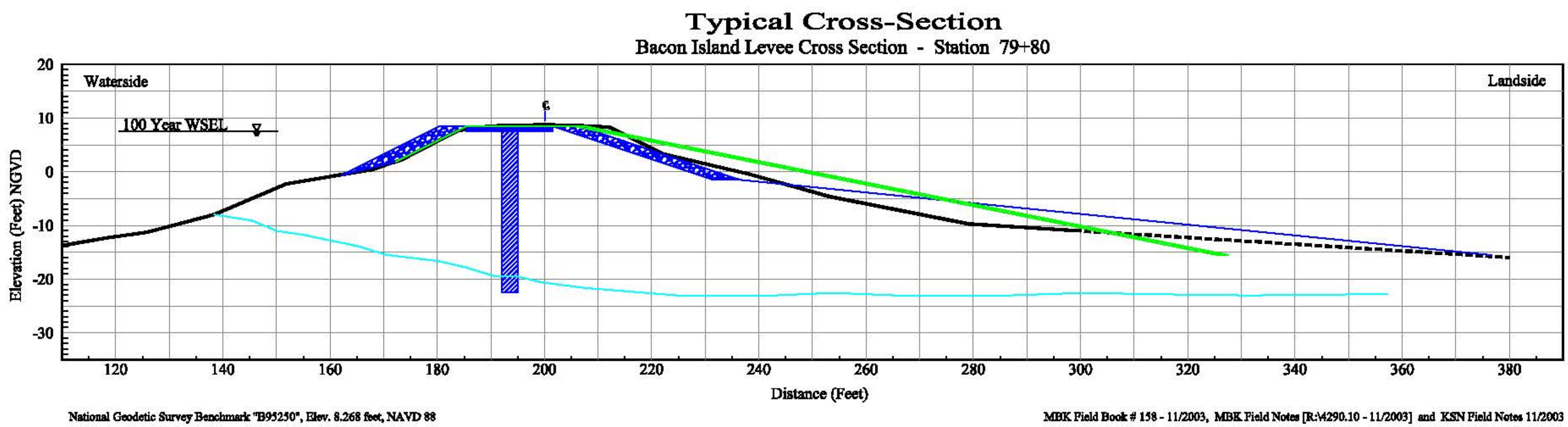
Project water would be discharged for export during periods of water demand in designated places of use or for groundwater bank recharge, subject to Delta regulatory limitations, export pumping capacities, and restrictions imposed by the FOC, BOs, and The Project applicant's stipulated agreements. The discharge for water export and delivery to designated places of use most likely would be during the July–September water transfer window, while the discharge for delivery to recharge the groundwater banks likely would be in the fall months. Project discharges for export would be pumped at a maximum daily rate of about 4,000 cfs for the two islands. Actual discharges will be based on available export capacity and average discharges are anticipated to be considerably less than 4,000 cfs.

Project water that cannot be exported because of permitted pumping limits (limited unused capacity) likely would be discharged for increased Delta outflow to reduce Delta (and export) salinity in September, October, and November. The Project Reservoir Islands generally would be emptied at the end of each year to reduce the accumulation of salinity and total organic carbon in the stored water, and refilled during the winter flood events.

Levee Improvements and Maintenance

The Project conversion to storage islands and Habitat Islands would include strengthening and maintaining 56 miles of levees. The interior of levees on the Reservoir Islands would be improved to resist the stresses and erosion potential of wind-waves and water level drawdown (see Figure 2-5). The Project would raise and widen the perimeter levees on the Reservoir Islands to hold water at a maximum elevation of +4 feet. Levee improvements are designed to meet or exceed state-recommended criteria for levees in DWR Bulletin 192-82 (California Department of Water Resources 1982). Levee design would control wave erosion through placement of rock revetment on the inside slopes of the perimeter levees. Project-related seepage would be controlled with a slurry wall and an extensive monitoring and shallow groundwater pumping system. During Project operation, the perimeter levees would be inspected weekly to identify any erosion, cracking, or seepage problems. Ongoing maintenance activities on the





LEGEND

- BASE DESIGN
- 2009 DESIGN
- 2001 "BROKEN-SLOPE" DESIGN
- APPROXIMATE BASE OF EXISTING FILL
- 2001 "CONSTANT-SLOPE" DESIGN
- CORE TRENCH
- AGGREGATE BASE
- RIP-RAP

2009 Design Assumptions

1. Final levee crest elevation is 1.5' above 100-year flood elevation.
2. The waterside levee slope will be 2:1
3. The landside levee slope will be 3:1 on the upper end and 10:1 on the lower end. The 3:1 and 10:1 slopes intersect at 10 to 15 feet below the levee crest. Typical assumes 10 feet below levee crest.
4. The core trench will be 3' wide, excavated to 3' below the base of existing fill, and will be backfilled with low-permeability material.
5. Final crown width will be 26'. Assumes 16' for the levee crest plus 5' of riprap on either side.
6. 100-year flood elevation based on the USACE's 1992 report: "Sacramento-San Joaquin Delta, California, Special Study: Hydrology"

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Figure 2-5
Reservoir Island Levee Design

levees would include periodic placement of fill material, placement or installation of erosion protection material, reshaping or grading of fill material, vegetation control, and re-grading or repairing the levee road surface. The islands' Reclamation Districts will remain responsible for levee operation and maintenance for flood control after development of the Project.

Recreation Facilities

Water storage operations on Bacon Island and Webb Tract would not preclude recreation including hunting on the Reservoir Islands. The 2001 FEIR identified up to 11 recreation facilities on each Reservoir Island along the perimeter levees. This 2010 Place of Use EIR proposes to eliminate the recreation facilities on the Reservoir Islands as mitigation discussed in Section 4.2, Water Quality; Section 4.4, Utilities; Section 4.5, Fishery Resources; Section 4.9, Recreation; Section 4.10, Traffic and Navigation; and Section 4.13, Air Quality.

Shallow-water management on Bacon Island and Webb Tract could be used to enhance forage and cover for wintering waterfowl when water would not be stored on the Reservoir Islands if it does not interfere with water storage operations. An inner dike and check system would consist of low-height dikes and connecting waterways to manage shallow water during periods of non-storage. The inner dikes would be broad earthen structures large enough to serve as roadways and similar to the structures currently in place on existing farm fields.

Habitat Islands

Bouldin Island and Holland Tract would be dedicated to and managed for wetlands and other wildlife habitat vegetation (Figures 2-3 and 2-4). The primary function of the Habitat Islands, as described in the HMP, is to offset effects of water storage operations on listed Threatened and Endangered species, and on waters of the United States (including wetlands) pursuant to Section 404 of the CWA, and to provide other enhanced and dedicated wildlife habitat areas for wintering waterfowl and support limited hunting opportunity. The Habitat Islands would be developed and managed to provide breeding and foraging habitat for special-status wildlife species and other important wildlife species groups.

Wetland management on the Habitat Islands would require grading, planting, and seasonally diverting water. Improvements would be made to existing siphon and pump facilities and to perimeter levees, including buttressing levees to meet DWR's recommended standards for levee stability and flood control. State-of-the-art, positive barrier fish screens would be added to all siphon or diversion pump stations on the Habitat Islands. Recreation facilities could be constructed on the Habitat Island perimeter levees. The Bouldin Island airstrip could be operated to support recreational access. The dedication of the two habitat enhancement islands is considered an environmental commitment and is more fully described and evaluated in Section 4.6, Vegetation and Wetlands, and Section 4.7, Wildlife.

Habitat Island Diversions and Discharges

The Project would utilize the existing irrigation water right licenses to supply water for wetlands and wildlife habitat purposes on the Habitat Islands. The timing and volumes of diversions onto the Habitat Islands would depend on the needs of wetlands and wildlife habitat. Wetland diversions typically would begin in September, and water would be circulated through the winter months.

The maximum rate of proposed diversions onto Holland Tract and Bouldin Island would be 200 cfs per island. Water likely would be applied to the Habitat Islands in most months for management of open water and perennial wetlands, flooded seasonal wetlands, and irrigated croplands (grown partially for wildlife food). Approximately 20 taf would be diverted annually onto the Habitat Islands, which is less than the current agricultural diversions of about 30 taf. As stated above, positive barrier fish screens would be added to all Habitat Island diversions.

Levee Improvements and Maintenance

Levee improvements on the Habitat Islands would be designed to meet criteria for agricultural levees as described in PL 84-99. Routine maintenance activities on Habitat Island perimeter levees would not differ from current practices. Interior slopes of perimeter levees on the Habitat Islands would be planted and maintained according to current practices. The islands' Reclamation Districts will remain responsible for levee operation and maintenance for flood control after development of the Project.

Recreation Facilities

Habitat restoration on Bouldin Island and Holland Tract has been designed to include recreation. The 2001 FEIR included conceptual designs for up to 10 new recreation facilities on Bouldin Island and up to six new recreation facilities on Holland Tract. This 2010 Place of Use EIR proposes a significant reduction in the development of future recreation facilities on the Habitat Islands as mitigation discussed in Section 4.2, Water Quality; Section 4.4, Utilities; Section 4.5, Fishery Resources; Section 4.9, Recreation; Section 4.10, Traffic and Navigation; and Section 4.13, Air Quality. HMP designates open hunting areas for waterfowl and upland hunting, as well as closed zones where hunting is prohibited. The HMP allows waterfowl hunting in free-roam hunting zones and spaced-blind hunting zones. Additional details can be found in the HMP and Section 4.7, Wildlife.

Project Alternatives

The 2001 FEIR and 2001 FEIS analyzed three Project alternatives (Alternatives 1, 2, and 3) and the No-Project Alternative to represent a range of Project operations for purposes of determining environmental impacts. The proposed Project in the 2001 FEIR consists of storage of water on two Reservoir Islands and implementation of an HMP on two Habitat Islands. No changes are being made to the proposed Project other than the identification of specific places of use, incorporation of several environmental commitments, and improvement to the Reservoir Island levee design.

Therefore, the alternatives analyzed in detail in the 1995 DEIR/EIS, the 2000 RDEIR/EIS, and the 2001 FEIR represent a reasonable range of alternatives. A brief summary of the Proposed Project (Alternative 2), as well as Alternatives 1, 3, and the No-Project Alternative, follow. For a more detailed discussion of the original design and operational details of the Project alternatives, please refer to the 1995 DEIR/EIS, 2000 RDEIR/EIS, and the 2001 FEIR.

Proposed Project (Alternative 2)

Alternative 2 consists of water storage on two Reservoir Islands and implementation of an HMP on two Habitat Islands. Alternative 1 entails the potential year-round diversion and storage of water on Bacon Island and Webb Tract, and wetland and wildlife habitat creation and management on Bouldin Island and Holland Tract. To operate Alternative 2, the Project would improve levees on the perimeters of the Reservoir Islands, install additional siphons and water pumps, and construct inner dike and berm systems on all four islands for shallow-water management. Under Alternative 2, during periods of availability throughout the year, water would be diverted onto the Reservoir Islands to be stored for later sale or release and would be discharged from the islands into Delta channels for sale for beneficial uses for export or for Bay-Delta estuary needs during periods of demand. Discharges from the islands would be subject to state and federal regulatory standards, endangered species protection measures, and Delta export pumping capacities.

The Proposed Project is Alternative 2, as modified by incorporation of the BOs, FOC, WQMP, protest dismissal agreements, and other environmental commitments. In review:

- the terms and conditions of the DFG, USFWS, and NMFS BOs are based on this alternative;
- all of the revised operating criteria developed from the BOs were included in the FOC for the Project; and
- these operations were simulated and evaluated in the 2000 RDEIR/EIS.

Following the 2000 Water Rights Hearings, the WQMP was developed in the course of negotiating protest dismissal agreements with CUWA and CCWD.

These water quality operations criteria are also included in the Project operations described in Chapter 3, “Project Operations,” and the resulting water quality conditions for salinity and dissolved organic carbon (DOC) are evaluated as part of the water quality impact assessment in Section 4.2, Water Quality.

Revised Project operations have been simulated for this Place of Use EIR to demonstrate the likely south-of-Delta water delivery to designated water districts and associated groundwater banking. These water supply simulations are also described in Chapter 3, “Project Operations.”

Alternative 1

Alternative 1 differs from Alternative 2 only with regard to operating criteria for diversion and discharge of stored water. Under Alternative 1, Project discharges would be subject to a conservative (strict) interpretation of “percent of inflow” export limits specified in the 1995 WQCP.

Alternative 3

Under Alternative 3 all four of the Project islands would be used as reservoirs with limited compensation habitat provided on a portion of Bouldin Island. Alternative 3 would be inconsistent with the FOC and BOs previously issued for the Project.

No-Project Alternative

The No-Project Alternative has not changed since publication of the 2001 FEIR and 2001 FEIS. If Corps permit applications or SWRCB water right permit applications for the Project are denied, the Project applicant would implement intensive agricultural operations on the four Project islands or sell the property to another entity that would likely implement intensive agriculture. The No-Project Alternative is based on the assumption that intensified agricultural conditions represent the most realistic scenario for the Project islands if permit applications are denied.

It is assumed that no new recreation facilities would be built. However, under the No-Project Alternative, an intensive for-fee hunting program would be operated on the Project islands, creating an additional 12,000 hunter-use days over existing conditions.

Changes in Project island operations under the No-Project Alternative would be limited to those farming activities that increase cropping intensity and could be implemented without a permit issued by the Corps or SWRCB. The cropping scenario for this alternative is described in Section 4.8, Land Use and Agriculture. The No-Project Alternative would entail implementing more efficient drainage and weed management practices on Holland and Webb Tracts and shifting some crop types on Bacon and Bouldin Islands.

Under the No-Project Alternative, consumptive use would increase, reflecting more extensive agricultural use of the islands, but not measurably so at the scale of monthly water supply modeling. Currently existing siphon facilities on the islands, which are unscreened, would not be modified under the No-Project Alternative.

Project Environmental Commitments

Environmental commitments are measures incorporated by the project proponent as part of the project description, meaning they are proposed as elements of the proposed action and are to be considered in conducting the environmental analysis and determining effects and findings. The purpose of environmental commitments is to reflect and incorporate best practices into the project that avoid, minimize, or offset potential environmental effects. *Note: The term* mitigation *is specifically applied in this EIR only to designate measures required to reduce environmental impacts of the proposed Project, including Project environmental commitments, triggering a finding of significance.* These best practices tend to be relatively standardized and compulsory; they represent sound and proven methods to reduce the potential effects of an action. The rationale behind including environmental commitments is that the Project proponent commits to undertake and implement these measures as part of the Project in advance of impact findings and determinations in good faith to improve the quality and integrity of the Project, streamline the environmental analysis, and demonstrate responsiveness and sensitivity to environmental quality.

Several changes in Project design, mitigation measures from the 1995 DEIR/EIS and the 2000 RDEIR/EIS, and many prior agreements with Delta water rights holders or agencies (such as FOC to protect fish and the WQMP) have been incorporated as Project environmental commitments. The Project environmental commitments are detailed below.

Two-Island Habitat Management Plan

The original plans proposed in 1990 consisted of a four-reservoir project. The Project dedicated two islands to environmental management with wildlife-friendly agriculture and habitat protection and enhancement areas as a condition of the DFG Incidental Take Permit. The HMP is a major environmental commitment relative to the original proposal. The goal of the HMP is to offset Project impacts from the two Reservoir Islands on listed Threatened and Endangered species, wintering waterfowl, and jurisdictional wetlands. Land management practices to benefit other wildlife species also have been incorporated. The HMP planning team (the Project applicant, in collaboration with DFG, State Water Board, and others) designed the island habitats and management prescriptions to achieve three goals, listed in order of importance.

- Compensation goals. Compensate for Project impacts on species listed as Threatened or Endangered under the CESA, wintering waterfowl habitat, and jurisdictional wetlands, including riparian habitats. Compensation goals must be achieved to offset Project impacts.
- Species goals. Without compromising compensation goals, implement land management practices to provide the greatest benefit to upland wildlife species; enhance breeding habitat for waterfowl, roosting habitat for greater sandhill cranes, and nesting habitat for Swainson's hawks; and provide potential habitats for other special-status species. Species goals should be implemented to enhance overall wildlife values associated with compensation habitats.
- Other important goals. Implement best land management practices that do not detract from compensation and priority species goals to enhance habitat conditions for other important species or species groups, such as migratory shorebirds, nongame water birds, and species associated with riparian habitats.

The HMP is a major environmental commitment that avoids and reduces many potential impacts on vegetation and wildlife species. Management prescriptions for habitat types and acreages of habitat types to be developed on Holland Tract and Bouldin Island will depend on the preparation of a final HMP that is subject to agency review and approval. Additional details of HMP implementation are described in Section 4.7, Wildlife.

Reservoir Island Construction Monitoring

To avoid construction-related take of federally- and state-listed wildlife species on the Reservoir Islands, a Reservoir Island Construction Monitoring program will be developed. This program will include preconstruction survey protocols and avoidance measures for giant garter snake, Swainson's hawk, greater sandhill crane, California black rail, and other avian species. Additional details of the Reservoir Island Construction Monitoring program are described in Section 4.7, Wildlife.

Screened Diversions

The diversion siphons/pumps will be screened for fish protection. Positive barrier screens may not protect larvae and small juvenile fish, but they are very effective in reducing the entrainment loss of larger juvenile and adult migrating fish. The fish screens will meet USFWS criteria for delta smelt (0.2 feet per second [ft/sec] approach velocity) and are a drum design to minimize the length of exposure, drawing water from all directions. Additional information on the type of screens that are likely to be used for the Project is available at:

<http://www.intakescreensinc.com>.

Fish Monitoring and Habitat Protection

Previous fish impact evaluations and the Project BOs have suggested or required monitoring and operational criteria for fish protection. These are generally described together here as an environmental commitment. This includes several operations for Webb Tract diversions that were agreed to with EBMUD. The details of these monitoring and operational criteria are given at the end of Section 4.5, Fish.

The Project applicant previously agreed to provide a conservation easement on about 200 acres of brackish tidal wetlands. The Project will provide this easement on the western tip of Chipps Island, a property owned by the Project applicant, to protect this prime estuarine tidal wetlands habitat from future conversion back to duck club managed wetlands. This is now considered an environmental commitment.

Conservation Easements on Habitat Islands

To ensure continued habitat management and agricultural production on the Habitat Islands, the Project applicant will record conservation easements over Bouldin Island and Holland Tract lands controlled by Delta Wetlands Properties. The easements will be developed to be consistent with the HMP and will be recorded in San Joaquin County and Contra Costa County, respectively.

Prior Agreements with Other Parties

Many of the stipulations in the protest dismissal agreements are now incorporated as environmental commitments. Some are agreements to operate the Project consistent with existing Delta objectives and prior water rights. Others are for fish protection and water quality protection. The operational agreements are described in Chapter 3, “Project Operations.” Those agreements that include environmental commitments are summarized here. All protest dismissal agreements are included on each compact disc of the digital version of this EIR and are available for public review at public buildings as referenced in the included distribution list.

In response to the 1997 State Water Board water right hearing, 18 parties filed protests with the State Water Board against the Project applicant’s water rights applications. The Project entered into negotiations with some of these parties. As a result of these discussions, the Project applicant entered into stipulated agreements with Reclamation, DWR, Amador County, the City of Stockton, and North Delta Water Agency that affirm the seniority of protesting parties’ water rights (Amador and Stockton), or agree to operate the Project in a manner that is consistent with the existing CVP and SWP Delta operations and follows the water quality objectives in the Delta that protect existing water users (Reclamation, DWR, North Delta Water Agency).

The State Water Board resumed and completed the water right hearing in 2000. During the hearing, the Project applicant entered into protest dismissal agreements with CUWA, EBMUD, and CCWD. The Project applicant entered into an agreement with PG&E in 2006 to address PG&E's protest to the Project's water right applications concerning maintenance and repair of gas transmission lines under Bacon Island.

Water Quality Management Plan

The agreement with the CUWA included the WQMP. This is an environmental commitment to manage the reservoir storage and discharges to minimize the drinking water quality impacts. The WQMP is described in more detail in Section 4.2, Water Quality. The WQMP is an environmental commitment that reduces previously identified water quality impacts to a less-than-significant level. A similar agreement with CCWD includes the WQMP developed with CUWA. In addition, the CCWD agreement includes operational restrictions to reduce the impacts of the Project on CCWD's diversions and Los Vaqueros salinity management and fish protection operations.

The Pacific Gas and Electric Company

The Project applicant and PG&E entered into an agreement in 2006 (Delta Wetlands Properties 2006), amended in 2007, that resolved PG&E's protest to the Project water right applications. The agreement includes measures to reduce Project effects on PG&E's gas transmission pipelines that cross Bacon Island. For example, if levee embankment construction for the Project creates stress on the Line 57B pipeline that is significantly greater than the stress on the pipeline caused by the current levee, the Project will pay for the design and construction of a mutually acceptable engineering solution to reinforce, replace, or relocate the Line 57B eastern levee crossing on Bacon Island before water is diverted for storage onto Bacon Island. The stipulations in this agreement, as they pertain to the Project's responsibilities, are now considered to be environmental commitments. The settlement agreement is described in more detail in Section 4.4, Utilities, Public Services, and Highways.

East Bay Municipal Utility District

The stipulated agreement between the Project applicant and EBMUD includes several measures to reduce Project effects on migrating Mokelumne River fish. For example, whenever possible the southeast diversion station on Webb Tract (diverting from Franks Tract) will be used rather than the northeast station to reduce impacts on Mokelumne River fish. The agreement also requires the Project to eliminate recreational boat slips from some locations and to reduce overall number of boat slips. A Reservoir Island design review board will serve as an oversight committee for the Reservoir Islands while construction is ongoing. A Reservoir Island monitoring and action board will serve as a technical review committee for operations of the Reservoir Islands and for enforcing the implementation of the Project Seepage Control Plan. These are now considered to be environmental commitments.

Improved Reservoir Island Levee Design

Based on the recommendations by Hultgren-Tillis Engineers contained in the 2003 document, "Preliminary Design Report: Reservoir Island Levees, Delta Wetlands Project," the proposed Reservoir Island levee design has been improved to provide increased stability and reduced through-levee seepage potential. The proposed Reservoir Island levee design now includes a more stable and flat reservoir-side slope, with a wider top width and a vertical cutoff trench to reduce seepage. The wider top width will allow future maintenance activities to place additional fill as needed to make up for any post-construction settling or sea-level rise while still providing minimum top widths and acceptable slopes after fill placement.

The design includes placement of fill and revetment on the landside slope, addition of a 10:1 to 14:1 slope interior toe berm, and addition of a 3-foot wide core trench to reduce through-levee seepage potential. Figure 2-5 shows the new reservoir levee design as well as the previously proposed Reservoir Island levee designs, as described in the 2001 FEIR, for comparison. The new Reservoir Island levee design is described in more detail in Section 4.3, Flood Control and Levee Stability. Final levee design will be subject to engineering review.

Seepage Monitoring and Control System

Though the new reservoir levee design reduces the risk of through-levee seepage damage, the risk of under-seepage to neighboring islands is still a concern. Deep sand aquifers underlie the Reservoir Islands and adjacent islands, as well as the channels and sloughs separating them. Storing water on the Reservoir Islands could increase the elevation of the groundwater surface and the hydraulic pressure on the aquifer, thereby inducing seepage through the sand aquifer onto the neighboring islands. Agricultural uses on neighboring islands could be impaired by an increase in seepage.

The Project has designed a seepage monitoring and control system to avoid seepage issues and to provide early detection of seepage problems caused by the Project. This system was described in detail in 2000 RDEIR/EIS, Appendix H. The seepage control system will consist of a series of interceptor wells or relief wells that would be used to regulate hydraulic pressure that could cause increased seepage to a neighboring property. The Seepage Monitoring Program would use infrared aerial photography, weir monitoring, visual inspection, and piezometer readings on islands adjacent to the Reservoir Islands to quantify and document Project-related seepage impacts, and to determine the basis for appropriate mitigation and compensation measures, if necessary. The Seepage Monitoring Program sets forth a series of performance standards to determine net increases in seepage caused by the Project as well as guidelines for evaluating the monitoring information. Diversions of water onto the Project islands would continue only if seepage to adjacent and neighboring islands does not increase beyond existing conditions or if increases can be effectively mitigated.

In response to concerns about seepage, and in accordance with the recommendations of the 2000 report issued by URS entitled "Levee Stability and Seepage Analysis Report for the Delta Wetlands Project Revised EIR/EIS," the 2000 RDEIR/EIS incorporated a mitigation measure (Mitigation Measure RD-2) in the "Flood Control" analysis that made minor modifications to the Seepage Monitoring Program and seepage performance standards. These modifications have since been incorporated into the Seepage Monitoring Program. The changes are as follows.

- Locate the background monitoring wells at least 1,000 feet from the nearest seepage monitoring wells.
- Use more than one background monitoring well for each row of seepage monitoring wells.
- Use at least 1 year of data to establish reference water levels in all the background monitoring wells and in at least half of the seepage monitoring wells.
- Reevaluate seepage performance standards 2, 5, and 10 years after reservoir operations begin and then every 10 years.

Additional modifications to the seepage control system and Seepage Monitoring Program may be made in concert with the final design process and/or consultation with the owners of adjacent islands.

The modifications to the Seepage Monitoring Program listed above include removal of two elements of Mitigation Measure RD-2 in the 2001 FEIR and 2001 FEIS. These elements called for using a running straight-line mean from the monitoring well data when applying seepage performance standards, as well as reducing the seepage performance standard for the single well condition from 1 foot to 0.5 foot. These recommendations have been removed at the direction of Project engineers, as they do not account for daily tidal and yearly fluctuations in the groundwater levels and because they conflict with the EBMUD PDA (Tillis pers. comm. 2010).

New Information and Circumstances

The Delta ecosystem (e.g., habitat, species abundance) and infrastructure (e.g., levees, conveyance) and land use (e.g., agricultural, urban development) and water management operations (e.g., outflow, exports) remain the focus of many ongoing studies, evaluations, and planning efforts. Some of these have provided new information directly relevant to the Project design, and are discussed here. Those that relate most directly to Project operations are reviewed in Chapter 3, and others are reviewed in the appropriate resource analysis section.

California Department of Water Resources In-Delta Storage Operations Studies

DWR conducted several operations studies for the ISI (see the table below). DWR assumed that Bacon Island and Webb Tract would be operated as described in D-1643 FOC and the Project BOs. DWR developed a daily operations model for Delta flows and in-Delta storage, as was described in Appendix A4 of the 1995 DEIR/EIS. The major difference in the DWR studies was that the in-Delta storage was operated as a new SWP facility, integrated with upstream storage and Delta operations to help meet full SWP Table A demands. For reference, the average export pumping simulated for the 1922–1994 (73-year) period with CALSIM was 6,030 taf/yr. The integrated operations generally allowed the in-Delta storage to provide a water supply benefit (i.e., average yield) of about 125 taf/yr.

The table below lists the individual studies that were completed for the in-Delta storage investigations. These technical reviews and draft reports represent several thousand pages describing and evaluating the in-Delta storage project, essentially the same as the Project described in this Place of Use EIR. Only the general findings as summarized in the last report of the series in 2006 are reviewed below.

California Department of Water Resources Reports for the CALFED Bay-Delta Program Integrated Storage Investigations Program

2001 Reports
• Evaluation of Delta Wetlands Proposed Fish Screens, Siphons and Pumping Stations—Draft Report. December 2001. *(prepared by URS Corporation and CH2M Hill for DWR)* • In-Delta Storage Program Risk Analysis—Final Draft Report. December 2001. *(prepared by URS Corporation for Bureau of Reclamation and DWR)*
2002 In-Delta Storage Program Reports
• Draft Report on Economic Analysis. May 2002. • Draft Report on Engineering Investigations. May 2002. • Draft Report on Environmental Evaluations. May 2002. • Draft Report on Operation Studies. May 2002. • Draft Report on Water Quality Investigations. May 2002. • Draft Summary Report. May 2002. • Synthesis of Data for Development of Reservoir Island Organic Carbon Model in DSM2—Technical Report. May 2002. *(prepared by Marvin Jung for DWR)* • Draft Water Quality Modeling Technical Appendix. May 2002.
2003 In-Delta Storage Program State Feasibility Study Reports
• Draft Engineering Investigations. July 2003. • Draft Environmental Evaluations. July 2003. • Draft Report on Operations. July 2003. • Draft Report on Operations. December 2003. • Draft Report on Water Quality. July 2003. • Draft Report on Water Quality. December 2003.

- Results of Geologic Exploration Program. January 2003.
- Reservoir Stratification Study—Final Report. July 23, 2003. *(prepared by Flow Science Incorporated for DWR)*
- Results of Laboratory Testing-Geologic. January 2003.
- Borrow Area Geotechnical Report—Draft. April 2003. *(prepared by URS for DWR)*
- Integrated Facilities Engineering Design and Analysis—Draft. July 2003.
- Integrated Facility Structures Construction Cost Estimate—Draft Report. June 2003. *(prepared by CH2M Hill for DWR)*
- Flooding Analysis—Draft Report. June 2003. *(prepared by URS for DWR)*
- Embankment Design Analysis—Draft Report. June 2003. *(prepared by URS for DWR)*
- Earthwork Construction Cost Estimate —Draft Report. June 2003. *(prepared by URS for DWR)*
- Risk Analysis. June 2003. *(prepared by URS for DWR)*

2004 In-Delta Storage Program State Feasibility Study Reports

- Draft Report on Economic Analysis. January 2004.
- Draft Executive Summary. January 2004.
- Draft Summary Report. January 2004.
- Piezometer Installation Report. July 2004. *(prepared by Lowney Associates for DWR)*
- California Bay-Delta Authority In-Delta Storage Program State Feasibility Study—Public Comment Letters

2005 In-Delta Storage Program State Feasibility Study Reports

- Review of Delta Wetlands Water Quality: Release and Generation of Dissolved Organic Carbon from Flooded Peatlands—Final Report. *(prepared by K. Reddy for DWR)*
- Risk Analysis—Draft Report. May 2005. *(prepared by URS for DWR)*
- Integrated Facilities Supplemental Structural Engineering Design and Analysis—Draft Report. May 2005. *(prepared by URS for DWR)*
- Proposed Integrated Facility at Webb Tract Supplemental Geotechnical Exploration—Draft Report. April 2005. *(prepared by URS for DWR)*
- Groundwater Monitoring Jones Tract Flood Sacramento-San Joaquin Delta, California. April 2005. (*prepared by Hultgren-Tillis Engineers for DWR)*

2006 In-Delta Storage Program State Feasibility Study Reports

- 2006 Supplemental Report to 2004 Draft State Feasibility Study In-Delta Storage Project. May 2006.

The DWR operations studies generally confirmed the results from the 1995 DEIR/EIS and the 2000 RDEIR/EIS, suggesting that the in-Delta storage would be filled in about 75% of the years, and this water would be able to be exported in many years with a delivery deficit. The DWR studies allowed water to remain in storage if there was not sufficient excess pumping capacity or unmet water demand in a given year. The DWR studies did not need to identify specific SWP contractors as the place of use because the SWP operates to supply all contractors equally. Their water rights already include all contractors as the place of use.

The DWR studies evaluated many different types of operations and delivery targets, including several that would increase Delta outflow at times for water quality (salinity control), and for EWA purposes to make-up for reduced export pumping for fish protection. The use of the stored water easily could be shifted from year to year as conditions changed, but the general ability to capture the full in-Delta storage volume in about 75% of the years was confirmed.

DWR found that in-Delta storage would allow several short-term SWP and CVP re-operation improvements. Upstream reservoir releases that were made for upstream fisheries benefits that were greater than exports and required outflow could be temporarily stored in the in-Delta reservoirs and then exported when conditions allowed. These integrated operations increase the potential value of in-Delta storage, but are not evaluated in the Place of Use EIR.

DWR evaluated several different assumptions about DOC release rates, and the allowed discharge rates depending on the in-Delta storage DOC concentrations. These operations are reviewed in Section 4.2, Water Quality.

Public Policy Institute of California Reports

Since the 2000 FEIR, Public Policy Institute of California (PPIC) has issued two reports that compile and address new information relevant to the Delta and the Project description. *Envisioning Futures for the Sacramento–San Joaquin Delta*, released in February 2007 (Lund 2007), and *Comparing Futures for the Sacramento–San Joaquin Delta*, released in July 2008 (Public Policy Institute of California 2008), suggest that many changes in the Delta are inevitable because of seismic risk, peat-soil subsidence and sea-level rise, hydrology changes from climate change, urban development, and ecosystem dynamics (new species of fish and invertebrates and plankton). They suggest that planning to accommodate these future changes should be a state priority. In the first report, a wide range of alternatives is described. However, in the second report they conclude that a peripheral canal is likely the best long-term solution for water supply reliability and ecosystem stability.

Envisioning Futures examines nine Delta alternatives, concluding that only five should be considered economically and environmentally feasible: three “Fluctuating Delta” alternatives, in which environmental conditions, especially salinity, would be allowed to fluctuate in the western Delta to improve habitat conditions for native fish species; and two “Reduced-Exports” alternatives, which would necessitate significant modification of the pattern and quantity of Delta water exports. One such Reduced Export model, titled “Opportunistic Delta,” allows opportunistic seasonal exports during times of high discharge of fresh water from the Delta (generally winter and spring) and the building of additional surface storage within the Delta to divert and store water during these periods of high outflow.

Both PPIC Delta reports acknowledge that in-Delta storage may be one of the future uses for the relatively deep central Delta islands. They suggest that levee maintenance and repair costs exceed the benefits of the existing agricultural uses. Both documents and extensive technical appendices for *Comparing Futures* are available from the PPIC website:

<http://www.ppic.org/main/home.asp>.

Delta Vision and Strategic Plan

The Delta Vision policy initiative was created by Governor Arnold Schwarzenegger in September 2006, to find a durable vision and strategic plan for sustainable management of the Delta. Delta Vision is designed to coordinate and build on the many ongoing but separate Delta planning efforts, while assessing the risks and consequences to the Delta's many uses and resources in light of changing climatic, hydrologic, environmental, seismic, and land use conditions. Ultimately, Delta Vision seeks sustainable management of the Delta over the long term, broadening the focus of past Delta efforts to recommend actions that will address the full array of natural resource, infrastructure, land use, recreation, and governance issues necessary to achieve a sustainable Delta.

The California Blue Ribbon Task Force was appointed by the Governor in February 2007 and charged with the goal of:

> ...managing the Delta over the long term to restore and maintain identified functions and values that are determined to be important to the environmental quality of the Delta and the economic and social well being of the people of the state.

The Task Force issued its report, *Delta Vision: Our Vision for the California Delta*, in December 2007, recommending, in small part, that new storage facilities for surface water or groundwater should capture water when and where it would be least damaging to the environment. A stakeholder group also was appointed by the Governor to provide input and feedback to the task force. The task force produced the *Final Delta Vision Strategic Plan* in October 2008, which includes seven major goals, with 22 basic strategies, and several recommendations for accomplishing each strategy and goal. In-Delta storage was fully described in some of the stakeholder group's suggested strategies and was identified as a possible component of the future Delta in the vision document. However, no specific new information about Delta conditions or changes that would affect the Project description was given in *Our Vision* or *Strategic Plan* documents.

The Delta Vision process and documents are thoroughly documented on the website:

> <http://deltavision.ca.gov>.

Delta Water Legislative Package

As a result of the Delta Vision process, California lawmakers passed a package of legislation addressing many of California's water supply-related challenges. Among the bills in the package is Senate Bill (SB) 1, designed to carry out the Delta Vision strategic plan, and to legally acknowledge the co-equal goals of restoring the Delta ecosystem and creating a more reliable water supply for California.

SB 1 creates new policies, programs and governance for the Delta. Among its primary elements is creation of the Delta Stewardship Council, which is tasked with developing and implementing the Delta Plan to guide state and local actions in the Delta. SB 1 also gives the Delta Stewardship Council jurisdiction to review state or local agencies' projects in the Delta to determine consistency with the Delta Plan. The Council also acts as the appellate body in the event of a claim that such a project is inconsistent with the co-equal goals.

The Delta Water legislative package, and extensive Delta Stewardship Council information, are available on the website:

<http://deltacouncil.ca.gov>.

Bay Delta Conservation Plan

The purpose of the BDCP is to provide for the recovery of Endangered and sensitive species and their habitats in the Delta in a way that also will provide for reliable water supplies from the Delta. The BDCP planning and evaluation process will identify and recommend conservation strategies to improve the overall ecological health of the Delta.

The draft conservation strategy was released for public review and comment in August 2009. The BDCP draft conservation strategy emphasizes Delta water conveyance improvements (north-of-Delta isolated conveyance facility or "dual conveyance" that includes an isolated facility with improvements to existing through-Delta conveyance) and habitat restoration. The Project water storage and habitat restoration are not included in but are consistent with the draft conservation strategy. The available documentation and summary of deliberations are available on the BDCP website:

<http://baydeltaconservationplan.com/default.aspx>.

Future Circumstances in the Delta

Each of these recent or ongoing Delta planning studies (PPIC, Delta Vision, and BDCP) has suggested that changes should be expected in the Delta ecosystem, infrastructure, and water supply operations. The Project generally fits into this future Delta with a variety of contributions. The 21,000 acres in the central Delta would be transformed according to a very well-planned, specific, and fully evaluated plan. The Project would dramatically increase the managed wetlands, riparian, and upland vegetated habitats and dedicate much of the existing agriculture lands on Bouldin Island and Holland Tract to wildlife-friendly (i.e., partial harvest) agricultural production and wetlands habitat.

The levee maintenance on the Habitat Islands and strengthening of the interior portions of the Reservoir Island levees would reduce the risk of failure on these 56 miles of levee. In most years, the diversion and storage of water would increase the water supply by a substantial amount (about 100 taf) without major environmental impacts from the screened diversions and summer-fall export pumping.

The Project will have the potential to contribute multiple benefits for the Delta environment, water quality, and water supply, regardless of what future Delta conditions may be implemented. However, the possibility that the Project could become part of the CVP/SWP facilities with integrated operations is not proposed as part of the Project and is not described or evaluated. This Place of Use EIR evaluates the Project only as an independent facility with no effects or interference with the CVP and SWP operations, as discussed more fully in Chapter 3, "Project Operations."

Chapter 3
Project Operations

Introduction

The Project would provide new water storage facilities in the central Delta (in-Delta storage) that would be used to increase the available water supply from the Delta in most years. Water would be diverted onto Webb Tract and Bacon Island Reservoir Islands (Project Reservoir Islands) during high-flow periods (i.e., excess Delta outflow), typically in the winter months of December–March. Project storage water would be discharged into Franks Tract (from Webb Tract) or Old River and Middle River channels (from Bacon Island) for export when excess CVP or SWP pumping capacity is available, typically in the summer and fall months of July–November. Project storage water could be discharged to increase Delta outflow for improved water quality (i.e., reduced salinity) or estuarine habitat improvements in the fall months of September–November.

Project operations are the water diversions, storage, and discharges for export or for increased Delta outflow. Project operations begin with the diversion of excess Delta outflow to the Project Reservoir Islands. The full storage capacity of Webb Tract (100 thousand acre-feet [taf]) and Bacon Island (115 taf) can be filled in about 1 month with screened diversions of about 3,500 cubic feet per second (cfs). During the summer or fall months, Project water would be discharged for export. Some of the Project water would be exported and delivered directly to designated places of use. Other Project water would be exported and transferred to groundwater banks within Semitropic and to the Antelope Valley Water Bank, with subsequent delivery to the designated places of use in dry years. Some Project storage water may be released in the fall months to increase Delta outflow and thereby reduce salinity intrusion and improve the water quality of CCWD diversions and CVP and SWP exports.

Project operations were simulated with a monthly spreadsheet model, developed by MBK Engineers (MBK), for this Place of Use EIR. The Project operations model is called In-Delta Storage Model (IDSM). The model formulations and assumptions are described in Appendix B, "Delta Wetlands Project In-Delta Storage Model." The Project operations model begins with the results from a selected CALSIM baseline simulation. The 1922–2003 rainfall and runoff record used for the CALSIM baseline represents the existing hydrologic conditions (i.e., sequence) for this water supply and Project operations evaluation. The CALSIM model simulates the operation of the existing CVP and SWP reservoirs to meet the water supply demands in the CVP and SWP service areas.

This chapter describes the latest monthly CALSIM modeling of the existing CVP and SWP upstream reservoirs and existing Delta operations governed by State Water Board Water Right Decision 1641 (D-1641), and describes the most likely pattern of Project diversions to storage and subsequent discharges from storage for export or outflow augmentation. The delivery patterns to the designated places of beneficial water uses, and the intermediate storage in the designated groundwater banks, are fully disclosed and evaluated.

The Project operations described in this chapter and subsequently evaluated in water quality and fish impact sections are based on D-1641 objectives without reverse Old and Middle River (OMR) flow restrictions, in order to evaluate the maximum possible Project diversions and exports. If the restrictions on reverse OMR flows also are applied to the Project operations, the Project's effects on fish, water quality, and hydrodynamics likely would be reduced compared to the simulated operations under D-1641.

Changes from the existing Delta flow conditions caused by the Project operations are described in this chapter. Project diversions to storage would cause reductions in outflow; the export of stored Project water would cause increased reverse OMR flows and increased SWP exports to the designated places of use or to the groundwater banks; and Project discharges for salinity management or estuarine habitat would cause increased Delta outflow.

Review of 1995 DEIR/EIS and 2000 RDEIR/EIS Project Operations

The State Water Board and Corps joint evaluation of the Project was described in the 1995 DEIR/EIS. The simulations of the Project operations using the monthly DeltaSOS model from 1995 were changed for the 2000 RDEIR/EIS to reflect slightly different existing conditions results for the CVP-SWP operations model (DWRSIM) and to restrict Project deliveries to the delivery deficits calculated in DWRSIM. The Project was evaluated under the same D-1641 objectives with the same basic Project storage and discharge rules (Final Operations Criteria [FOC]) as are currently proposed and simulated with the IDSM. A review of these 1995 and 2000 Project simulations is useful for identifying changes since the 2001 FEIR and 2001 FEIS.

A relatively small change from the 1995 and 2000 modeling is the assumed Bacon Island and Webb Tract storage volumes. The maximum assumed Project storage volume in the 1995 and 2000 simulations was 238 taf (at elevation of +6 feet msl), about 23 taf more than the current maximum storage of 215 taf (at elevation of +4 feet msl). This 10% reduction would cause a 10% reduction in the average Project diversion volume, but may not reduce the average Project discharge for export, if the exports are constrained by unused pumping and delivery deficits in the designated places of use.

The major differences in the Project operations simulated with the IDSM from the 1995 and 2000 DeltaSOS modeling are the specified monthly delivery of some exported Project water to designated places of beneficial uses and the transfer of some exported Project water to identified groundwater banks, for subsequent pumping and delivery to the designated places of beneficial uses in later years with delivery deficits (unmet demands). The 1995 Project simulations with the DeltaSOS model assumed that any exported Project water would be used by unidentified CVP or SWP contractors. The 2000 Project simulations restricted Project deliveries to the monthly CVP and SWP delivery deficits but did not designate specific contractors within the general CVP and SWP places of use. The previous modeling did not track delivery deficits in the designated places of use, did not simulate intermediate storage in groundwater banks, and did not check for physical capacity along the aqueducts for Project deliveries. The IDSM Project simulations do account for each of these important water supply factors. The IDSM model also simulates Project releases in the fall to increase Delta outflow for salinity reduction and estuarine habitat improvement.

The Project diversion criteria in the 1995 simulations included all of the D-1641 objectives (from the 1995 WQCP) to not interfere with CVP and SWP operations, and added some specific objectives to reduce potential impacts on fish habitat (X2) and water quality (outflow). These diversion criteria were modified for the 2000 simulations to reflect the FOC. Both simulations limited Project diversions to the months of September–March when the X2 position was downstream of Collinsville (81 km) and the 2000 simulations did not allow Project diversions until the X2 position had been downstream of Chipps Island (75 km) for at least 10 days. The Project diversions were limited to a fraction of the surplus outflow (i.e., above minimum outflow and within export/import [E/I] ratio) and to a fraction (25%) of the existing outflow. The X2 position could not be shifted upstream more than 2.5 km. The diversion flow would be limited further (50%) if the Fall Mid-Water Trawl (FMWT) index of delta smelt abundance was low (less than 239).

The 1995 and 2000 Project discharge criteria (i.e., FOC) limited Project discharge for export to a percentage (75%) of the available unused export capacity (11,280 cfs maximum capacity in most months) in order to reserve some export capacity for other water transfers. Webb Tract discharges for export were not allowed from January through June, and Bacon Island discharges for export were limited from April through June to 50% of the San Joaquin River flow. The Project discharges for export simulated in 1995 with the DeltaSOS model were predominantly in the months of February–March and in the months of June–July.

The Project diversions simulated in 1995 with the DeltaSOS model occurred predominantly in the months of October–February. The average annual simulated Project diversion volume was 225 taf/yr for Alternative 2 (the Proposed Project). The 1995 DeltaSOS model did not limit the exports of Project water to the unmet CVP and SWP water demands, so there were some years with a simulated filling in the fall, simulated discharge for exports in February, refilling in March, and discharge for exports in the summer (i.e., double-filling). This maximum Project export assumption resulted in an average Project discharge for export of 202 taf/yr.

The 2000 DeltaSOS model incorporated the FOC and limited the Project deliveries to the CVP and SWP delivery deficits. The 2000 Project simulations with this limited delivery resulted in an average diversion volume of 144 taf/yr with an average Project discharge for export of 114 taf/yr. Because of limited demands for Project water in wet years, Project carryover storage was more than 50 taf in 16 of the 73 years (20% of years).

The major weakness with the 1995 Project simulation with the DeltaSOS model was that exports were not constrained by demand or conveyance capacity; Project exports were simulated in some very wet years when there would not likely have been actual need for the water supply. The 2000 Project simulations were limited to the delivery deficits, and allowed water to remain in storage until there was a demand and unused export capacity. However, the 2000 Project modeling did not include a groundwater bank and did not designate places of use within the CVP and SWP delivery areas. The IDSM accounts for the actual unmet water demands for specified SWP contractors, and allows some Project water to be exported to the Semitropic and Antelope Valley groundwater banks for intermediate storage until delivery in a subsequent dry year to designated SWP contractors.

The assumed existing conditions for Project monthly agricultural diversions and the assumed Habitat Island diversions remain the same as simulated in 1995 and 2000. Project implementation would cause a decrease in the existing agricultural diversions to the Project islands (17,000 irrigated acres), representing about 5% of the Delta lowlands irrigated acreage (340,000 acres). The existing agricultural diversions to the Project islands for summer irrigation and winter salt leaching are about 60 taf/yr. The Habitat Island diversions would be about 20 taf/yr.

Hydrodynamics

The 1995 DEIR/EIS included a chapter on Hydrodynamics. The Resources Management Associates (RMA) model of Delta tidal hydrodynamics and water quality (salinity) was used to simulate the effects of project operations on the channel flows and salinity movement and distribution within the Delta. The general results showed that the tidal hydraulics within the Delta are the result of the basin channel geometry and connections, as well as the tidal elevations and tidal flows at the downstream boundary (Martinez). The river inflows and the SWP and CVP exports will change the net flows within each Delta channel, but these net flows are generally superimposed on the relatively steady tidal fluctuations of elevation and velocities within each channel. Because the Delta channel geometry is the same as analyzed in the 1995 DEIR/EIS, and because the Project facilities are very similar (same diversion and discharge capacities), the tidal hydrodynamics were not simulated with a Delta tidal model for this Place of Use EIR.

Similarly, the Delta hydrodynamics model was used in the 1995 DEIR/EIS to establish the quantitative effects of Project operations on Delta outflow and the corresponding changes in salinity intrusion and export salinity. These potential effects are greatly reduced because of modifications in Project operations that will be fully described in this Chapter. The salinity effects from the Project are fully described in Section 4.2, Water Quality.

The hydrodynamic impacts evaluated in the 1995 DEIR/EIS are:

- Impact B-1 Hydrodynamic Effects on Local Channel Velocities and Elevations during Maximum Project Diversions. Less than significant.
- Impact B-2. Hydrodynamic Effects on Local Channel Velocities and Elevations during Maximum Project Discharges. Less than significant.
- Impact B-3. Hydrodynamic Effects on Net Channel Flows. Less than significant.

The hydrodynamic impact assessment methods remain valid and no new Delta hydrodynamic modeling was done for this Place of Use EIR. The maximum daily combined diversion rate for the two reservoir islands has been reduced from 9,000 cfs to 6,000 cfs, and the maximum daily discharge rate from the two reservoir islands has been reduced from 6,000 cfs to 4,000 cfs. Therefore, the maximum hydrodynamic effects on the local channel velocities, elevations, and net flows are considerably less than simulated in the 1995 DEIR/EIS.

New Information about Project Operations

The 2000 Record of Decision (ROD) for the CALFED Bay-Delta Program (CALFED) directed DWR and Reclamation to study five surface storage proposals, including an in-Delta storage project that followed the Project applicant's proposal for Bacon Island and Webb Tract. DWR completed an initial evaluation in May 2002, reporting that the in-Delta project was feasible but would require additional study to evaluate fully. DWR completed these evaluations in the 2004 Draft State Feasibility Study (California Department of Water Resources 2004). Public review of these studies led to further modeling and investigations that were reported in the 2006 Supplemental Report (California Department of Water Resources 2006). The list of reports done on separate topics concerning in-Delta storage is very extensive. These reports are available on the DWR website at:

<http://www.water.ca.gov/storage/indelta/index.cfm>.

Several of the DWR studies of in-Delta storage were modeling evaluations of the potential future operations and water supply or environmental water releases that the in-Delta storage might provide if integrated with CVP and SWP facilities and operations. However, this Place of Use EIR evaluates the Project only as an independent facility with no effects of or interference with the CVP and SWP operations.

Simulation of Project Operations

The Project water right decision, D-1643, includes several restrictions on the monthly Project diversions and discharges for export pumping. These provisions, called FOC, were developed in 1997 during consultation with USFWS, NMFS, and DFG for the Project BOs (for Project compliance with the federal and state Endangered Species Acts). An overall limit of 250 taf per water year was placed on the Project exports. This eliminated the occasional filling, discharging, and refilling potential that was simulated in the 1995 DEIR/EIS evaluation. Not all FOC terms can be modeled; however, all FOC will be complied with in real-time daily operations. This Place of Use EIR simulates the FOC using CALSIM-derived monthly Delta flows and simulating Project diversions in the December–March period and Project discharges for export in the July–November period.

Additional restrictions to protect the water quality of Delta exports and diversions of municipal water supplies were required in the 2000 Water Quality Management Plan (WQMP) (The WQMP is described in more detail in Chapter 2, “Project Description” and Section 4.2, Water Quality). The provisions of the WQMP were included qualitatively in the 2001 FEIR and 2001 FEIS, but the effects of the monitoring, modeling comparisons, and potential Project discharge restrictions were not included in the monthly Project operations modeling. Therefore, the major provisions in the FOC and WQMP are summarized here to describe the linkage between these fish and water quality protective measures and the revised Project operations evaluated in this Place of Use EIR.

The simulated Project operations are simplified compared to the D-1643 criteria, so some of the adaptive management rules in the FOC may no longer be needed. There are a few Project operating criteria in D-1643 (adopted in 2001) that might be revised to allow Project diversions to be increased in moderate flow years, when capturing the additional water supply would have the greatest value. Possible modifications in the Project FOC are described here with some rationale for the proposed changes.

The Project diversions (fish-screened) to storage typically would occur during the 4-month period of December–March. Outflow would remain above 11,400 cfs to position X2 downstream of Chipps Island. The Project discharges for increased exports (i.e., water transfer) typically would occur during the 3-month period of July–September that is identified in the OCAP Biological Assessment (BA) and briefly evaluated in the USFWS BO for delta smelt as the water transfer window when salvage of Chinook salmon, steelhead, delta smelt, and other fish of interest generally would be low. Some discharge for export to the groundwater banks would occur in the September–November period.

The State Water Board will revise or issue Project water rights that will include the actual criteria and objectives for controlling the Project operations in the Delta and for conveyance (pumping) and groundwater storage and place of use deliveries.

Final Operating Criteria Diversion Measures

Measure 1 limits September–November diversions unless X2 is located downstream of Chipps Island (75 km), which requires an outflow greater than 11,400 cfs. September–November diversions are not simulated because the Delta outflow is rarely greater than 11,400 cfs in these months.

Measure 2 limits September–March diversions unless X2 is downstream of Collinsville (outflow > 7,100 cfs), and downstream of Montezuma Slough (outflow >8,000 cfs) if the FMWT delta smelt index is less than 239. The FMWT delta smelt index cannot be simulated. The Place of Use EIR simulation allows Project diversions only if X2 is downstream of Chipps Island (outflow > 11,400 cfs).

Measure 3 limits the upstream shift of X2 to less than 2.5 km. Because of the logarithmic effect of outflow on X2, this is equivalent to about 25% of the outflow.

Measure 4 eliminates Project diversions in April or May for fish protection, and eliminates diversions from Feb 15 to March 31 if the previous FMWT delta smelt abundance is less than 239. The FMWT provision will need to be reviewed during re-consultation for updated Project BOs from USFWS, NMFS, and DFG to be more consistent with the current Delta operations specified in the OCAP BOs.

Measure 5 limits the Project diversions to a monthly specified fraction of the surplus Delta outflow, calculated using the D-1641 required outflow and E/I objectives. The specified fraction is 90% for December and January, 75% in February, and 50% in March. A monthly average of 3,500 cfs would fill the Project storage capacity. With full CVP and SWP permitted pumping of about 11,280 cfs, filling of the Project would occur when Delta inflow was greater than about 30,000 cfs for 65% E/I months (December–January) and when inflow was greater than 52,500 cfs for 35% E/I months (February and March). The outflow would remain above 11,400 cfs for the 65% E/I months and above 34,000 cfs for the 35% E/I months. These Project operations criteria are more restrictive than the E/I ratio itself, and could be reviewed during re-consultation.

Measure 6 limits the Project diversions to a specified monthly fraction of the outflow (without the Project diversions). The fraction in December is 25% and the fraction in January–March is 15%. This measure would limit the Project diversions whenever Delta outflow was less than about 25,000 cfs.

Measure 7 limits the Project diversions for 15–30 days as selected by fish agencies to a specified fraction of the San Joaquin River inflow to protect delta smelt spawning and rearing in the south Delta. This measure may be reviewed during re-consultation to be more consistent with the current Delta operations specified in the OCAP BOs from USFWS and NMFS.

Measure 8 requires a fish monitoring program during the diversion period. If delta smelt are detected nearby, the Project diversions must be reduced by half until no delta smelt are detected. This requirement will be complied with in real-time daily operations but cannot be simulated. The fish monitoring provisions may be reviewed during re-consultation.

Measure 9 limits the Project diversions in November–January when the Delta Cross Channel gates are closed for fish protection (Chinook). This measure reduces the daily diversion to 3,000 cfs when total inflow is less than 30,000 cfs, and to 4,000 cfs when total inflow is less than 50,000 cfs. This is a moderate restriction on the Project diversions which would already be limited by the E/I ratio and allowable SWP and CVP exports. This measure may be reviewed during re-consultation for updated BOs.

Measure 10 allows specified monthly diversions to match evaporation losses on the Reservoir Islands from June through October. These diversion values are similar to existing agricultural diversions.

Most of these FOC diversion restrictions are satisfied with the Place of Use EIR simulated monthly operations that allow diversions in December–March with a minimum Delta outflow of 11,400 cfs, and the Project diversions would be treated as exports within the maximum D-1641 E/I ratio. These criteria would minimize entrainment impacts and provide low–electrical conductivity (EC) storage water (See Section 4.2, Water Quality). The FOC could be modified to match the monthly diversion rules simulated with IDSM.

FOC Discharge Measures

Measure 1 limits Bacon Island discharges to 50% of the San Joaquin River flow from April through June. The Place of Use EIR assumes Project discharges for export will occur July–November.

Measure 2 does not allow Webb Tract discharges from January–June.

Measure 3 does not allow Habitat Island discharges to be exported.

Measure 4 limits Project discharges in July to 75% of the unused permitted export capacity. This was not simulated for the Place of Use EIR to allow maximum possible Project exports to designated places of use or the groundwater banks.

Measure 5 allocates some Project storage water to be used for increased Delta outflow to improve estuarine habitat. However, this was assumed to be about 10% (20% if FMWT index <239) of the discharges for export made from December–June. The Place of Use EIR simulated operations assumed discharges will occur July–November, but simulated releases (1,000 cfs) for Delta outflow in the fall of some years when export capacity was not available if water was available in storage and Delta salinity was high (e.g., chloride of 125 milligrams per liter [mg/l] at CCWD). This measure may be reviewed during re-consultation.

Measure 6 requires a fish monitoring program during the discharge period. If delta smelt are detected in Old River or Middle River, the Project discharges must be reduced by half until no delta smelt are detected. This requirement will be complied with in real-time daily operations but cannot be simulated. Delta smelt are not expected to be detected in the vicinity of the Project in the July–November period.

The Project discharges for increased export are assumed to be a water transfer from within the Delta and not subject to the 65% E/I export limits. Project exports for delivery to designated places of use or to the groundwater banks should be possible unless the CVP and SWP pumping is already near permitted capacity.

Water Quality Management Plan Measures

The WQMP was developed during the 2000 water rights hearing as part of a protest dismissal agreement with CCWD and CUWA. The major provisions of the WQMP address salinity and dissolved organic carbon (DOC) concentrations at the exports and municipal diversions. A key principle of the WQMP is that "Project operations will minimize and mitigate any degradation in the quality of drinking water supplies." The WQMP requires the establishment of a water quality management board to review, approve, and implement the annual water quality operating plan. The operating plan will establish maximum storage concentration for salinity (total dissolved solids [TDS]), chloride, bromide, and total organic carbon (TOC). Measures to control impacts on exports and diversions will be established and implemented when the Project storage concentrations approach these maximum allowable concentrations. These measures generally involve adjusting discharges for export or releasing storage water during periods of high outflow to minimize potential impacts on exports and diversion water quality.

A monitoring program will be established to support and implement the WQMP. Available California Data Exchange Center (CDEC) data will be incorporated into the water quality monitoring and reporting program to implement the water quality control measures. Hydrodynamic and water tracking models will be used to calculate the effects of the Project discharges on water quality at municipal water intakes. The WQMP covers short-term impacts as well as a long-term accounting of the effects of Project operations on export and diversion water quality.

Short-term impacts will be minimized using operational criteria. A short-term impact is defined by the WQMP as any adverse health effects, contribution to any non-compliance with drinking water regulations, and any increase in treatment or operation cost caused by increased concentrations of TOC or salinity. The Project operations criteria are established for TOC, bromide, and chloride based on existing DBP regulations. These criteria do not necessarily limit the Project discharges, if the treatment plant operators agree that the additional water supply or other benefit of the Project discharges would compensate for the increased treatment expenses. Not all WQMP measures can be modeled; however, all WQMP terms will be complied with in real-time daily operations. The specific operational criteria are described in Section 4.2, Water Quality.

In-Delta Storage Model

The primary source of new information to describe the likely Project operations was a monthly water supply model prepared by MBK (Appendix B). This model uses the results from the CALSIM monthly model with the existing level of development (2005) for facilities and water demands to describe existing Delta conditions without the Project. The Project operations were simulated with the spreadsheet model, and the Project diversions to storage and the Project releases for increased export or for increased Delta outflow were simulated and summarized in tables and graphs.

This MBK model supersedes DeltaSOS, which was the monthly spreadsheet model of 1922–1991 operations used for the 1995 DEIR/EIS. This new MBK model of the monthly Project operations, called IDSM (In-Delta Storage Model), is the major source of information for the changes in Delta water management that would result from the Project operations. The IDSM includes the Project diversions to storage, releases for export, conveyance to places of use, and conveyance to the groundwater storage banks located along the California Aqueduct for supplemental storage of Project water until needed at the designated places of use.

The IDSM simulates the diversion of excess Delta outflow to the Project storage islands in the winter months of December–March, and the discharge of Project water for increased export in the summer and fall months of July–November. The IDSM has the ability to simulate some Project water being delivered directly to designated places of use in some years and some Project water being stored in groundwater banks until needed in the designated places of use. The IDSM also simulates the discharge of some Project water to increase Delta outflow for salinity management and estuarine habitat in the fall months of some years.

Project Simulation

The 1995 DEIR/EIS analyzed three project alternatives compared to an existing conditions (No-Project) baseline. Alternatives 1 and 2 both consisted of water storage on two Reservoir Islands and implementation of an HMP on two Habitat Islands. The only difference between the two alternatives was the assumed operational criteria for the discharge of stored water. Under Alternative 3, all four Project islands would be used as reservoirs and only limited compensation wetland habitat would be provided on a portion of Bouldin Island (north of SR 12). Alternative 3 would be inconsistent with the Project BOs and FOC.

Alternative 2, with the highest amount of discharge for export pumping and delivery to designated places of use, would have the maximum potential effects on water quality, hydrodynamics, and fisheries associated with Project diversions and discharges. Alternative 2 was therefore used to represent the proposed Project operations in the 1997 BA for fish species. The terms and conditions of the DFG, USFWS, and NMFS BOs were based on Alternative 2 operations. This Place of Use EIR simulates the Proposed Project, which is Alternative 2 as amended by the inclusion of the FOC, as discussed in Chapter 2. The simulation of the Proposed Project encompasses the full range of impacts associated with Alternatives 1 and 2. Alternative 3 is not simulated in this Place of Use EIR because the impacts would be consistent with the 2001 FEIR and 2001 FEIS conclusions and because Alternative 3 would be inconsistent with the BOs and FOC.

Several monthly modeling assumptions are used that may not apply in actual, real-time daily Project operations. The actual Project operations will follow the specified conditions in the water rights, the WQMP, and the revised BOs from DFG, USFWS, and NMFS. The monthly modeling of the Project is adequate for evaluating the general frequency and magnitude of the likely environmental impacts resulting from the operation of the Project in the Delta, in comparison with the existing CVP and SWP operations under D-1641.

It is likely that the future Delta configuration and/or operating criteria may be changed with the BDCP or other Delta fish protection and habitat restoration efforts (See Chapter 5, “Cumulative Impacts”). The basic FOC and WQMP rules and objectives for the Project operation are likely to remain similar and could allow the Project to operate in a comparable fashion to that described and evaluated under the existing D-1641 objectives. Therefore, the future water quality and fish impacts are expected to be similar in magnitude to those described for the simulated monthly Project operations evaluated in this Place of Use EIR in Section 4.2, Water Quality, and Section 4.5, Fish.

Central Valley Project and State Water Project Existing Conditions

The CALSIM simulation of existing conditions was used to evaluate the environmental impacts from Project operations as required by CEQA. *Existing conditions* (No-Project Alternative) refers to the current system of CVP and SWP reservoirs with the current flood control storage and minimum outflow constraints, current CVP and SWP water supply demands, and current Delta water quality objectives and constraints as required under the State Water Board water right decision D-1641. The simulated existing conditions also provide the basis for evaluating the potential Project benefits for increased water supply and Delta salinity and fish habitat improvements.

The CALSIM model simulates the CVP and SWP operations, assuming a repeat of the inflow hydrology (rainfall-runoff) for 1922–2003 (an 82-year sequence) but with existing:

- reservoirs and upstream diversions,
- Delta pumping facilities,
- water demands, and
- regulatory requirements for
  - maximum reservoir flood control storage,
  - minimum reservoir release flows, and
  - Delta flow and water quality (i.e., salinity) objectives.

This section presents the water supply conditions in California that are relevant to the potential Project operations. Because the Project would be operated independently of the CVP and SWP, there were assumed to be no changes in upstream reservoir operations and no changes in Delta inflows or CVP and SWP exports caused by Project operations.

The existing Delta flow conditions can be characterized by the monthly inflows, Delta outflow, and the CVP and SWP exports. Various flows within the Delta channels also may be of interest for water quality and fish impact evaluations. The Delta outflow requirements often control (limit) the exports. The CVP and SWP exports sometimes are controlled by the monthly E/I ratio and may be limited by the permitted pumping capacity, available storage in San Luis Reservoir, or monthly water demands. The CALSIM model provides an integrated description of the water management operations that result from these multiple Delta criteria and operational limits. The Project diversions and discharges would not change these CVP and SWP operations and would not affect compliance with the D-1641 objectives.

As was done for the 1995 DEIR/EIS, these simulated Delta flows from the CALSIM model will be compared to the historical Delta inflows and exports that are recorded in the DWR database DAYFLOW. The monthly Delta inflows, outflow, exports, and water deliveries from the most recent years (since the 1995 WQCP objectives) should compare favorably (i.e., match) with the simulated CVP and SWP conditions. This comparison will provide confidence in the simulated CALSIM results that subsequently are used in IDSM to simulate the likely Project operations, for specified monthly Project operating criteria.

The CALSIM model uses a water year framework for simulating CVP and SWP reservoir and Delta operations. The monthly results for Delta inflows, Delta outflow, and the CVP and SWP exports are usually evaluated with a month *x* year format table. The CALSIM results provide the monthly cumulative probability distribution for the Delta inflows and the corresponding allowable exports and outflow. The monthly cumulative distribution will be summarized with the minimum (0%), and the incremental 10% cumulative distribution values to the maximum (100%) and the average value for the 82-year sequence of 1922–

2003. Monthly flows are expected to be higher than the median value in 50% of the years and less than this value in 50% of the years. For some variables, the cumulative distribution from the more recent 41-year sequence of 1963–2003 will be compared. The recent monthly sequences for 1980–2003 are used for the fish entrainment assessment because the CVP and SWP salvage fish density are considered most reliable for this period of the CALSIM simulation.

Sacramento River Flows at Freeport

Table 3-1 gives the CALSIM-simulated monthly cumulative distributions of Sacramento River flows at Freeport for existing conditions for 1922–2003. For example, the simulated minimum October flow was 7,590 cfs, and the simulated median (50%) October flow was 11,720 cfs. The simulated maximum (100% October flow was 36,228 cfs, and the average simulated October flow was 12,149 cfs. The cumulative distribution of the annual (water year) flow volume (taf) is given in the right-hand column. The minimum simulated December flow was 6,703 cfs, the median December flow was 16,785 cfs, and the maximum December flow was 72,281 cfs. The minimum simulated annual Sacramento River flow was 6,252 taf, the median simulated annual flow was 13,931 taf, and the maximum simulated annual flow was 34,969 taf. The Sacramento River channel capacity at Freeport is about 80,000 cfs. At higher Sacramento River flows, water is diverted (spilled) into the Yolo Bypass at the Fremont Weir and at the Sacramento Weir.

The CALSIM-simulated distribution of monthly Sacramento River flows for the recent 1963–2003 period was generally similar, but was higher in some months. The median annual flow was 18,345 taf for the 1963–2003 period compared to 13,931 taf for the full period. The average annual flow was 17,396 taf, compared to an average of 16,201 taf for the full period.

The historical Sacramento River monthly flows for the 1963–2003 period were very similar to the simulated Sacramento River flows for this same period. The median monthly flows were similar, and the median and average annual flows were nearly identical. This indicates that the CALSIM simulations of the upstream reservoirs, with existing reservoir operations and existing upstream diversions, remain similar to the historical conditions for this recent period.

Yolo Bypass Inflows

Because the Project diversions would occur during high-flow periods, the monthly distribution of Yolo Bypass inflows is also of interest. Yolo Bypass flows occur when daily flows at the mouth of the Feather River exceed about 55,000 cfs (because the river elevation exceeds the weir crest). However, there can be flood peaks that exceed this threshold for several days within the month, so there can be some Yolo Bypass monthly flows when the Sacramento River at Freeport monthly flows are above 30,000 cfs.

Table 3-2a gives the CALSIM-simulated monthly cumulative distribution values for the Yolo Bypass flows for 1922–2003. Table 3-2b indicates that Yolo Bypass flows for the second half of the record (1963–2003) were a little higher than for the entire period. Table 3-2c indicates that the historical Yolo Bypass flows for 1963–2003 were a little higher than the simulated values for this period. There were a few years with Yolo Bypass monthly flows of more than 1,000 cfs in October and November and in May and June, but the majority of the Yolo Bypass flows were in the months of December–April. Yolo Bypass flows of more than 4,000 cfs (enough to fill Project storage in a month) were simulated in about 20% of the years for December, about 25% of the years in January, about 30% of the years for February, and about 20% of the years for March. This is a rough indication of the frequency that high runoff from the Sacramento River would occur.

In wet years the Yolo Bypass flows may be high for several months. The cumulative distribution of annual volumes (right-hand column) indicates that the Yolo Bypass flow volume would be greater than 215 taf (Project storage volume) in about 60% of the years. The Yolo Bypass flow volume was simulated to be greater than 1,000 taf in about 40% of the years. This generally indicates that the Sacramento River runoff is high enough to spill into the Yolo Bypass for at least a month, with the most common months being January–March. This is the period when the Project would fill the storage islands.

San Joaquin River Flows at Vernalis

Table 3-3a shows the CALSIM-simulated monthly cumulative distributions of San Joaquin River flows at Vernalis for the 1922–2003 hydrology sequence. Because there are major water supply reservoirs and substantial irrigation diversions on the upper San Joaquin River (Friant Dam), on the Merced River (New Exchequer Dam), on the Tuolumne River (New Don Pedro Dam), and on the Stanislaus River (New Melones Dam), the San Joaquin River flow at Vernalis is highly regulated. The median flows in all months are between about 1,500 cfs and 5,000 cfs. In the summer and fall months of some dry years, the minimum dilution flows needed to meet the D-1641 salinity criteria at Vernalis may require releases from New Melones reservoir. The great majority of the simulated San Joaquin River flows are less than 5,000 cfs, and most summer and fall months have flows of less than 2,000 cfs.

Table 3-3b shows the simulated Vernalis flows for the second half of the simulation period, from 1963 to 2003. The average annual flow volume was 3,470 taf, which is 15% more than the average annual volume of 3,039 taf for the entire 82-year period. Therefore, the average annual San Joaquin River flow volume for the first half of the period was only 2,608 taf (85% of average). Table 3-3c indicates that the historical flows for 1963–2003 were about the same as the simulated flows for this period. The CALSIM-simulated median flows are higher than historical flows for April and May (perhaps because of Vernalis Adaptive Management Plan [VAMP] pulse flows) and lower in January and

February (perhaps because of the increased reservoir storage capacity compared to the historical operations).

Total Delta Inflows

Table 3-4a gives the monthly cumulative distributions of the CALSIM-simulated total Delta inflow for 1922–2003. The total Delta inflows are highly regulated by the upstream reservoirs, so the median monthly flows range from about 15,000 cfs in September–October and November to about 45,000 cfs in February. Table 3-4b gives the CALSIM-simulated monthly flow distributions for the 1963–2003 period. The average annual inflow volume was about 22,000 taf for the 1922–2003 period, but was about 10% higher (24,276 taf) in the second half of the hydrologic sequence. The average annual inflow was therefore about 10% lower than the average in the first half of the period.

Table 3-4c indicates that the historical monthly total inflows were very similar to the simulated monthly total inflows for the 1963–2003 period. The historical average annual inflow was 25,407 taf. The historical and simulated average (and median) monthly flows were very similar for most months. The simulated median flows were about 10% lower than the historical median flows in December–March. The simulated median December total inflow was about 20,000 cfs, the median January flow was about 30,000 cfs, the median February flow was about 42,000 cfs, and the median March inflow was 33,000 cfs.

The total Delta inflow is used in D-1641 to limit the allowable SWP and CVP exports. This objective is referred to as the E/I ratio. Exports cannot exceed 65% of the inflow during the July–January period, and they cannot exceed 35% of the inflow during the February–June period (the February E/I is 45% in some years with January runoff of less than 1 million acre-foot [maf]).

The total Delta inflow is an important flow parameter because it is assumed that the Project diversions to storage also would be limited by the E/I ratio. This allows a minimum monthly inflow for potential Project diversion to be calculated. For example, in December and January with the maximum E/I objective at 65%, the Delta inflow would need to be about 20,000 cfs to allow 11,280 cfs exports and about 23,000 cfs to allow 15,000 cfs exports. Because Project diversions of 4,000 cfs would be allowed (within the E/I objective) only if the outflow was greater than 15,000 cfs, the total Delta inflow would be greater than 30,000 cfs in December or January to allow Project diversions.

For February and March, with the maximum E/I objective at 35%, the total Delta inflow would be greater than 32,000 cfs to allow 11,280 cfs export and greater than 43,000 cfs to allow full capacity exports of 15,000 cfs. Project diversions of 4,000 cfs therefore would be allowed when total Delta inflow was greater than about 55,000 cfs in February or March. The Delta outflow would be greater than 35,000 cfs for full capacity exports of 15,000 cfs.

Table 3-4a gives the percentage of the years with enough total Delta inflow to allow full capacity CVP and SWP exports and also Project diversions of at least 2,000 cfs. For December, the 30,000-cfs threshold for Project diversions is exceeded at the 80% cumulative distribution value. Project diversions would be possible in about 20% of the years in December. The January total Delta inflow is greater than 30,000 cfs in about 50% of the years. For February, the 55,000-cfs threshold for full capacity CVP and SWP exports and Project diversions is exceeded in about 40% of the years. The March total Delta inflow is greater than 55,000 cfs in about 30% of the years. The IDSM uses the CALSIM total Delta inflow to simulate the opportunity for Project diversions, given the specified constraints for monthly required Delta outflow and other specified Project operational parameters.

Delta Channel Depletions

Table 3-5a gives the monthly estimated gross channel depletion flow for irrigation diversions and evaporation used in the DAYFLOW water budget accounting by DWR. The monthly values are assumed to be constant from year to year. The total annual gross depletion attributable to Delta consumptive use is estimated to be 1,684 taf. Table 3-5b gives the monthly cumulative distributions of channel depletion (net) flow for the recent 1963–2003 period from DAYFLOW that accounts for both estimated consumptive use and precipitation. The summer net depletion values are nearly equal to the gross depletion values since rainfall is rare in these months. The average net depletion was about 736 taf.

Table 3-5c gives the monthly cumulative distributions of gross channel depletion flows for the recent 1963–2003 period from CALSIM. The CALSIM model uses variable channel depletions that vary with the estimated weather and soil moisture conditions. The July and August values are lower than the DAYFLOW estimates. The annual gross channel depletion estimate was 1,318 for the 1963–2003 period. This is about 80% of the DAYFLOW estimate. Table 3-5d gives the monthly cumulative distributions of net channel depletion flow (cfs) for the recent 1963–2003 period from CALSIM. The average annual channel depletion is estimated to be 663 taf. The average net channel depletion estimates are similar. The net channel depletions are assumed to be diverted for irrigation of the Delta agricultural lands. These Delta consumptive uses always will be supplied from the total Delta inflow. The Delta outflow will be the total Delta inflow minus the Delta depletions minus the exports.

Central Valley Project and State Water Project Water Demands and Deliveries

Understanding the monthly CVP and SWP water supply demands is important to evaluate the water supply effect from the Project operations because the Project is considered as a supplemental water supply for years when the full CVP and

SWP water demands cannot be delivered with existing facilities and Delta operations.

Central Valley Project Water Supply Demands

South-of-Delta CVP demands include agricultural and municipal needs served from the San Luis Reservoir and San Felipe Unit, the Cross Valley Canal, the DMC and Mendota Pool. These CVP demands also contain exchange contractors, refuge water supplies, and operational losses. The monthly demand patterns are determined based on recent historical CVP deliveries. CVP demands south of the Delta are always set to contract amount and do not vary based on hydrologic conditions in CALSIM. The water supply allocations (i.e., percentage of demand) for each contract year (i.e., March–February) are estimated in the CALSIM model based on reservoir storage and projected hydrologic conditions.

The total CVP water supply demand at the CVP Jones Pumping Plant is about 3,475 taf/yr. This includes 875 taf/yr for the San Joaquin River exchange contractors, about 1,965 taf/yr for agricultural uses, about 150 taf/yr for municipal uses, and about 300 taf/yr for refuges located in the San Joaquin River and Tulare River basins that must be supplied from CVP Jones pumping. The CVP losses to evaporation and canal seepage are assumed to be about 185 taf/yr (about 5% of demands) in the CALSIM model. There is an additional Cross Valley Canal demand of 128 taf/yr that the SWP has agreed to wheel (pump for CVP at the SWP Banks facility) to allow an exchange of CVP Friant water.

Table 3-6a gives the constant monthly CVP demands assumed in the CALSIM model. Because of the recent increases in the wildlife refuges' water supply deliveries and the limited CVP Jones pumping capacity, the CVP rarely can deliver the full south-of-Delta demands. Table 3-6b shows the monthly cumulative CVP delivery volumes (taf) for the simulated 1922–2003 period. The cumulative distribution of CVP annual delivery is given at the right-hand side of the table. Table 3-6c shows the monthly cumulative distribution of CVP agricultural deliveries. The exchange contractors and refuges and municipal supply are given higher allocations, so most of the shortage in CVP deliveries is for the agricultural contractors. The average agricultural delivery was about 1,064 taf/yr compared to the full agricultural demand of about 1,963 taf/yr (55% average allocation).

Figure 3-1 shows the CALSIM-simulated annual CVP deliveries for 1922–2003. The CVP deliveries ranged from a minimum of 1,412 in 1933 to a maximum of 3,334 in 1983. The annual delivery was never as high as the full demands of 3,475 taf. The CVP deliveries were greater than 90% of the demands in eight of the 82 years (10% of the years). The CVP deliveries were greater than 80% of demands in 25 years (30% of the years). The CVP deliveries were less than 50% of demands in eight years (10% of the years). Because of limited Jones pumping capacity and pumping restriction for fish protection in the spring months, it would be difficult to increase these CVP deliveries without wheeling water at the SWP Banks Pumping Plant. The existing conditions CALSIM simulation assumed that the Delta-Mendota Canal/California Aqueduct Intertie (DMC-CA Intertie) was built and operating, allowing full CVP Jones pumping of 4,600 cfs in each month.

Central Valley Project Jones Pumping Plant Capacity

The CVP Jones Pumping Plant has an authorized capacity of 4,600 cfs. This is equivalent to 9,125 acre-feet per day (af/day). Table 3-7 compares the CVP monthly demands to the maximum possible CVP Jones monthly pumping. The full CVP monthly demands usually exceed the CVP monthly pumping capacity in the May–August period. Water must be stored in San Luis Reservoir during the winter period to supply the full CVP demands. If the CVP Jones Pumping Plant were at maximum capacity for the entire year, about 3,330 taf/yr could be delivered from the Delta (about 275 taf each month). This is unlikely to occur, however, because there are required periods for maintenance of the pump units, and the hydrology in the Delta may not allow full pumping every day of the year.

The Central Valley Project Improvement Act (CVPIA) has introduced additional constraints on the CVP Jones pumping capacity. A portion of the Section (b)(2) water that is dedicated to anadromous fish restoration purposes (maximum of 800 taf) normally is allocated by USFWS to reduce CVP Jones pumping during the VAMP period (April 15–May 15), and additional pumping reductions are often applied during the remainder of May and June (normally a 3,000-cfs limit in May and June outside the VAMP period) and at times during fish-sensitive periods in December–March. Therefore, under current regulations, it is difficult for the CVP Jones facility to supply the full CVP demands. During some wet years, flows from the upper San Joaquin River (Friant Dam) and the Kings River can meet San Joaquin River Exchange Contractor demands at Mendota Pool and allow CVP Jones pumping to supply other CVP contractor demands.

Table 3-8a gives the monthly cumulative distribution of CALSIM-simulated CVP Jones pumping for the 1922–2003 hydrologic sequence. CVP Jones pumping is typically near capacity in most months of many years. Pumping often is reduced in April, May, and June for fish protection actions (VAMP and CVPIA [b][2] water). The maximum CVP Jones pumping was only 2,912 taf, considerably less than the full demands of 3,474 taf. Table 3-8b gives the monthly cumulative distribution of CALSIM-simulated CVP Jones pumping for the 1963–2003 hydrologic sequence. CVP Jones pumping was slightly higher in the second half of the record. Table 3-8c gives the monthly cumulative distributions of historical CVP Jones pumping for 1963–2003. The CVP Jones historical pumping was seasonal in the first 5 years because the San Luis Reservoir was not completed and operated for winter storage of CVP water until 1968. The historical CVP pumping has been very similar to the simulated CVP pumping for the past 35 years, with nearly full capacity CVP pumping year-round.

The planned DMC-CA Intertie facility would allow slightly more CVP water to be pumped at the CVP Jones Pumping Plant and pumped at the Intertie Pumping

Plant to the CA in the winter months and stored in CVP San Luis Reservoir until the summer period. Because the CVP Jones Pumping Plant is near capacity in most months of almost every year, there are only limited times when additional water supply from Project storage could be pumped at the CVP Jones Pumping Plant and transferred to CVP contractors.

State Water Project Water Supply Demands

The 29 SWP contractors that divert from the Delta have a combined contract amount (Table A) of 4,133 taf/yr (California Department of Water Resources 2008). This is the maximum future demand that the SWP is obligated to meet. Additional SWP pumping can occur under Article 21 of the contracts (i.e., interruptible water) when there is surplus Delta flow and the SWP portion of San Luis Reservoir is full.

Metropolitan is the largest SWP contractor with a Table A contract amount of about 1,912 taf, nearly half of the combined contract amount. There are 12 other SWP contractors in southern California, with Table A contract amounts that total 580 taf. These SWP deliveries must be pumped over the Tehachapi Mountains at the Edmonston Pumping Plant. The Edmonston Pumping Plant has 14 units that each can pump 320 cfs, for a maximum of 4,480 cfs. However, at least one unit normally is held in reserve, so the maximum annual delivery over the Tehachapi Mountains to southern California contractors is limited to about 3 maf. Delivery of the maximum Table A contract amounts of 2,500 taf would require operating the Edmonston pumping units at about 85% of capacity.

The San Joaquin Valley agricultural contractors have a combined contract amount of about 1.2 maf (the Kern County Water Authority has a maximum Table A contract of 1 maf). The South Bay aqueduct contractors have a total Table A amount of 220 taf. The other SWP contractors have a total Table A amount of about 130 taf; some of this water is pumped at the North Delta Pumping Plant on Barker Slough.

Table 3-9a shows the monthly cumulative distribution of CALSIM-simulated SWP Table A (i.e., firm water) deliveries for the 1922–2003 period. The cumulative distribution of annual SWP Table A delivery is given at the right side of the table. The Table A delivery is the allocated portion of the Table A maximum contract amounts each year. This water is delivered on a monthly pattern that is assumed to shift slightly with water allocation. The Table A deliveries ranged from a minimum of 1,100 taf to a median of 2,750 taf and a maximum of 3,500 taf.

Table 3-9b shows the monthly cumulative distributions of CALSIM-simulated SWP carryover (i.e., Article 56) deliveries for the 1922–2003 period. The CALSIM model simulates some carryover of Table A water in SWP San Luis Reservoir that is delivered in January–March of the next water year. This is a way for SWP contractors to shift deliveries from one year into the next. However, this reduces the deliveries in one year as a hedge (insurance) for the next year's deliveries. The CALSIM model simulated average carryover storage was 243 taf/yr with 60% of the years having more than 200 taf of shifted deliveries.

Table 3-9c shows the monthly cumulative distributions of CALSIM-simulated SWP interruptible (i.e., Article 21) deliveries for the 1922–2003 period. This is water that can be delivered to SWP contractors with local storage facilities (i.e., reservoir or groundwater bank) in months when SWP San Luis Reservoir is full and there is surplus water in the Delta (within the E/I objective). The CALSIM model assumes that relatively high (5,000 cfs) Article 21 deliveries can be made to MWD and other SWP contractors. The Project operations would not interfere with these Article 21 deliveries.

Table 3-9d gives the monthly cumulative distributions of CALSIM-simulated total SWP deliveries for 1922–2003. The monthly distribution of total SWP delivery is seasonal, with highest delivery in summer months and lowest in the winter months. The maximum annual SWP delivery was highest in years with substantial Article 56 carryover and Article 21 interruptible deliveries.

Figure 3-2 shows the CALSIM-simulated annual SWP deliveries for 1922–2003. The total SWP deliveries ranged from 1,229 taf in 1977 to 5,342 taf in 1983. The total SWP delivery was greater than 4,100 taf (full Table A contract amount) in 15 of the 82 simulated years (18% of the years). The total SWP delivery was greater than 90% of the Table A contract amount in 32 years (40% of the years). The total SWP delivery was less than 50% of the Table A contract amount in 12 of the 82 years (15% of years).

State Water Project Banks Pumping Capacity

SWP Banks Pumping Plant has an installed capacity of about 10,668 cfs (two units of 375 cfs, five units of 1,130 cfs, and four units of 1,067 cfs). The SWP water rights for diversions specify a maximum of 10,350 cfs. With full diversion capacity (20,530 af/day) each day of the year, SWP Banks Pumping Plant theoretically could pump about 7,500 taf each year. However, the current permitted Clifton Court Forebay (CCF) diversion capacity of 6,680 cfs would provide a maximum delivery of about 4,836 taf/yr. Additional permitted CCF diversions of one-third of the San Joaquin River at Vernalis are allowed under the current permit rule for a 90-day period from December 15 to March 15, if the Vernalis flow is above 1,000 cfs. The maximum permitted CCF diversions still would be less than 5,000 taf/yr.

The assumed CALSIM monthly Table A SWP demands (estimated from historical delivery patterns) and the permitted SWP Banks pumping capacity are given in Table 3-10. The seasonal SWP demands are highest in the summer months, requiring a portion of the demands to be supplied from San Luis Reservoir storage. San Luis Reservoir releases are also often needed during the spring months of April through June because SWP Banks pumping is limited during April–June by a combination of VAMP export reductions and the 35% maximum export/inflow ratio specified in D-1641 from February through June.

Table 3-11a gives the monthly cumulative distribution of CALSIM-simulated SWP Banks pumping for the 1922–2003 hydrologic sequence. Some of this SWP pumping was CVP water (i.e., wheeled Cross Valley Canal deliveries). There was more variation in the monthly SWP Banks pumping than in the CVP Jones pumping, with lower pumping in drier years and very high pumping (8,500 cfs maximum monthly estimated in CALSIM for January and February) during the winter months with high Delta inflows. Table 3-11b gives the monthly cumulative distribution of CALSIM-simulated SWP Banks pumping for the second half of the period. The simulated pumping was a little higher during this 1963–2003 hydrologic sequence.

Table 3-11c gives the monthly cumulative distribution of the historical SWP Banks pumping for the 1968–2008 hydrologic sequence (most recent 41 years). Although SWP pumping began in 1968, the Banks Pumping Plant was not fully operational (with the last four units) until 1989. Comparison of the recent historical SWP pumping (1995–2008 period with E/I objectives) indicates that the summer maximum pumping in July–September generally has been very high, approaching the 6,680 cfs permitted capacity. The historical SWP Banks pumping was more than 6,000 cfs in July for nine of the last 14 years, was more than 6,000 cfs in August for nine of the last 14 years, and was more than 6,000 cfs in September for five of the last 14 years. The CALSIM-simulated SWP Banks pumping was at capacity during these summer (i.e., water transfer) months in about 50% of the years.

San Luis Reservoir Operations

San Luis Dam and Reservoir, with a capacity of about 2 maf, is a pumped-storage reservoir used primarily to provide seasonal storage for both CVP and SWP water exported from the Delta. The CVP share of the San Luis Reservoir storage is 972 taf. The SWP share of the San Luis Reservoir storage is 1,067 taf.

Table 3-12a gives the CALSIM-simulated monthly cumulative distributions of SWP San Luis Reservoir storage for the 1922–2003 existing conditions. The SWP San Luis storage reaches the maximum annual storage in the month of February or March, and generally declines in April through September as SWP demands are satisfied during the summer. The SWP San Luis storage is filled in about 30% of the years by the end of December, in about 60% of the years by the end of January, and in about 80% of the years by the end of February. When SWP San Luis Reservoir is filled, pumping of Article 21 (interruptible) water for SWP contractors with available storage (groundwater or surface reservoir) is simulated.

Table 3-12b gives the CALSIM-simulated monthly cumulative distributions of CVP San Luis Reservoir storage for the 1922–2003 existing conditions. The CVP San Luis storage also reaches the maximum annual storage in the months of

February or March, and generally declines in April through September as CVP demands are satisfied during the summer. The CVP San Luis storage is filled in about10% of the years by the end of January, in about 30% of the years by the end of February, and in about 60% of the years by the end of March.

Table 3-12c gives the CALSIM-simulated monthly cumulative distributions of combined SWP and CVP San Luis Reservoir storage for the 1922–2003 existing conditions. The San Luis Reservoir storage is full in about 50% of the years by the end of March.

Figure 3-3a shows the CALSIM-simulated annual SWP Banks pumping and SWP total deliveries for the 1922–2003 existing conditions. The SWP pumping is a little higher than the SWP deliveries because of aqueduct and San Luis Reservoir losses, and because some of the SWP pumping is wheeling water for CVP deliveries. The SWP pumping and SWP deliveries for the October–March period also are shown to illustrate the seasonal pattern of pumping, San Luis Reservoir storage, and deliveries. The October–March pumping ranged between 1,000 taf and 2,500 taf each year and was always greater than SWP deliveries in the same period. This additional SWP water was stored in SWP San Luis Reservoir.

Figure 3-3b shows the SWP San Luis Reservoir storage at the end of March (maximum) and end of September (carryover) for 1922–2003. The graphs use the same scale of 0 to 5,000 taf to illustrate the modest contribution of the SWP San Luis Reservoir storage for SWP deliveries. The San Luis Reservoir allows more than half of the annual SWP pumping to be delivered in the summer months of peak demand. The average CALSIM-simulated SWP San Luis Reservoir storage release between March and September was about 525 taf. This is somewhat less than the releases from SWP San Luis Reservoir in recent years because the CALSIM model is simulating more carryover storage (Article 56) for deliveries in January and February of the next water delivery year.

Figure 3-4a shows the CALSIM-simulated annual CVP Jones pumping and CVP total deliveries for the 1922–2003 existing conditions. The CVP pumping is a little less than CVP deliveries because of some SWP pumping (wheeling) water for CVP deliveries. The CVP pumping and CVP deliveries for the October–March period are shown to illustrate the seasonal pattern of pumping, San Luis Reservoir storage, and deliveries. The October–March CVP pumping ranged between 1,000 taf and 1,500 taf in most years, and pumping was about twice the CVP deliveries (average of 720 taf) in the same period. This additional CVP water was stored in CVP San Luis Reservoir.

Figure 3-4b shows the CVP San Luis Reservoir storage at the end of March (maximum) and end of September (carryover) for 1922–2003. The graphs use the same scale as the SWP graphs to illustrate the CVP pumping and delivery volumes relative to the larger SWP pumping and delivery volumes. The contribution of the CVP San Luis Reservoir storage to seasonal CVP deliveries is greater than for SWP deliveries. The San Luis Reservoir allows the majority (70%) of annual CVP pumping to be delivered in the summer months of peak demand. The average CALSIM-simulated CVP San Luis Reservoir storage release between March and September was about 660 taf.

The seasonal CVP and SWP water supply (pumped in October–March and delivered in April–September) provided by San Luis Reservoir is limited in about 50% of the years by the maximum San Luis Reservoir storage capacity of about 2,000 taf. The Project would divert some additional water (within the E/I objective) in the months of December–March and store the water for later discharge for export pumping in July–November. Therefore, the proposed Project would provide about the same water supply benefits as increasing the San Luis Reservoir capacity by 215 taf (10% of the San Luis Reservoir capacity).

The actual operations of the Project each year will depend on the sequence of Delta inflow, CVP and SWP exports, and CVP and SWP water demands (i.e., allocation of maximum contract amounts). The IDSM was used to determine the monthly Project operations for the CALSIM-simulated existing conditions for 1922–2003. The next section describes the IDSM results.

IDSM-Simulated Project Operations

The water supply evaluation using the IDSM spreadsheet model provides a quantitative approach for evaluating Project operations—the Project diversions to storage, the Project discharges for export pumping and delivery to designated places of use or groundwater banks, and the release of Project water for increased Delta outflow. The recharge and pumping operations of the groundwater banking facilities also are simulated. A summary and discussion of the IDSM results for the Project operations are presented in this section. The simulated monthly outflow and export pumping changes caused by Project operations are presented to evaluate the basic Project water supply benefits (i.e., water supply yield). These results also are used to evaluate potential impacts caused by the Project diversions or discharges for increased SWP pumping in subsequent resource impact sections of this Place of Use EIR (e.g., water quality, fish sections).

The IDSM results are used to evaluate potential water supply changes for designated SWP contractors. The simulated changes in combined SWP and CVP monthly exports are shown in the following tables and figures to document the flow changes that will be important for evaluating water quality and fish effects. The changes in annual SWP deliveries are used to evaluate potential SWP water supply changes.

Figure 3-5 depicts the CALSIM-simulated annual baseline CVP and SWP Delta exports and the IDSM-simulated Project export pumping and releases for Delta outflow for 1922–2003. Overall, the IDSM results indicate the Project would be able to increase the combined CVP and SWP exports and deliveries by about 96 taf/year. In addition, about 64 taf/yr would be released for Delta outflow in years when the Project stored water could not be exported because of limited SWP pumping capacity. The IDSM results suggest that about 45% of the Project water would be delivered directly to the places of use without groundwater storage. The remaining 55% of the Project water would be stored for at least 1 additional year in the designated groundwater banks and subsequently delivered to the places of use.

The Project storage water may be released to increase Delta outflow in the fall months when there was not enough available export pumping capacity for all of the Project storage and the Project elects not to carry storage over to the successive water year. The IDSM estimates some storage remaining in the fall would occur in about 50% of the years. The IDSM modeling disclosed that releasing the water for salinity and estuarine habitat improvements, and not carrying storage over to the successive water year would not substantially reduce the total export and delivery capability of the Project because the probability of refilling the Reservoir Islands each year was comparatively high. Another advantage of releasing unused Project storage water each year was to reduce the potential water quality degradation (i.e., increased EC and DOC) that may occur in the Reservoir Islands during a 2-year water storage period.

Excess Delta Outflow

Project diversions would occur only when there was surplus or excess Delta outflow. Project diversions would be allowed if the required Delta outflow was exceeded and the allowable E/I ratio was not exceeded with Project diversions included as though they were increased exports.

Table 3-13a shows the CALSIM-simulated monthly distributions of Delta outflow for the 1922–2003 period. The average Delta outflow was about 15,000 taf. The simulated Delta outflow was often controlled by the required Delta outflow but may be higher if the E/I ratio is limiting exports, or if the inflow is greater than the maximum needed to supply full export pumping. Table 3-13b indicates that the simulated Delta outflow was higher during the second half of the hydrologic record, with an average outflow of about 17,000 taf for 1963–2003. This suggests that the average annual outflow during the first half of the hydrologic period was an average of about 1,300 taf. Table 3-13c compares the historical Delta outflow for the 1963–2003 period. The average annual historical Delta outflow was about 3,000 taf higher than the simulated outflow, most likely because the CALSIM inflows were slightly lower and the simulated CVP and SWP exports were higher.

Table 3-14a shows the IDSM-calculated monthly distribution of the required Delta outflow for the 1922–2003 period. There are D-1641 specified Delta outflow requirements for each year-type in the months of October–January and July–September. The X2 requirements vary in the months of February–June. Table 3-14b shows the IDSM-calculated "surplus" Delta outflow that is greater than the required Delta outflow and within the E/I ratio with the simulated monthly CVP and SWP exports. Some months have very high excess Delta outflow of more than 10,000 cfs. The median monthly excess outflow was more than 2,000 cfs for November–May. However, these excess Delta outflow calculations in April and May do not account for the export reductions in April and May for fish protection. Project diversions generally would occur in April and May under the existing conditions because of the assumed VAMP protections for San Joaquin River fish. Therefore, the months with the highest occurrence of excess Delta outflow (within the E/I ratio) that could be diverted onto the Project Reservoir Islands are November–March.

Figure 3-6 shows the CALSIM-simulated monthly Delta outflow for the recent 20-year period of 1984–2003. The D-1641 required Delta outflow for the period is shown in red. The dark blue color indicates the outflow that is above the required outflow but within the required E/I ratio for exports (and assumed to limit Project diversions). The total simulated Delta outflow is shown in light blue. This graph indicates that in about half the years, the simulated Delta outflow would be more than 50,000 cfs for 1 or more months, and Project diversions would be possible within the E/I ratio (dark blue shaded). In about 25% of the years, the Delta outflow would not exceed 50,000 cfs, but there would be at least 1 month of surplus Delta outflow within the E/I ratio to allow Project diversions. In about 25% of the drier years, however, there would not be sufficient surplus Delta outflow to allow Project diversions.

The Reservoir Islands would have a combined maximum diversion capacity of about 5,500 cfs (11 taf/day), so that the full available storage volume of about 215 taf could be diverted in 1 month, assuming the daily excess outflow (within the E/I ratio) remained greater than 5,500 cfs for at least 3 weeks during a month. Project diversions may be limited by other, more specific operational rules (FOC) to protect water quality and fish.

Project Diversions to Reservoir Storage

Table 3-15a shows the IDSM-simulated monthly distributions of the Project diversions for storage for the 1922–2003 period. The Webb Tract and the Bacon Island diversions were simulated separately because these diversions may be subject to slightly different operating rules (FOC). The cumulative distribution of Project diversions was highest in December and decreased in January, February, and March because the Project storage islands were more likely to already be filled later in the diversion period. The simulated annual average Project diversion volume was 168 taf. The Project diversions were less than 28 taf in 20% of the years. There was not enough excess Delta outflow to fill the Project storage islands in about 25% of the years.

Figure 3-7 shows the IDSM-simulated Project diversions for the 1984–2003 period. The monthly Delta outflow with (green line) and without (blue line) the Project diversions is shown for comparison. The Project diversions were limited to the months of December–March when the Delta outflow was greater than 11,400 cfs to maintain X2 downstream of Chipps Island. Project diversions of about 4,000 cfs (215 taf) were simulated in about 16 of these 20 years. The change in Delta outflow can be identified for the months when Project diversions were simulated. Project diversions were not simulated in four of these 20 years because there was not sufficient surplus Delta outflow within the E/I ratio in the months of December–March. For example, no Project diversions were simulated in 1990 or 1994 because Delta outflow did not exceed 15,000 cfs. No Project diversions were simulated in 1991 or 2001, although the Delta outflow was more than 15,000 cfs for at least one month, because the Project diversions would have exceeded the E/I ratio. This graph indicates that there is usually (in 75% of the years) available surplus Delta outflow for Project diversions.

Project Discharges for Export

Table 3-15b shows the simulated monthly distributions of the Project discharges for export for the 1922–2003 period. The Webb Tract and the Bacon Island discharges were simulated separately because these discharges for export may be subject to slightly different operating rules (FOC). The cumulative distribution of Project discharges for export were highest in July and decreased in August and September, with some discharge for export in October and November. The simulated annual average volume of Project discharges for export was 96 taf. Therefore, about 57% of the simulated average annual Project diversions were exported in the July–November period. The Project annual discharges for export were less than 10 taf in 30% of the years, and less than 83 taf in 50% of the years. A storage volume of at least 190 taf was discharged in about 20% of the years.

Figure 3-8 shows the monthly combined CVP and SWP export pumping for the 1984–2003 period. The monthly pumping (green bars) varied from about 2,000 cfs in a few months (e.g., April and May VAMP reductions) of dry years to more than 10,000 cfs in many winter and summer months. The exports may be limited by fish protection actions (i.e., VAMP and CVP b[2] reductions) or by the maximum E/I fraction of the Delta inflow. The SWP maximum permitted pumping may limit exports in some years. These possible export limits are indicated by the E/I ratio (gray line) and the maximum allowable pumping for fish protection (blue line with diamonds). When the blue diamonds are on the gray line, the E/I ratio is limiting exports. When the diamonds are below the E/I ratio (gray line), fish protection measures are limiting exports. The CALSIM-simulated export pumping is often less than the allowable pumping, indicating that outflow requirements were limiting exports, or that San Luis Reservoir was full.

Figure 3-8 also shows the IDSM-simulated Project exports (red bar on top of the green bar), which were allowed in July–September whenever there was available export pumping capacity. The Project exports were allowed to exceed the E/I ratio because the Project stored water was diverted under the E/I criteria. The increased SWP pumping during the July–September period was considered a water transfer from within the Delta. The maximum Project exports were assumed to be 4,000 cfs to allow full discharge within 1 month if there was available permitted pumping capacity. Project exports of at least 100 taf were simulated in 13 of the 20 years.

Project Releases for Outflow

Table 3-15c shows the simulated monthly distributions of the Project releases for outflow for the 1922–2003 period. The Webb Tract and the Bacon Island releases for outflow were simulated separately because these releases for outflow may be subject to slightly different operating rules (FOC). The Project releases for outflow were simulated in September and October to reduce the salinity at CCWD diversions (and at SWP and CVP exports) if the estimated chloride concentrations were greater than 125 mg/l. The changes in salinity caused by the release of 1,000 cfs from the Project storage islands would be measurable upstream of Antioch (i.e., central and south Delta), and estuarine habitat conditions would be changed slightly between Chipps Island and Collinsville. Any remaining Project storage water was assumed to be released in November, to reduce salinity and to reduce the accumulation of DOC concentrations (See Section 4.2, Water Quality). Project releases for outflow were simulated in September and October for about 10% of the years and in November for about 30% of the years. The simulated annual average volume of Project releases for outflow was 64 taf (about 38% of the average annual Project diversions).

Figure 3-9 shows the IDSM-simulated Project releases for outflow (red bars) for the 1984–2003 period. The Project releases were simulated in September, October, and November when the Project storage water could not be exported during the July–November period. Releases of 1,000 cfs were simulated if the estimated Rock Slough chloride concentration was greater than 125 mg/l in September or October. The remainder of Project storage was released in November. An average of 64 taf/yr of Project stored water was simulated to be released for Delta outflow. The actual releases would vary depending on the available water that could not be exported and the forecasted Delta conditions in these months. This release of water for increased Delta outflow is simulated as a beneficial use for improved fish and wildlife habitat in the estuary and is considered as a designated place of use for Project water.

Figure 3-9 also indicates the reduction in chloride concentration resulting from the Project storage releases for outflow that were simulated for the 1984–2003 period. Releases for outflow of more than 50 taf were simulated in eight of the 20 years. The improvement in chloride concentration depends on the Delta outflow during the release. If the chloride concentration was 250 mg/l (maximum D-1641 criteria), a release of 1,000 cfs would reduce the chloride concentration to about 150 mg/l. If the chloride concentration was 150 mg/l, a release of 1,000 cfs would reduce the chloride concentration to about 100 mg/l (See Section 4.2, Water Quality).

Figure 3-10 shows the simulated changes in the X2 position caused by the Project diversions in December–March and by the Project releases for outflow in September–November. Project discharges for export pumping in July–November would not change the outflow or the X2 position. The Project diversions will increase the X2 position by less than 1 km and were assumed to occur only when X2 would remain downstream of Chipps Island (75 km). The Project releases of 1,000 cfs for outflow generally would move X2 downstream about 1 km if X2 was about 85 km upstream from the Golden Gate. Less of a downstream movement would occur if X2 was already farther downstream.

Figure 3-11 shows the IDSM-simulated Project storage on Webb Tract and Bacon Island for the 1984–2003 period. As described above, the surplus Delta outflow was sufficient to allow Project diversions in 16 of the 20 years. Bacon Island was assumed to be filled first, so there were small diversions to Bacon in a few more years. Discharges in July–November were for export pumping and direct delivery to CVP and SWP contractors or storage in the groundwater banks for subsequent delivery to SWP contractors. Project storage water was assumed to be released for Delta outflow in September–November, if the water was not discharged for exports in the July–November period. Actual Project operations in these months with both discharges for exports and releases for outflow would depend on forecasted SWP pumping capacity.

Figure 3-12 shows the IDSM-simulated Project operations, indicated by the Bacon Island and Webb Tract diversions and discharges for export or for outflow for the 1984–2003 period. The IDSM results indicate that the Project would operate in more than 75% of the years.

Delivery of Project Water

The amount of Project water delivered to designated SWP contractors each year would depend on the water delivery allocations for each contractor within the designated places of use for the Project water. The IDSM simulation of Project exports is calculated by considering the simulated SWP water demand deficits, the available pumping capacity, the aqueduct capacity, and the recharge capacity of the groundwater banks. The selected fraction of the demand deficits that can be supplied to the Project designated places of use (50% SWP, 0% CVP) was adequate to allow a majority (57%) of the Project storage water to be exported. This fraction could be increased by allowing a greater fraction of the SWP demand deficits to be met with Project water (increased designated places of use) or by increasing the permitted SWP summer pumping capacity of 6,680 cfs.

Table 3-16a gives the IDSM-simulated monthly distributions of Project water that was exported for direct delivery to designated places of use using 50% of the SWP contractor unmet demands (i.e., delivery deficits) as a proxy for the designated place of use unmet demands. All designated places of use can be supplied with Project water directly using SWP conveyance facilities, except that CVWD would get water through an exchange with Metropolitan. Three places of use, Metropolitan, Valley District, and CVWD, are SWP contractors. Three places of use, Semitropic, Western, and Rosedale–Rio Bravo, are member agencies of SWP contractors. There are no CVP contractors designated for Project delivery at this time. The direct SWP contractor deliveries occur in the months of July–November, which include the peak demand months for agricultural and municipal contractors. The average IDSM-simulated SWP direct deliveries from Project storage water were about 43 taf. The actual export and delivery pattern would vary each year according to the delivery deficits for the designated places of use, and the forecasted SWP pumping (i.e., unused permitted capacity).

Table 3-16b gives the IDSM-simulated monthly distributions of Project water that was delivered (i.e., pumped) from the designated groundwater banks. The delivery of groundwater was simulated in the months of May through November. The groundwater banks can deliver water directly to SWP contractors only because the groundwater banks are located south of the CVP service areas. Deliveries from the groundwater banks were simulated in about 20% of the years. The average annual simulated delivery of Project water pumped from the groundwater banks was about 53 taf/yr.

Figure 3-13 shows the CALSIM-simulated monthly delivery to CVP contractors (green bars) for the 1984–2003 period. The CVP deliveries are almost always less than the full contractor demands (blue diamonds), so additional delivery from Project storage might be possible in some years. This increased CVP delivery often would require pumping at the SWP Banks Pumping Plant (i.e., wheeling), and may be limited by available SWP permitted pumping capacity. There are no CVP contractors in the designated places of use for Project water at this time. Temporary water transfer approvals or changes in the designated places of use would be required for future delivery to CVP contractors.

Figure 3-14 shows the CALSIM-simulated monthly delivery to SWP contractors (green bars) and the IDSM-simulated delivery of Project storage water to SWP contractors (red bars) for the 1984–2003 period. The SWP deliveries were sometimes enough for full contract (Table A) deliveries, but often were less than the full contractor demands, so additional delivery from Project storage was possible in many years. Some of these SWP deliveries were made after storage in the groundwater banks for 1 or more years. SWP deliveries were simulated in about 13 of the 20 years.

Storage of Project Water in Groundwater Banks

Table 3-17a gives the IDSM-simulated monthly distribution of Project water that was exported and stored in the designated groundwater banks for 1922–2003. The groundwater recharge would occur in the months of Project exports when direct delivery to designated SWP contractors was not needed. The IDSM-simulated average annual volume of Project storage that was exported at the SWP pumps and recharged to the groundwater banks in July–November was about 53 taf. Table 3-17b gives the IDSM-simulated monthly distribution of groundwater bank storage for 1922–2003. Groundwater storage was used for Project water in about 30% of the years.

The amount of Project water that can be exported to the groundwater banks in wet years depends on the available export capacity in the July–November water transfer period not already used by CVP and SWP pumping. In wet years when CVP and SWP are delivering most of the water demands, the pumping already may be at permitted capacity. The available summer pumping could be increased in the future by the State Water Board and the Corps raising the permitted SWP pumping capacity of 6,680 cfs to 8,500 cfs or 10,300 cfs (physical capacity) for at least the summer water transfer period of July–September. This higher summer pumping would allow more CVP and SWP water to be exported and delivered during peak summer demands and would facilitate Project water exports, as well as other water transfers from upstream.

These simulated results demonstrate the importance of the Semitropic and Antelope Valley groundwater banks for allowing more of the Project storage water to be exported and delivered to designated places of use in more years than would be possible with only direct deliveries. There are several dry years (25%) with no Project diversions to storage and therefore no direct Project deliveries. There are several other years when Project diversions to storage were possible, but there was no unused export pumping capacity in the summer or fall months for Project deliveries. Project storage water that could be exported in the summer or fall months in wet years when SWP water deliveries were high can be stored again in the designated groundwater banks. The Project yield therefore is increased substantially with the designated groundwater banks. The IDSM simulations indicate that the water supply delivery (i.e., yield) was increased by 53 taf/yr, from 43 taf/yr to 96 taf/yr, with the groundwater banks.

Figure 3-15 shows the IDSM-simulated groundwater bank storage for the 1984–2003 period. The groundwater banks were used in about half of the years, and this water then was pumped to SWP contractors in the next water year with a demand deficit. The actual operation of the groundwater banks might be different from the relatively simple monthly operations simulated with IDSM and would depend on the needs of the designated SWP contractors.

Effects of Project Operations

The IDSM-simulated monthly Project operations are adequate for evaluating the likely effects on Delta flows, Delta salinity, fish entrainment, and estuarine habitat conditions.

These CALSIM-simulated monthly Delta flows are representative of the future monthly CVP and SWP operations (No-Project Alternative) that will govern Project diversions, exports, and deliveries. The IDSM-simulated monthly Project operations are accurately calculated and adequate to describe the likely Project water supply benefits (for contractor delivery to designated places of use and for Delta outflow augmentation) and to allow the nature and magnitude of water quality and fishery impacts to be determined and evaluated.

There will be variations from the monthly rules used to control the IDSM simulations in the actual daily Project operations. The actual Project operations will be governed by the revised D-1643 FOC, revised Project BOs, and the WQMP requirements. There will be some differences between monthly flows and daily flows; these were generally explored and described in Appendix A4 of the 1995 DEIR/EIS. These were also evaluated in the DWR in-Delta storage investigations, which used daily modeling of Delta flows and in-Delta storage operations (a list of these reports is provided in Chapter 2). However, monthly operations are generally adequate for characterizing water quality and fish impacts, as shown in the 1995 DEIR/EIS (Appendix A4).

Simulated Project Operations for Water Year 1980–2003

The Project operations would depend on the simulated monthly sequence of Delta inflow, Delta exports, and Delta outflow. The CALSIM-simulated monthly flows for the 24-year period of 1980–2003, along with the simulated Project operations, would be shown as an example of the Delta flows and Project operations with the corresponding changes in Delta flows. The range of monthly Delta inflows for this 24-year period was similar to the 82-year range of monthly inflows for the full 1922–2003 CALSIM period. Therefore, this 24-year sequence allows most of the variations in potential Project operations to be described and evaluated. These most recent 24 years of the CALSIM and IDSM simulation period also will be used for describing the simulated water quality and fish effects of the Project operations.

Table 3-18 gives the CALSIM-simulated monthly total Delta inflow for 1980–2003. The monthly total Delta inflows (cfs) are given in water year by month format. The annual inflow volumes (taf) are given in the right-hand column. The average annual total Delta inflow volume for 1980–2003 was 25,112 taf, which was considerably higher (15%) than the 1922–2003 average of 21,918 taf because the 1982 and 1983 inflows were exceptionally high.

Table 3-19 gives the CALSIM-simulated monthly combined Delta exports for 1980–2003. The monthly combined Delta exports (cfs) are given in water year by month format. The annual combined export volumes (taf) are given in the right-hand column. The average annual combined Delta export volume for 1980–2003 was 5,882 taf, very similar to the 1922–2003 average annual combined Delta export volume of 5,939 taf.

Table 3-20 gives the CALSIM-simulated monthly Delta outflows for 1980–2003. The annual Delta outflow volumes (taf) are given in the right-hand column. The average annual Delta outflow volume for 1984–2003 was 18,207 taf, considerably higher (20%) than the 1922–2003 average annual Delta outflow volume of 14,878 taf.

Table 3-21 gives the IDSM-simulated monthly Project diversions to storage for 1980–2003. The Project diversions would reduce the Delta outflow by the same amount. The simulated Project diversions in December–March were always limited to outflows greater than 11,400 cfs because the simulated Project operating criteria specify that X2 must be downstream of Chipps Island.

Table 3-22 gives the IDSM-simulated monthly Project discharges for export for 1980–2003. The Project discharges for export would increase SWP exports by the same amount. The simulated Project discharges in July–November generally were between 1,000 cfs and 2,000 cfs, and were always less than the specified maximum discharge of 4,000 cfs. The Project discharges usually were distributed over several months, including the 3-month water transfer window identified in the OCAP BOs (July–September), to facilitate delivery to the designated places of use or groundwater banks. The Delta outflow would not be changed by Project discharges for export.

Table 3-23 gives the IDSM-simulated monthly Project releases for outflow for 1980–2003. The Project releases for outflow would increase Delta outflow by the same amount. The simulated Project releases in September and October were always less than the specified maximum release for salinity control of 1,000 cfs. Some of the November releases were higher because all remaining Project storage was assumed to be released in November. Releases in November also would reduce salinity in December and January if the Delta outflow remained relatively low. Project releases for outflow were made in about 10% of the years.

Table 3-24 gives the CALSIM-simulated end-of-month X2 position (kilometers) for the existing conditions (without Project operations) for 1980–2003. Project diversions would increase X2 (upstream movement), and Project releases for outflow would reduce X2 (downstream movement). Project discharges for export in July–November would not change the X2 location. Table 3-25 gives the IDSM-simulated end-of-month X2 position (kilometers) with Project operations for 1980–2003. Table 3-26 gives the monthly changes in calculated X2 caused by Project operations. The effects of Project operations on the simulated X2 location persist for 1 or 2 months after the diversion to storage or the release for outflow because of the “moving average” effects of Delta outflow on X2. Comparing Table 3-21 (Project diversions) with Table 3-26, it can be seen that Project diversions in December–March often change (increase) X2 for 2 or 3 months. Project releases for outflow in September, October, and November can be seen to change (reduce) the X2 position for more than 1 month.

The IDSM-simulated Project operations shown in these water-year-by-month tables for 1984–2003 will be used to describe and evaluate changes in Delta water quality and fish effects from estuarine habitat changes or entrainment of larvae, juveniles, or adult fish and zooplankton (fish food).

Table 3-1. Monthly Cumulative Distribution of CALSIM-Simulated Sacramento River Flow (cfs) at Freeport for 1922–2003

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual taf
A. CALSIM-Simulated Sacramento River flow at Hood (cfs) for 1922–2003 (82 years)													
Min	7,590	7,082	6,703	6,155	7,904	7,384	7,678	5,365	8,792	10,113	7,676	7,451	6,252
10%	8,122	8,463	9,500	12,157	13,966	11,803	10,389	7,998	11,684	13,579	9,260	8,274	8,923
20%	9,300	9,524	12,513	13,168	15,897	16,068	11,422	11,619	13,205	15,740	11,776	9,434	10,433
30%	9,920	10,682	13,720	16,342	22,532	20,040	12,393	12,207	14,896	17,209	12,846	11,016	11,503
40%	10,723	11,563	14,741	19,447	26,172	22,358	14,522	13,280	15,767	18,465	13,601	11,856	12,666
50%	11,720	12,446	16,785	25,535	33,171	27,120	16,568	14,064	16,140	19,163	14,771	12,511	13,931
60%	12,380	13,184	18,018	32,093	46,418	33,075	20,405	16,456	17,168	20,018	15,298	13,528	18,201
70%	13,394	14,567	25,093	44,904	55,328	42,703	23,812	21,978	18,246	21,141	15,828	14,254	19,672
80%	14,044	15,979	34,880	57,196	69,098	56,924	36,295	28,020	20,020	22,126	16,305	16,870	22,006
90%	15,668	24,551	61,635	73,080	74,107	70,100	55,058	42,133	25,865	23,392	16,709	19,826	26,053
Max	36,228	64,087	75,281	78,752	78,781	77,204	74,616	66,494	63,393	24,535	20,692	26,648	34,969
Avg	12,149	15,010	25,147	33,725	39,591	34,311	23,863	20,159	18,431	18,773	14,036	13,325	16,201
B. Simulated for 1963–2003 (41 years)													
Min	7,733	7,099	6,703	6,155	7,904	7,384	8,743	5,365	8,792	10,113	8,063	7,451	6,252
10%	8,042	9,078	11,215	13,131	12,513	12,824	11,108	8,499	11,978	14,336	9,607	8,234	8,936
20%	9,534	10,459	13,675	16,278	18,387	18,712	12,118	10,368	13,785	17,054	12,561	9,385	10,580
30%	10,125	11,069	14,680	19,081	22,822	22,684	12,492	12,020	15,267	17,869	13,436	11,166	12,199
40%	11,372	12,473	15,612	25,119	27,625	27,208	15,799	13,301	15,841	19,117	14,841	11,787	13,884
50%	11,745	13,000	17,044	32,558	33,691	32,754	16,720	14,021	16,731	19,710	15,263	12,976	18,345
60%	12,203	14,519	21,939	45,875	50,310	39,805	20,986	16,258	17,921	20,554	15,536	13,797	19,279
70%	13,550	15,395	27,908	55,939	60,096	49,012	24,319	22,981	18,381	21,388	15,979	14,528	21,159
80%	14,323	19,139	35,540	70,657	71,693	59,473	35,588	28,319	20,839	22,705	16,627	18,418	22,112
90%	16,484	29,701	66,114	74,168	74,171	70,240	50,308	42,863	25,947	23,672	16,836	21,043	26,858
Max	36,228	64,087	75,281	78,752	78,781	77,204	74,616	66,494	63,393	24,279	20,692	26,648	34,969
Avg	12,654	17,069	27,359	39,172	41,635	38,036	24,671	20,515	19,500	19,388	14,458	13,878	17,396

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual taf
C. Historical for 1963–2003 (41 years)													
Min	4,494	6,380	7,743	8,984	8,003	6,573	5,961	6,414	6,865	8,248	7,687	6,838	5,505
10%	8,255	7,823	12,388	13,171	12,772	14,310	11,826	9,060	9,583	11,622	12,145	10,949	9,667
20%	9,398	10,872	13,671	17,190	18,271	21,316	12,724	10,974	10,729	12,142	13,219	12,360	10,978
30%	9,891	12,283	16,371	19,432	22,117	23,677	14,477	12,963	11,787	14,216	13,839	13,243	12,261
40%	11,684	12,680	20,319	23,190	31,196	24,510	16,887	13,799	12,660	15,000	14,916	14,567	13,395
50%	12,577	14,593	22,010	32,868	39,779	30,481	21,273	15,406	13,889	16,035	15,658	15,827	18,310
60%	13,942	15,500	25,545	38,277	48,596	43,374	25,827	19,735	16,017	17,726	17,020	16,463	19,968
70%	15,261	18,597	29,130	51,784	56,089	50,942	35,983	29,177	17,813	19,490	18,345	17,693	20,787
80%	16,077	22,250	36,558	56,803	62,372	56,235	43,213	40,113	23,710	20,848	19,497	18,573	22,620
90%	19,174	26,280	58,419	64,610	68,893	63,829	60,510	42,784	30,473	22,242	21,303	24,393	27,827
Max	28,688	48,820	74,513	87,110	81,368	78,290	76,580	63,181	55,690	31,000	25,177	25,317	34,096
Avg	13,097	17,016	27,669	36,297	40,629	37,204	28,124	22,806	18,275	16,925	16,236	16,132	17,521

Table 3-2. Monthly Cumulative Distribution of CALSIM-Simulated Yolo Bypass Flow (cfs) for 1922–2003

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual taf
A. CALSIM-Simulated for 1922–2003 (82 years)													
Min	0	0	0	0	0	0	39	24	52	41	41	19	24
10%	4	0	0	0	20	6	53	50	61	47	53	50	61
20%	15	0	0	20	75	47	76	55	63	47	54	54	119
30%	27	3	20	70	234	110	89	60	64	47	54	56	171
40%	37	7	64	291	684	269	110	61	65	47	54	57	243
50%	43	9	144	501	1,900	772	136	64	66	47	54	57	418
60%	49	24	293	1,854	2,518	1,463	228	67	66	47	54	57	744
70%	55	49	874	3,121	4,858	2,925	631	70	66	47	54	57	1,460
80%	58	113	2,162	6,418	7,902	4,145	2,571	74	66	47	54	77	3,408
90%	61	480	4,107	24,773	37,800	15,728	4,831	252	66	47	181	146	5,790
Max	1,250	2,750	57,349	131,642	122,751	122,683	38,245	1,580	1,118	47	654	293	12,872
Avg	69	150	2,197	8,188	10,680	7,175	1,912	151	91	47	102	75	1,861

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual taf
B. CALSIM-Simulated for 1963–2003 (41 years)													
Min	0	0	0	0	0	0	42	24	52	41	41	22	24
10%	5	0	0	0	23	0	52	50	60	47	53	50	91
20%	11	0	0	3	62	44	55	59	63	47	54	53	130
30%	36	1	0	52	287	171	84	61	64	47	54	57	198
40%	41	6	34	573	861	758	110	62	65	47	54	57	376
50%	45	8	87	1,923	2,075	1,152	116	64	65	47	54	57	814
60%	51	49	233	3,157	2,746	2,200	293	68	66	47	54	58	1,287
70%	56	114	982	6,290	5,024	3,271	1,331	71	66	47	54	92	2,468
80%	59	192	2,486	7,927	14,120	5,096	2,639	75	66	47	185	148	4,452
90%	67	559	3,739	32,424	37,988	12,417	6,727	373	66	47	512	178	9,159
Max	1,250	2,750	57,349	131,642	122,751	122,683	38,245	1,580	1,118	47	654	293	12,872
Avg	97	217	2,903	12,267	13,234	9,432	2,431	169	110	47	150	94	2,483
C. Historical for 1963–2003 (41 years)													
Min	0	0	0	3	1	4	0	0	0	0	0	0	1
10%	5	11	25	25	20	26	24	21	17	3	7	4	32
20%	9	15	25	38	110	96	46	32	25	14	12	11	75
30%	17	21	30	142	717	265	46	36	33	17	15	20	154
40%	20	25	41	459	1,301	893	123	43	37	24	21	20	653
50%	20	25	171	1,571	2,515	1,080	333	51	43	32	23	27	1,306
60%	22	43	586	6,628	7,181	3,004	851	174	50	40	29	30	3,001
70%	25	149	1,131	15,733	20,132	9,011	1,378	462	79	43	34	36	4,169
80%	133	232	6,341	21,640	26,362	13,017	2,306	589	561	50	34	61	6,399
90%	193	640	10,983	41,439	45,185	18,368	8,981	1,392	608	586	499	376	9,481
Max	13,513	10,932	57,490	127,167	115,391	130,358	38,218	13,133	3,955	640	539	398	14,957
Avg	379	620	4,944	15,219	16,176	11,508	3,883	707	282	125	104	85	3,260

Table 3-3. Monthly Cumulative Distribution of CALSIM-Simulated San Joaquin River Flow (cfs) at Vernalis for 1922–2003

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual taf
A. CALSIM-Simulated for 1922–2003 (82 years)													
Min	1,060	1,305	1,345	1,099	1,366	1,277	1,112	886	594	577	640	986	869
10%	1,548	1,723	1,690	1,629	2,042	1,804	1,688	1,698	1,057	967	1,095	1,491	1,117
20%	1,839	1,859	1,858	1,766	2,147	1,974	2,493	2,413	1,334	1,171	1,289	1,674	1,397
30%	1,970	1,965	1,961	1,980	2,321	2,219	3,235	3,074	1,454	1,245	1,376	1,765	1,588
40%	2,118	2,094	2,087	2,193	2,568	2,586	3,963	3,653	1,804	1,457	1,464	1,842	1,818
50%	2,320	2,164	2,179	2,411	3,366	3,082	5,052	4,461	2,225	1,627	1,553	1,947	1,951
60%	2,578	2,356	2,281	2,531	4,462	4,979	5,451	5,165	2,595	1,839	1,775	2,243	2,709
70%	2,737	2,557	2,485	3,308	6,160	6,933	6,175	5,591	3,182	2,038	2,387	2,476	3,343
80%	2,913	2,756	2,891	5,013	9,642	8,659	7,272	7,173	7,199	3,548	2,799	2,712	4,473
90%	3,647	3,036	4,563	9,623	15,548	14,513	12,542	14,305	13,090	7,188	4,210	3,972	5,805
Max	7,538	16,747	24,168	60,107	34,475	48,555	27,422	26,218	28,027	23,800	9,146	7,945	15,990
Avg	2,486	2,561	3,355	4,774	6,444	6,346	6,015	6,035	4,643	3,228	2,113	2,366	3,039
B. CALSIM-Simulated for 1963–2003 (41 years)													
Min	1,060	1,305	1,345	1,099	1,366	1,277	1,112	886	594	577	640	986	869
10%	1,329	1,648	1,567	1,392	1,894	1,722	1,564	1,697	910	740	891	1,328	1,031
20%	1,756	1,739	1,686	1,700	2,129	1,895	2,380	2,364	1,218	1,099	1,259	1,602	1,358
30%	1,909	1,881	1,912	2,171	2,415	2,440	3,173	3,063	1,396	1,234	1,373	1,691	1,585
40%	2,284	2,039	2,099	2,353	2,547	2,711	3,882	3,370	1,511	1,440	1,464	1,798	1,837
50%	2,424	2,176	2,204	2,455	3,563	3,602	5,168	4,513	2,516	1,698	1,716	2,096	2,252
60%	2,659	2,377	2,276	2,823	4,877	6,655	5,864	5,261	3,205	1,900	2,257	2,477	3,210
70%	2,912	2,810	2,333	4,146	8,262	7,784	6,398	5,419	6,141	2,430	2,515	2,675	3,654
80%	3,281	3,018	2,735	5,095	11,691	9,157	7,267	8,480	9,467	4,237	2,825	2,929	5,749
90%	3,809	3,396	4,610	11,918	22,400	15,883	14,394	16,865	14,144	9,676	4,666	4,043	7,242
Max	7,538	16,747	24,168	60,107	34,475	48,555	27,422	26,218	28,027	23,800	9,146	7,945	15,990
Avg	2,646	2,872	3,681	5,832	7,644	7,490	6,534	6,664	5,418	3,927	2,292	2,523	3,470

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual taf
C. Historical for 1963–2003 (41 years)													
Min	246	430	506	816	758	524	212	400	118	93	124	179	416
10%	1,101	1,136	982	1,255	1,389	1,760	1,168	891	587	481	537	869	1,058
20%	1,370	1,404	1,381	1,913	1,987	2,023	1,435	1,279	1,109	1,009	892	1,067	1,219
30%	1,411	1,643	1,988	2,305	2,617	2,241	1,961	1,967	1,549	1,227	1,067	1,308	1,525
40%	1,992	1,759	2,238	2,872	3,092	2,743	2,599	2,393	1,990	1,330	1,221	1,452	1,766
50%	2,532	2,158	2,487	3,251	5,094	3,430	3,421	2,937	2,322	1,510	1,418	1,597	2,395
60%	2,706	2,355	2,812	4,059	6,645	6,536	4,285	3,972	2,737	1,756	1,627	2,029	2,843
70%	2,944	2,842	3,635	4,730	7,928	8,332	6,437	5,296	3,860	1,908	1,969	2,330	3,808
80%	3,741	3,290	4,331	6,025	9,191	12,098	10,249	9,339	6,233	2,567	2,171	2,846	5,484
90%	4,543	3,891	6,037	13,815	18,648	19,352	20,030	19,119	14,101	6,163	3,183	4,181	6,304
Max	13,323	10,876	19,126	30,377	35,057	40,035	36,447	31,771	27,887	19,227	9,035	11,310	15,459
Avg	2,833	2,545	3,643	5,698	7,812	7,917	7,084	6,458	4,891	2,772	1,803	2,252	3,361

Table 3-4. Monthly Cumulative Distribution of CALSIM-Simulated Total Delta Inflow (cfs) for 1922–2003

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual taf
A. CALSIM-Simulated Total Delta Inflow (cfs) for 1922–2003 (82 years)													
Min	8,884	8,640	8,319	7,427	9,672	8,910	9,735	7,192	9,925	10,824	9,022	8,856	7,325
10%	10,071	10,659	11,863	14,542	17,016	14,256	13,554	10,419	13,597	16,557	10,590	10,195	10,178
20%	11,472	12,335	14,848	15,732	20,411	19,373	14,264	14,699	15,889	19,083	13,552	10,939	12,378
30%	12,288	13,400	16,327	18,880	26,400	24,261	16,296	16,120	17,249	20,843	15,120	12,996	13,330
40%	13,307	14,493	17,379	22,757	30,578	29,359	20,326	17,945	18,325	21,451	17,155	13,984	15,747
50%	14,613	15,309	19,905	30,379	42,242	33,392	23,133	20,805	19,455	22,610	17,745	15,270	17,286
60%	15,635	16,837	21,522	36,789	57,204	40,479	28,678	24,813	20,583	23,661	18,019	16,487	21,833
70%	16,400	17,426	28,633	52,684	65,833	52,213	32,172	29,167	22,119	24,052	18,330	17,143	26,202
80%	16,950	20,086	39,697	77,017	85,624	72,582	52,559	34,290	26,682	24,303	18,472	19,793	31,010
90%	19,479	28,767	74,768	109,876	132,330	99,319	72,219	59,554	44,561	26,216	19,836	23,635	39,133
Max	40,175	89,880	164,239	286,122	230,891	260,626	148,683	96,651	87,869	49,463	31,601	35,662	67,175
Avg	14,920	18,557	31,906	48,587	59,127	49,883	33,373	27,858	23,981	22,399	16,576	16,109	21,918

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual taf
B. CALSIM-Simulated Total Delta Inflow for 1963–2003 (41 years)													
Min	8,884	8,640	8,319	7,427	9,672	8,910	10,582	7,192	9,925	10,824	9,098	8,856	7,325
10%	9,711	10,947	13,875	15,099	14,546	16,391	13,590	10,028	14,490	18,324	10,582	10,171	10,344
20%	11,471	12,950	15,457	18,798	21,271	21,721	14,544	14,632	16,429	20,814	14,283	10,529	12,634
30%	13,016	14,421	17,063	20,709	27,626	29,925	17,257	16,053	17,496	21,220	17,111	12,982	14,371
40%	13,959	15,216	19,119	29,664	31,427	33,374	22,043	17,782	18,476	22,286	17,818	14,249	17,153
50%	14,899	16,837	20,282	36,990	46,126	38,600	23,252	21,532	20,263	22,878	17,922	15,702	23,029
60%	15,738	17,244	24,757	53,240	59,402	45,664	29,205	25,243	22,032	23,733	18,311	16,923	25,677
70%	16,728	18,708	31,008	68,944	72,149	67,579	32,925	31,531	24,057	24,115	18,396	17,571	30,479
80%	17,433	22,339	40,047	85,367	103,382	73,597	53,322	35,450	26,834	25,556	18,614	21,233	34,358
90%	20,072	35,810	85,179	119,973	140,347	94,111	71,374	63,410	49,954	26,891	20,164	26,639	39,816
Max	40,175	89,880	164,239	286,122	230,891	260,626	148,683	96,651	87,869	49,463	31,601	35,662	67,175
Avg	15,623	21,128	35,233	59,745	65,282	57,293	35,235	28,981	25,885	23,783	17,286	16,896	24,276
C. Historical Total Delta Inflow (cfs) for 1968–2008 (41 years)													
Min	4,749	7,151	8,767	9,894	8,833	7,150	6,199	7,609	7,007	8,409	7,828	7,030	5,953
10%	9,931	9,140	13,456	16,018	15,120	16,656	13,806	11,989	11,794	13,219	13,428	11,977	11,089
20%	10,797	12,692	16,463	20,357	22,727	23,239	15,947	13,060	12,448	14,981	15,124	14,148	12,781
30%	12,167	14,404	18,300	23,383	27,224	27,423	16,998	15,058	14,830	16,662	16,332	15,463	13,783
40%	14,832	15,281	20,158	27,472	34,781	38,006	20,257	16,679	15,340	18,435	17,562	16,939	16,334
50%	15,841	16,349	24,733	40,664	49,178	43,949	25,394	20,085	18,131	20,656	18,901	18,419	23,390
60%	16,416	17,115	29,177	55,360	64,285	63,895	34,181	27,325	20,429	22,225	20,397	19,868	26,579
70%	17,906	18,905	31,774	69,528	83,862	76,489	42,096	34,333	28,028	23,875	21,478	21,359	32,734
80%	19,997	25,320	49,788	99,978	100,899	91,161	61,257	50,786	33,723	24,875	23,175	23,053	35,929
90%	22,640	31,343	83,570	125,071	129,294	105,687	94,841	71,513	52,117	27,796	24,574	28,420	45,561
Max	36,150	71,675	154,696	262,855	227,302	266,621	185,142	104,088	80,632	53,428	35,542	37,543	69,067
Avg	16,013	20,069	35,572	60,381	66,935	62,496	42,293	32,269	25,409	21,348	19,177	19,146	25,407

Table 3-5. Monthly Cumulative Distribution of CALSIM-Assumed Delta Channel Depletions (cfs) for 1922–2003

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	taf
A. Gross Consumptive Use (Evapotranspiration) for 1963–2003 from DAYFLOW													
All years	1,865	1,730	2,081	1,210	880	1,310	1,880	2,434	3,747	4,352	3,785	2,632	1,684
B. Delta Channel Depletions (cfs) for 1963–2003 (41 years) from DAYFLOW													
Min	-246	-4,217	-3,901	-6,794	-7,095	-6,836	-2,450	534	2,940	3,501	2,872	549	-29
10%	66	-2,147	-2,371	-4,771	-4,264	-4,050	-806	1,043	3,441	4,222	3,490	1,839	303
20%	485	-1,900	-1,875	-3,598	-3,597	-2,195	-30	1,570	3,494	4,296	3,739	2,311	390
30%	880	-1,319	-1,252	-2,980	-3,243	-1,551	390	1,807	3,594	4,352	3,785	2,417	645
40%	1,176	-487	-685	-1,828	-2,438	-924	650	2,082	3,670	4,352	3,785	2,570	743
50%	1,300	-36	-293	-1,205	-1,977	-727	902	2,212	3,716	4,352	3,785	2,594	824
60%	1,434	149	-76	-961	-522	-230	1,259	2,314	3,747	4,352	3,785	2,632	876
70%	1,661	872	203	-381	-294	23	1,364	2,388	3,747	4,352	3,785	2,632	933
80%	1,795	1,059	1,119	333	123	302	1,508	2,425	3,747	4,352	3,785	2,632	966
90%	1,865	1,281	1,748	609	375	672	1,643	2,434	3,747	4,352	3,785	2,632	1,042
Max	1,912	1,730	2,081	1,010	757	1,276	1,880	2,434	3,747	4,353	3,785	2,632	1,300
Avg	1,134	-342	-469	-1,718	-1,971	-1,095	629	1,980	3,686	4,289	3,711	2,367	736
C. Gross Channel Depletions (cfs) for 1963–2003 Assumed in CALSIM													
Min	980	703	755	112	359	818	1,326	478	2,460	2,869	1,944	1,153	1,224
10%	1,023	829	932	167	570	1,079	1,405	1,752	2,829	3,047	1,983	1,225	1,270
20%	1,058	989	1,139	233	715	1,260	1,505	1,785	2,959	3,092	2,062	1,301	1,286
30%	1,126	1,181	1,301	288	854	1,349	1,542	1,869	3,078	3,178	2,101	1,303	1,298
40%	1,187	1,471	1,429	417	888	1,454	1,589	1,963	3,098	3,199	2,113	1,333	1,310
50%	1,278	1,874	1,545	612	941	1,544	1,665	2,026	3,127	3,222	2,144	1,340	1,323
60%	1,440	1,975	1,663	741	1,020	1,637	1,684	2,101	3,216	3,269	2,144	1,362	1,327
70%	1,538	2,387	2,104	861	1,066	1,660	1,802	2,168	3,273	3,311	2,183	1,379	1,345
80%	1,684	2,768	2,434	1,046	1,249	1,698	1,832	2,223	3,289	3,356	2,183	1,403	1,355
90%	1,853	3,182	2,781	1,354	1,557	1,806	1,895	2,392	3,345	3,402	2,223	1,435	1,363
Max	3,242	3,611	3,828	2,336	2,481	2,946	2,077	2,670	3,414	3,579	2,341	2,259	1,382
Avg	1,417	1,872	1,758	714	1,048	1,512	1,658	2,000	3,129	3,232	2,131	1,372	1,318

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	taf
D. Delta Channel Depletions (cfs) for 1963–2001 Assumed in CALSIM													
Min	320	-814	-1,470	-5,366	-6,817	-3,422	-790	183	2,335	2,940	1,503	635	28
10%	645	7	-776	-4,025	-2,933	-894	129	1,273	2,585	3,076	1,971	991	324
20%	692	179	-437	-3,289	-2,361	-259	596	1,332	2,791	3,166	2,032	1,094	439
30%	731	371	-111	-1,613	-1,418	-151	873	1,556	2,907	3,187	2,097	1,162	577
40%	821	448	73	-1,168	-932	62	915	1,624	2,984	3,257	2,134	1,204	659
50%	885	482	230	-958	-272	207	1,020	1,814	3,028	3,302	2,153	1,249	693
60%	933	534	368	-670	-69	288	1,146	1,880	3,088	3,350	2,197	1,291	772
70%	970	583	622	-453	118	489	1,243	1,950	3,155	3,393	2,197	1,322	833
80%	1,004	618	657	-194	182	689	1,281	2,143	3,201	3,430	2,237	1,351	868
90%	1,042	653	696	-77	245	821	1,445	2,178	3,257	3,486	2,278	1,351	907
Max	1,072	690	738	40	323	1,115	1,609	2,565	3,384	3,667	2,399	1,409	978
Avg	847	378	84	-1,539	-1,008	-1	912	1,706	2,985	3,289	2,123	1,204	663

Table 3-6. Monthly Cumulative Distribution of CALSIM-Simulated CVP Deliveries (cfs) for 1922–2003

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	taf
A. CALSIM Assumed CVP Demands for 1922–2003 (taf)													
Agricultural	65	46	61	105	125	103	143	203	323	394	295	100	1,963
Exchange	60	20	9	9	25	69	70	96	127	149	146	95	875
Losses	7	5	5	7	10	10	14	20	30	35	29	11	184
Municipal	11	14	15	10	4	15	12	11	11	13	15	16	148
Refuges	71	45	21	9	6	6	13	28	30	8	13	54	305
Total	215	130	112	140	170	204	252	358	521	599	497	276	3,474
Total (cfs)	**3,491**	**2,179**	**1,813**	**2,285**	**3,061**	**3,312**	**4,238**	**5,827**	**8,762**	**9,741**	**8,083**	**4,641**	
B. CALSIM-Simulated CVP Deliveries for 1922–2003													
Min	1,940	1,123	697	493	776	1,365	1,649	2,310	3,188	3,220	3,066	2,411	1,412
10%	2,341	1,311	851	835	1,145	1,549	1,929	2,812	3,911	4,070	3,751	2,855	1,761
20%	2,721	1,609	1,117	1,165	1,539	1,809	2,499	3,624	5,191	5,556	4,875	3,430	2,119
30%	2,785	1,667	1,197	1,305	1,720	2,081	2,633	3,878	5,614	6,064	5,191	3,526	2,325
40%	2,876	1,727	1,337	1,531	2,047	2,281	2,824	4,268	6,256	6,835	5,585	3,669	2,530
50%	3,012	1,844	1,435	1,681	2,206	2,434	3,095	4,509	6,665	7,326	6,164	3,877	2,619
60%	3,048	1,875	1,467	1,738	2,265	2,501	3,163	4,614	6,821	7,537	6,274	3,932	2,715
70%	3,084	1,905	1,506	1,799	2,342	2,597	3,163	4,706	6,972	7,695	6,418	3,981	2,779
80%	3,158	1,965	1,586	1,923	2,521	2,657	3,234	4,891	7,276	8,060	6,700	4,076	2,889
90%	3,350	2,112	1,768	2,280	2,868	2,792	3,552	5,605	8,468	9,493	7,733	4,415	3,069
Max	3,350	2,112	1,789	2,280	2,971	3,127	3,961	5,606	8,469	9,495	7,734	4,416	3,334
Avg	2,895	1,764	1,346	1,556	2,053	2,304	2,886	4,266	6,268	6,867	5,795	3,714	2,517

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	taf
C. CALSIM-Simulated CVP Agricultural Contractor Deliveries for 1963–2003													
Min	0	0	0	0	0	0	0	0	0	0	0	0	154
10%	190	145	200	352	443	206	410	632	1,055	1,269	914	300	393
20%	343	262	362	636	780	314	742	1,143	1,908	2,295	1,654	542	668
30%	417	318	440	773	943	508	854	1,390	2,320	2,790	1,967	660	846
40%	533	406	562	987	1,244	708	1,044	1,766	2,948	3,545	2,348	838	1,049
50%	607	463	641	1,124	1,398	845	1,293	2,003	3,343	4,020	2,897	950	1,134
60%	635	484	670	1,176	1,455	902	1,355	2,104	3,512	4,223	3,027	998	1,229
70%	665	507	702	1,232	1,529	1,006	1,355	2,204	3,677	4,423	3,153	1,045	1,316
80%	733	559	773	1,357	1,711	1,040	1,455	2,397	4,001	4,812	3,467	1,137	1,408
90%	922	703	973	1,708	2,080	1,183	1,722	3,072	5,127	6,165	4,443	1,457	1,575
Max	922	703	973	1,708	2,154	1,493	2,130	3,073	5,128	6,167	4,444	1,458	1,831
Avg	548	418	578	1,015	1,269	746	1,126	1,811	3,022	3,634	2,605	859	1,064

Table 3-7. CVP Jones Pumping Plant Demands and Pumping Capacity

Month	Monthly CVP Jones Demand (taf)	Maximum Volume at 4,600 cfs Capacity (taf)	Additional Needed from San Luis Reservoir (taf)
October	215	283	–
November	130	274	–
December	112	283	–
January	140	283	–
February	170	255	–
March	204	283	–
April	252	274	–
May	358	283	75
June	521	274	247
July	599	283	316
August	497	283	214
September	276	274	–
Total	**3,474**	**3,330**	**852**

Table 3-8. Monthly Cumulative Distribution of CALSIM-Simulated CVP Jones Pumping (cfs) for 1922–2003

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual taf
A. CALSIM-Simulated CVP Jones Pumping (cfs) for 1922–2003 (82 years)													
Min	1,537	973	1,178	880	600	646	800	800	800	600	600	1,684	1,249
10%	3,015	2,967	3,052	2,809	1,152	1,287	800	800	1,694	1,671	1,200	2,887	1,771
20%	3,270	3,821	3,441	4,215	2,230	1,779	1,027	882	2,475	2,745	2,225	3,118	2,131
30%	3,665	4,222	4,210	4,219	3,225	2,173	1,565	1,265	2,563	3,629	3,728	4,113	2,255
40%	4,226	4,234	4,216	4,221	3,798	2,461	1,903	1,500	2,681	3,887	4,255	4,362	2,435
50%	4,321	4,244	4,220	4,224	4,158	2,612	2,152	1,911	2,941	4,254	4,506	4,445	2,523
60%	4,330	4,246	4,221	4,225	4,232	3,195	2,370	1,911	3,000	4,464	4,515	4,460	2,559
70%	4,336	4,248	4,221	4,226	4,241	3,522	2,547	2,081	3,000	4,548	4,521	4,464	2,590
80%	4,346	4,251	4,223	4,227	4,242	4,029	2,547	2,274	3,000	4,576	4,531	4,469	2,703
90%	4,387	4,264	4,226	4,231	4,245	4,258	2,727	3,295	3,000	4,600	4,571	4,490	2,791
Max	4,387	4,264	4,226	4,231	4,253	4,295	3,853	4,076	3,000	4,600	4,571	4,490	2,912
Avg	3,922	3,944	3,915	3,919	3,385	2,773	1,968	1,809	2,606	3,663	3,647	3,996	2,386
B. Historical CVP Jones Pumping (cfs) for 1968–2008 (41 years)													
Min	488	0	0	0	557	641	816	843	310	354	989	1,594	1,251
10%	1,639	927	13	765	1,505	1,889	1,458	906	1,384	2,580	3,086	2,247	1,670
20%	2,087	1,309	849	1,538	2,492	2,035	1,889	1,266	2,489	3,547	4,114	3,134	1,978
30%	2,886	2,047	1,579	2,400	3,075	2,374	2,155	1,671	2,947	4,155	4,279	3,394	2,054
40%	3,397	2,500	2,212	2,921	3,547	3,270	2,509	1,923	2,989	4,331	4,364	3,695	2,276
50%	3,609	3,433	3,245	3,417	3,799	3,741	2,762	2,545	2,997	4,382	4,377	3,998	2,398
60%	3,920	3,708	3,744	3,877	3,944	3,943	3,268	2,979	3,329	4,432	4,386	4,260	2,501
70%	4,139	3,881	3,902	4,006	4,037	4,083	3,609	2,991	3,704	4,459	4,406	4,292	2,610
80%	4,243	4,111	4,066	4,126	4,098	4,112	3,824	3,109	4,160	4,540	4,477	4,361	2,681
90%	4,311	4,220	4,144	4,214	4,268	4,232	4,073	4,054	4,411	4,608	4,540	4,387	2,755
Max	4,350	4,324	4,275	4,358	4,584	4,563	4,399	4,540	4,591	4,739	4,704	4,592	3,002
Avg	3,253	2,799	2,580	2,943	3,312	3,211	2,800	2,421	3,075	3,950	4,040	3,660	2,295

Table 3-9. Monthly Cumulative Distribution of CALSIM-Simulated SWP Deliveries (cfs) for 1922–2003

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual taf
A. CALSIM-Simulated SWP Table A Deliveries for 1922–2003 (82 years)													
Min	603	356	285	31	34	42	1,029	1,420	2,081	2,023	1,595	1,074	1,110
10%	1,426	936	772	34	44	142	2,055	3,061	4,452	4,436	3,613	2,506	1,415
20%	2,553	2,285	1,806	38	143	267	2,219	3,605	5,214	5,130	5,068	3,651	2,025
30%	3,165	2,802	2,304	96	212	618	2,901	4,035	5,738	5,649	5,618	4,124	2,461
40%	3,686	3,274	3,008	138	507	2,289	3,468	4,163	5,862	6,008	5,742	4,325	2,704
50%	4,081	3,637	3,358	183	965	2,476	3,885	4,547	6,297	6,196	6,182	4,719	2,774
60%	4,562	4,087	3,772	442	1,076	2,638	4,291	4,989	6,891	6,718	6,713	5,303	2,954
70%	4,982	4,480	4,156	493	1,238	2,959	4,622	5,387	7,400	7,202	7,236	5,688	3,067
80%	5,064	4,559	4,223	550	1,315	3,201	4,693	5,433	7,483	7,309	7,376	5,746	3,204
90%	5,106	4,629	4,326	612	1,318	3,225	4,735	5,475	7,540	7,346	7,433	5,808	3,345
Max	5,336	5,012	4,897	612	1,340	3,274	4,807	5,557	7,660	7,479	7,575	5,925	3,505
Avg	3,731	3,294	2,993	290	747	1,929	3,579	4,419	6,169	6,087	5,931	4,504	2,635
B. CALSIM-Simulated SWP Carryover Deliveries for 1922–2003 (82 years)													
Min	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	0	0	195	0	0	0	0	0	0	0	0	16
20%	0	0	0	266	21	0	0	0	0	0	0	0	30
30%	0	0	0	850	237	0	0	0	0	0	0	0	84
40%	0	0	0	1,961	1,187	0	0	0	0	0	0	0	218
50%	0	0	0	2,910	1,525	0	0	0	0	0	0	0	276
60%	0	0	0	3,167	1,880	0	0	0	0	0	0	0	339
70%	0	0	0	3,518	2,081	0	0	0	0	0	0	0	353
80%	0	0	0	3,773	3,007	468	0	0	0	0	0	0	376
90%	0	0	0	3,826	3,488	1,025	0	0	0	0	0	0	480
Max	95	14	0	3,908	3,741	1,256	153	158	48	5	0	6	546
Avg	2	0	0	2,271	1,531	207	7	5	1	0	0	0	243

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual taf
C. CALSIM-Simulated SWP Article 21 (Interruptible) Deliveries for 1922–2003 (82 years)													
Min	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	0	0	0	0	0	0	0	0	0	0	0	0
20%	0	0	0	0	0	0	0	0	0	0	0	0	130
30%	0	0	0	0	0	1,359	0	0	0	0	0	0	218
40%	0	0	0	0	663	2,166	0	0	0	0	0	0	332
50%	0	0	0	774	2,230	3,007	0	0	0	0	0	0	400
60%	0	0	0	2,054	3,469	3,070	0	0	0	0	0	0	504
70%	0	0	0	2,347	3,613	3,395	187	0	0	0	0	0	609
80%	0	0	401	2,617	4,390	3,533	1,060	0	0	0	0	0	687
90%	0	0	2,378	3,632	4,983	4,281	1,699	349	0	0	34	0	827
Max	2,567	3,157	3,383	5,009	5,546	5,009	3,176	3,169	2,236	2,407	136	1,827	1,573
Avg	32	60	454	1,373	2,233	2,346	416	122	27	31	8	23	430
D. CALSIM-Simulated SWP Total Deliveries for 1922–2003 (82 years)													
Min	603	356	285	124	153	123	1,029	1,420	2,081	2,023	1,595	1,074	1,229
10%	1,426	944	775	272	1,050	792	2,077	3,084	4,452	4,436	3,613	2,506	1,857
20%	2,553	2,285	1,971	1,579	2,220	2,461	2,541	3,605	5,223	5,130	5,068	3,651	2,597
30%	3,165	2,802	2,772	2,934	3,598	3,560	3,270	4,051	5,738	5,716	5,618	4,124	2,941
40%	3,686	3,274	3,164	3,649	4,511	4,476	3,812	4,164	5,873	6,008	5,742	4,325	3,358
50%	4,081	3,637	3,556	4,095	5,292	5,410	4,286	4,599	6,297	6,196	6,182	4,719	3,462
60%	4,562	4,087	3,874	4,903	5,764	5,970	4,625	5,014	6,891	6,718	6,799	5,303	3,667
70%	5,004	4,480	4,241	5,831	6,193	6,139	4,698	5,387	7,400	7,202	7,266	5,714	3,887
80%	5,075	4,602	4,448	6,274	6,423	6,231	4,893	5,474	7,483	7,318	7,388	5,755	4,062
90%	5,145	4,720	6,014	6,672	6,646	6,256	5,852	5,684	7,542	7,351	7,433	5,812	4,215
Max	7,579	7,669	7,562	7,411	7,566	6,937	7,953	8,684	9,812	9,674	7,575	7,489	5,342
Avg	3,765	3,354	3,447	3,934	4,511	4,482	4,001	4,546	6,197	6,118	5,939	4,527	3,308

Table 3-10. SWP Harvey O. Banks Pumping Plant Demands and Permitted Pumping Capacity

Month	Monthly SWP Banks Demand (taf)	Monthly Volume at 6,680 cfs Permitted Banks Capacity (taf)	Additional Needed from San Luis Reservoir (taf)
October	295	411	–
November	261	397	–
December	245	411	–
January	173	411	–
February	203	371	–
March	235	411	–
April	302	397	–
May	407	411	–
June	520	397	123
July	541	411	130
August	532	411	121
September	404	397	7
Total	4,118	4,836	381

Table 3-11. Monthly Cumulative Distribution of CALSIM-Simulated SWP Banks Pumping (cfs) for 1922–2003

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual taf
A. Total SWP Banks Pumping (cfs)													
Min	1,258	486	774	1,202	300	300	300	300	300	905	300	1,314	1,088
10%	2,075	2,093	3,400	4,462	1,992	1,948	301	870	754	2,598	2,053	2,331	2,116
20%	2,775	3,003	4,740	5,793	3,738	3,329	1,182	1,883	2,721	3,692	3,943	3,284	2,820
30%	3,481	3,800	5,435	6,495	5,082	4,423	2,076	2,264	3,008	5,012	5,020	4,222	3,195
40%	4,257	4,821	6,484	6,901	6,229	5,496	2,682	2,734	3,324	5,711	5,510	4,554	3,473
50%	4,921	5,626	7,052	7,138	6,535	6,296	3,456	3,251	3,553	6,017	6,102	5,603	3,801
60%	5,707	6,638	7,080	7,248	6,764	6,429	4,040	3,684	3,843	6,680	6,530	6,124	3,963
70%	6,289	6,680	7,110	7,392	7,005	6,479	4,662	4,217	3,965	6,680	6,680	6,680	4,096
80%	6,680	6,680	7,201	7,502	7,223	6,566	5,175	4,664	4,843	6,680	6,680	6,680	4,266
90%	6,680	6,680	7,418	8,047	8,072	6,753	6,125	6,165	6,680	6,680	6,680	6,680	4,615
Max	6,680	6,680	7,678	8,500	8,500	7,561	6,125	6,177	6,680	6,680	6,680	6,680	4,931
Avg	4,652	4,974	6,031	6,590	5,652	5,119	3,301	3,300	3,663	5,396	5,234	5,009	3,555
B. Article 21 Pumping (cfs) Included in Total SWP Banks Pumping													
Min	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	0	0	0	0	0	0	0	0	0	0	0	0
20%	0	0	0	0	0	0	0	0	0	0	0	0	130
30%	0	0	0	0	0	1,359	0	0	0	0	0	0	218
40%	0	0	0	0	663	2,166	0	0	0	0	0	0	332
50%	0	0	0	774	2,230	3,007	0	0	0	0	0	0	400
60%	0	0	0	2,054	3,469	3,070	0	0	0	0	0	0	504
70%	0	0	0	2,347	3,613	3,395	187	0	0	0	0	0	609
80%	0	0	401	2,617	4,390	3,533	1,060	0	0	0	0	0	687
90%	0	0	2,378	3,632	4,983	4,281	1,699	349	0	0	34	0	827
Max	2,567	3,157	3,383	5,009	5,546	5,009	3,176	3,169	2,236	2,407	136	1,827	1,573
Avg	32	60	454	1,373	2,233	2,346	416	122	27	31	8	23	430

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual taf
C. Historical SWP Pumping (cfs) for 1968–2008 (41 years)													
Min	138	76	113	302	47	0	17	283	269	206	425	167	416
10%	423	890	727	655	483	706	336	594	357	533	1,580	999	1,031
20%	1,057	1,377	1,844	1,428	1,659	1,153	880	815	491	870	2,176	1,820	1,551
30%	1,859	1,877	2,744	2,717	1,912	1,823	1,267	909	955	1,781	3,502	2,793	1,871
40%	2,314	2,339	2,901	3,088	2,445	2,245	1,724	1,131	1,186	2,457	4,123	3,311	2,113
50%	2,862	2,667	3,552	3,355	3,067	2,634	1,993	1,357	2,055	3,575	4,466	3,689	2,315
60%	3,010	3,197	3,903	4,095	3,509	2,948	2,578	1,688	2,265	4,377	4,981	4,199	2,546
70%	3,604	3,586	4,343	5,771	4,734	3,713	2,713	1,914	3,012	4,734	5,584	4,795	2,677
80%	4,323	4,116	5,229	6,227	5,205	5,554	3,361	2,617	3,402	5,994	6,313	5,870	2,898
90%	5,514	5,277	6,184	6,466	6,209	6,216	4,362	3,094	4,382	6,342	6,765	6,504	3,239
Max	6,455	6,060	6,838	7,801	7,391	6,888	6,408	3,184	5,965	7,162	7,147	7,149	3,688
Avg	2,868	2,883	3,520	3,800	3,278	3,017	2,257	1,580	2,116	3,507	4,305	3,789	2,228

Table 3-12. Monthly Cumulative Distribution of CALSIM-Simulated San Luis Reservoir Storage (taf) for 1922–2003

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
A. SWP San Luis Storage (taf)												
Min	55	55	58	414	461	387	316	286	295	175	123	64
10%	177	213	405	648	862	993	857	702	504	398	300	178
20%	332	408	524	868	1,026	1,067	922	762	566	507	365	289
30%	407	545	708	941	1,067	1,067	971	823	601	563	433	376
40%	487	611	830	1,036	1,067	1,067	994	848	624	574	474	448
50%	550	681	870	1,067	1,067	1,067	1,011	893	680	593	505	513
60%	647	731	912	1,067	1,067	1,067	1,048	936	745	609	546	594
70%	689	826	1,049	1,067	1,067	1,067	1,065	966	803	652	568	626
80%	760	899	1,067	1,067	1,067	1,067	1,067	1,042	895	725	614	684
90%	972	1,036	1,067	1,067	1,067	1,067	1,067	1,067	986	914	842	871
Max	1,067	1,067	1,067	1,067	1,067	1,067	1,067	1,067	1,067	1,067	1,065	1,067
Avg	559	651	805	960	1,012	1,033	977	878	706	617	517	510

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
B. CVP San Luis Reservoir Storage (taf)												
Min	116	197	335	451	514	544	491	400	296	83	45	80
10%	169	303	454	616	690	735	676	573	388	191	92	114
20%	210	351	517	690	770	836	776	633	430	226	127	143
30%	238	380	542	715	823	904	843	689	465	253	140	166
40%	253	396	563	732	861	969	874	717	499	293	168	182
50%	274	415	583	761	895	972	909	740	528	328	194	214
60%	316	450	628	790	923	972	930	770	552	390	240	248
70%	356	492	660	833	969	972	948	807	606	436	284	289
80%	394	540	709	877	972	972	972	851	666	488	306	333
90%	504	634	790	971	972	972	972	948	753	563	424	441
Max	727	872	972	972	972	972	972	972	861	726	615	649
Avg	313	448	612	768	860	908	868	742	546	358	226	246
C. Combined San Luis Reservoir Storage (taf)												
Min	303	414	598	899	1,176	1,062	958	838	605	328	213	236
10%	410	558	926	1,340	1,578	1,761	1,594	1,291	907	650	440	367
20%	569	796	1,040	1,567	1,761	1,834	1,703	1,406	1,005	754	492	439
30%	681	874	1,251	1,660	1,868	1,952	1,771	1,492	1,085	809	593	572
40%	754	1,014	1,432	1,765	1,917	2,017	1,853	1,534	1,148	876	651	671
50%	837	1,104	1,476	1,800	1,942	2,039	1,919	1,616	1,191	919	708	730
60%	942	1,197	1,524	1,833	1,981	2,039	1,952	1,682	1,268	986	760	804
70%	1,045	1,271	1,628	1,865	2,008	2,039	1,989	1,769	1,371	1,090	848	891
80%	1,181	1,442	1,709	1,906	2,039	2,039	2,039	1,885	1,527	1,212	964	1,071
90%	1,340	1,611	1,834	1,994	2,039	2,039	2,039	2,015	1,755	1,372	1,129	1,163
Max	1,758	1,921	2,039	2,039	2,039	2,039	2,039	2,039	1,850	1,700	1,564	1,617
Avg	872	1,099	1,416	1,728	1,873	1,941	1,845	1,620	1,253	976	742	756

Table 3-13. Monthly Cumulative Distribution of CALSIM-Simulated Delta Outflow (cfs) for 1922–2003

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual taf
A. CALSIM-Simulated Delta Outflow for 1922–2003 (82 years)													
Min	3,000	3,500	3,500	4,500	6,627	6,139	6,279	4,000	4,000	4,000	3,158	3,000	3,537
10%	3,573	4,252	4,869	5,834	9,998	9,863	9,853	5,967	6,012	4,487	3,892	3,000	4,965
20%	4,000	4,500	5,185	6,613	13,026	11,722	10,401	8,641	6,466	5,874	4,000	3,000	5,857
30%	4,000	4,500	5,799	8,248	17,290	15,383	11,259	9,747	7,121	6,507	4,000	3,000	6,730
40%	4,000	4,500	6,895	12,384	23,508	20,773	13,935	11,394	7,565	7,159	4,000	3,069	8,621
50%	4,000	4,860	7,962	19,577	32,166	26,469	16,616	13,665	8,491	8,000	4,000	3,469	10,491
60%	4,198	5,015	9,476	27,289	47,278	30,241	20,894	16,134	9,785	8,019	4,128	3,960	14,333
70%	4,388	5,749	17,212	42,155	55,847	41,953	23,543	20,211	10,566	9,338	4,337	4,141	18,807
80%	4,792	8,275	28,226	69,926	76,691	62,095	44,080	26,487	14,611	10,352	4,562	6,736	23,307
90%	7,147	16,988	63,561	102,729	126,361	89,947	62,567	48,761	30,704	12,053	5,450	10,378	30,750
Max	28,552	78,667	155,482	280,126	228,438	258,182	139,947	84,316	74,541	33,710	17,194	22,702	59,486
Avg	4,986	8,789	21,690	39,478	51,113	41,785	26,785	20,315	13,231	8,630	4,585	5,218	14,878
B. CALSIM-Simulated Delta Outflow for 1963–2003 (41 years)													
Min	3,000	3,500	3,500	4,500	6,627	6,139	7,100	4,000	4,000	4,000	3,158	3,000	3,537
10%	3,570	4,500	5,069	6,155	9,865	10,837	9,851	5,779	6,082	5,031	3,991	3,000	4,957
20%	4,000	4,500	5,787	8,553	12,939	15,852	10,527	7,592	6,452	6,372	4,000	3,000	5,947
30%	4,000	4,831	5,848	9,634	19,667	18,558	11,934	10,198	6,897	6,598	4,000	3,000	6,870
40%	4,000	4,943	7,513	19,371	26,080	23,056	14,678	11,231	7,994	8,000	4,000	3,033	9,953
50%	4,000	5,041	8,498	26,294	35,393	28,629	16,556	14,142	9,441	8,000	4,067	3,774	15,315
60%	4,327	5,764	13,090	42,855	49,126	35,801	20,872	15,168	10,638	9,087	4,262	4,110	17,814
70%	4,512	6,674	19,333	62,690	61,811	58,841	24,744	22,997	11,234	10,037	4,364	4,311	22,039
80%	5,029	11,966	28,377	80,259	94,842	65,277	44,994	26,667	14,772	11,170	4,573	8,093	26,661
90%	7,612	24,923	74,593	110,861	133,538	85,034	61,010	51,604	36,035	12,844	6,088	13,396	32,563
Max	28,552	78,667	155,482	280,126	228,438	258,182	139,947	84,316	74,541	33,710	17,194	22,702	59,486
Avg	5,585	11,195	24,855	50,823	57,340	48,728	28,429	21,276	14,801	9,662	4,902	5,966	17,108

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual taf
C. Historical Outflow for 1963–2003 (41 years)													
Min	2,046	3,643	4,213	3,604	3,039	3,007	2,977	3,255	2,383	2,983	2,248	1,737	2,482
10%	3,405	4,291	7,231	9,310	7,361	10,410	6,258	4,659	3,382	3,318	2,772	3,175	5,189
20%	4,184	5,478	8,986	15,120	16,859	15,761	8,729	7,291	3,782	3,854	3,335	3,761	6,528
30%	4,742	6,890	10,467	18,325	21,171	23,404	11,417	9,143	5,113	4,599	4,394	4,622	9,123
40%	5,214	8,205	15,351	21,541	34,196	27,860	12,158	10,761	6,214	5,264	4,846	5,306	12,389
50%	7,321	10,928	22,825	32,144	52,061	34,916	18,946	13,435	7,925	5,865	5,814	6,905	19,168
60%	10,608	16,202	27,133	51,440	57,330	55,986	28,628	22,057	9,223	9,123	6,487	10,476	23,183
70%	12,280	19,964	30,136	66,157	92,555	69,106	42,032	26,406	15,270	9,450	8,467	12,917	28,190
80%	14,978	25,944	47,241	100,906	103,173	85,619	61,170	41,877	21,218	11,065	9,592	14,587	30,432
90%	18,529	27,945	85,369	123,140	126,912	99,152	90,837	64,564	46,596	16,741	12,784	20,060	38,871
Max	42,900	74,137	154,587	262,325	230,854	266,623	142,192	98,659	71,736	43,759	24,484	31,442	64,590
Avg	10,203	16,355	33,074	56,182	64,265	55,055	35,718	25,363	15,597	9,163	7,065	9,775	20,381

Table 3-14. CALSIM-Simulated Required Outflow, Surplus Outflow, and Excess E/I Outflow (cfs) for 1922–2003

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	taf
A. Required Delta Outflow (Minimum and X2)													
Min	3,000	3,500	3,500	4,500	6,627	5,543	5,805	4,000	4,000	4,000	3,000	3,000	3,180
10%	3,000	3,500	3,500	4,500	7,211	7,230	7,957	4,114	5,115	4,000	3,000	3,000	3,838
20%	4,000	4,484	4,500	4,500	7,749	9,569	9,410	5,733	5,673	5,000	3,500	3,000	4,278
30%	4,000	4,500	4,500	4,500	9,756	11,025	10,003	6,644	6,001	5,000	3,500	3,000	4,448
40%	4,000	4,500	4,500	6,000	11,190	11,400	10,315	9,047	6,767	6,500	4,000	3,000	4,937
50%	4,000	4,500	4,500	6,000	11,400	13,793	11,197	9,632	7,522	6,500	4,000	3,000	5,667
60%	4,000	4,500	4,500	6,000	11,400	16,503	14,033	11,002	8,533	8,000	4,000	3,000	6,090
70%	4,000	4,500	4,500	6,000	17,668	17,661	15,262	14,675	9,955	8,000	4,000	3,000	6,608
80%	4,000	4,500	4,500	6,000	22,173	19,349	16,391	16,686	10,725	8,000	4,000	3,000	6,893
90%	4,000	4,500	4,500	6,000	25,447	22,760	18,666	20,219	14,975	8,000	4,000	3,000	7,408
Max	4,000	4,500	4,500	6,000	28,462	27,195	27,118	27,022	22,758	8,000	4,000	3,000	8,491
Avg	3,848	4,337	4,354	5,468	14,164	14,501	12,700	11,160	8,820	6,500	3,744	3,000	5,587

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	taf
B. Surplus Delta Outflow													
Min	0	0	0	0	0	0	0	0	0	0	0	0	322
10%	0	0	369	511	0	0	0	0	0	0	0	0	1,129
20%	0	0	806	1,540	1,843	0	0	6	0	0	0	0	1,536
30%	0	0	1,571	3,248	4,807	2,781	125	754	2	0	0	0	2,338
40%	2	271	2,533	6,384	9,362	4,900	1,558	1,686	288	685	15	69	3,572
50%	190	458	3,825	13,577	18,141	8,175	2,101	2,813	876	1,328	185	469	4,713
60%	332	818	5,020	22,558	28,502	16,331	5,862	3,465	1,515	1,600	402	960	6,916
70%	454	1,449	12,712	36,155	44,663	30,796	11,063	5,399	2,526	2,076	825	1,141	12,028
80%	918	3,793	23,726	63,926	61,892	42,231	27,938	13,518	4,059	3,001	1,266	3,736	16,810
90%	3,147	12,488	59,061	96,729	109,457	71,390	45,445	32,458	12,612	4,105	1,676	7,378	23,045
Max	24,552	74,167	150,982	274,126	204,038	243,799	123,427	65,860	62,023	25,710	13,194	19,702	52,878
Avg	1,138	4,452	17,336	34,010	36,948	27,284	14,086	9,155	4,411	2,130	841	2,218	9,292
C. Excess E/I Inflow (available for Project Diversions)													
Min	0	0	0	0	0	0	1,159	452	0	1,935	498	0	704
10%	0	61	514	86	0	0	1,561	1,124	0	3,344	710	0	1,194
20%	0	253	905	942	52	0	2,123	1,374	27	3,794	805	0	1,370
30%	177	451	1,508	1,998	2,634	973	2,358	1,870	170	4,232	926	0	1,625
40%	499	694	1,848	3,535	3,777	2,314	2,832	2,331	397	4,349	1,260	167	1,936
50%	711	946	2,221	8,165	6,626	3,615	3,378	2,617	918	4,593	1,412	443	2,783
60%	776	1,241	3,167	13,128	9,626	6,044	3,732	3,063	1,457	5,115	1,728	1,162	4,373
70%	1,472	1,575	7,339	22,718	14,420	8,647	4,429	4,156	1,834	5,836	2,117	1,488	5,756
80%	1,648	2,516	14,372	38,951	21,900	15,333	10,664	6,446	2,460	6,890	2,687	1,788	8,546
90%	1,959	7,788	36,856	60,174	36,874	25,542	17,032	11,745	6,100	7,705	3,690	4,196	12,588
Max	15,132	47,478	96,121	174,576	69,432	84,228	43,526	23,575	21,074	20,871	9,290	12,010	23,334
Avg	1,124	3,143	10,793	21,071	12,736	9,567	6,412	4,642	2,124	5,500	1,893	1,466	4,855

Table 3-15. Monthly Cumulative Distribution of IDSM-Simulated Project Diversions (cfs) for 1922–2003

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	taf
A. Project Diversions (cfs)													
Min	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	0	0	0	0	0	0	0	0	0	0	0	0
20%	0	0	0	0	0	0	0	0	0	0	0	0	28
30%	0	0	0	0	0	0	0	0	0	0	0	0	211
40%	0	0	0	0	11	0	0	0	0	0	0	0	215
50%	0	0	0	9	11	22	0	0	0	0	0	0	216
60%	0	0	0	9	11	22	0	0	0	0	0	0	216
70%	0	0	1,434	210	11	22	0	0	0	0	0	0	217
80%	0	0	3,497	2,629	891	22	0	0	0	0	0	0	217
90%	0	0	3,497	3,497	3,801	373	0	0	0	0	0	0	218
Max	0	0	3,497	3,497	3,801	3,497	0	0	0	0	0	0	218
Avg	0	0	1,014	802	681	291	0	0	0	0	0	0	168
B. Project Exports (cfs)													
Min	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	0	0	0	0	0	0	0	0	0	0	0	0
20%	0	0	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	0	0	0	0	0	0	0	0	0	1
40%	0	0	0	0	0	0	0	0	0	0	0	0	42
50%	0	0	0	0	0	0	0	0	0	0	0	0	82
60%	0	0	0	0	0	0	0	0	0	221	0	0	103
70%	0	0	0	0	0	0	0	0	0	728	0	265	146
80%	445	0	0	0	0	0	0	0	0	1,207	445	927	184
90%	811	51	0	0	0	0	0	0	0	2,122	1,357	1,374	210
Max	1,537	1,400	0	0	0	0	0	0	0	2,841	2,620	2,378	302
Avg	219	90	0	0	0	0	0	0	0	568	324	382	95

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	taf
C. Project Discharge for Outflow (cfs)													
Min	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	0	0	0	0	0	0	0	0	0	0	0	0
20%	0	0	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	0	0	0	0	0	0	0	0	0	0
40%	0	0	0	0	0	0	0	0	0	0	0	0	0
50%	0	0	0	0	0	0	0	0	0	0	0	0	0
60%	0	0	0	0	0	0	0	0	0	0	0	0	41
70%	0	823	0	0	0	0	0	0	0	0	0	0	101
80%	1	2,083	0	0	0	0	0	0	0	0	0	0	153
90%	1,000	3,529	0	0	0	0	0	0	0	0	0	184	210
Max	1,000	3,539	0	0	0	0	0	0	0	0	0	1,000	245
Avg	167	805	0	0	0	0	0	0	0	0	0	91	63

Table 3-16. Monthly Cumulative Distribution of IDSM-Simulated Project Deliveries (cfs) for 1922–2003

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	taf
A. Direct CVP Deliveries (cfs)													
Min	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	0	0	0	0	0	0	0	0	0	0	0	0
20%	0	0	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	0	0	0	0	0	0	0	0	0	0
40%	0	0	0	0	0	0	0	0	0	0	0	0	0
50%	0	0	0	0	0	0	0	0	0	0	0	0	0
60%	0	0	0	0	0	0	0	0	0	0	0	0	0
70%	0	0	0	0	0	0	0	0	0	0	0	0	0
80%	0	0	0	0	0	0	0	0	0	0	0	0	0
90%	0	0	0	0	0	0	0	0	0	0	0	0	0
Max	0	0	0	0	0	0	0	0	0	0	0	0	0
Avg	0	0	0	0	0	0	0	0	0	0	0	0	0

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	taf
B. Direct SWP Deliveries (cfs)													
Min	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	0	0	0	0	0	0	0	0	0	0	0	0
20%	0	0	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	0	0	0	0	0	0	0	0	0	0
40%	0	0	0	0	0	0	0	0	0	0	0	0	0
50%	0	0	0	0	0	0	0	0	0	0	0	0	14
60%	0	0	0	0	0	0	0	0	0	0	0	0	35
70%	0	0	0	0	0	0	0	0	0	335	0	78	61
80%	0	0	0	0	0	0	0	0	0	667	426	277	102
90%	210	0	0	0	0	0	0	0	0	899	940	776	121
Max	579	100	0	0	0	0	0	0	0	1,564	2,620	1,661	206
Avg	52	1	0	0	0	0	0	0	0	257	225	177	43
C. Groundwater Bank Pumping for SWP Deliveries (cfs)													
Min	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	0	0	0	0	0	0	0	0	0	0	0	0
20%	0	0	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	0	0	0	0	0	0	0	0	0	0
40%	0	0	0	0	0	0	0	0	0	0	0	0	22
50%	0	0	0	0	0	0	0	0	0	0	0	0	43
60%	0	0	0	0	0	0	0	0	0	0	0	0	61
70%	0	121	0	0	0	0	0	238	177	0	0	0	71
80%	264	233	0	0	0	0	0	595	361	0	0	93	95
90%	552	427	0	0	0	0	0	788	618	0	554	426	130
Max	1,013	646	0	0	0	0	0	1,067	1,063	838	1,070	957	179
Avg	129	108	0	0	0	0	0	219	164	20	123	97	52

Table 3-17. Monthly Cumulative Distribution of IDSM-Simulated Ground Water Bank Operations for 1922–2003

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	taf
A. Ground Water Bank Recharge (cfs)													
Min	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	0	0	0	0	0	0	0	0	0	0	0	0
20%	0	0	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	0	0	0	0	0	0	0	0	0	0
40%	0	0	0	0	0	0	0	0	0	0	0	0	17
50%	0	0	0	0	0	0	0	0	0	0	0	0	49
60%	0	0	0	0	0	0	0	0	0	0	0	0	68
70%	0	0	0	0	0	0	0	0	0	287	0	6	78
80%	193	0	0	0	0	0	0	0	0	797	6	150	89
90%	801	49	0	0	0	0	0	0	0	1,287	240	1,046	117
Max	1,300	1,306	6	6	6	6	6	6	6	1,306	1,306	1,306	176
Avg	164	85	0	0	0	0	0	0	0	301	97	190	51
B. Groundwater Bank Storage (taf)													
Min	0	0	0	0	0	0	0	0	0	0	0	0	
10%	0	0	0	0	0	0	0	0	0	0	0	0	
20%	0	0	0	0	0	0	0	0	0	0	0	0	
30%	12	0	0	0	0	0	0	0	0	0	0	0	
40%	26	14	14	14	14	14	14	0	0	0	0	26	
50%	31	26	26	26	26	26	26	11	0	7	9	35	
60%	48	46	46	46	46	46	46	15	0	26	26	48	
70%	61	48	48	48	48	48	48	26	10	48	41	64	
80%	70	69	69	69	69	69	69	45	26	66	61	83	
90%	111	95	95	95	95	95	95	69	48	85	103	92	
Max	143	214	214	214	214	214	214	155	130	177	142	142	
Avg	44	40	40	40	40	40	40	25	14	31	31	41	

Table 3-18. CALSIM-Simulated Existing Monthly Total Delta Inflow (cfs) for Water Years 1980–2003

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	taf
1980	13,325	18,127	23,614	118,028	140,347	67,579	25,180	22,486	24,730	22,362	15,538	16,923	30,664
1981	14,892	13,865	17,063	31,093	31,015	30,212	18,106	14,632	18,433	21,991	14,283	13,563	14,429
1982	15,997	36,248	97,048	78,495	115,768	91,165	148,683	53,785	33,833	23,733	18,396	30,941	44,894
1983	29,866	51,894	93,821	110,382	183,554	260,626	92,876	88,500	85,155	49,463	31,601	35,662	67,175
1984	24,125	89,880	164,239	72,554	46,126	43,213	22,867	18,239	20,263	26,226	18,335	15,702	33,893
1985	16,922	35,810	24,757	17,288	18,496	16,391	16,425	17,782	17,496	22,286	18,614	15,163	14,325
1986	13,959	14,421	19,939	25,145	222,419	153,110	31,229	25,243	21,607	20,814	17,111	17,734	35,158
1987	15,738	14,871	13,875	16,212	21,271	30,910	13,791	15,747	17,053	21,220	9,992	9,766	12,094
1988	11,572	11,150	19,119	29,664	13,879	10,723	13,205	10,382	15,378	17,801	9,098	9,478	10,344
1989	9,130	10,947	11,246	14,734	10,348	53,626	23,626	16,060	16,429	22,878	17,874	11,884	13,200
1990	13,096	12,950	15,428	20,709	14,546	13,787	13,097	8,457	13,072	19,333	10,193	10,281	9,952
1991	9,711	9,265	8,319	7,427	9,672	33,410	14,544	9,683	9,925	16,546	10,865	10,423	9,037
1992	9,369	8,928	8,873	11,244	33,763	21,425	14,010	9,956	14,490	12,389	13,453	10,482	10,159
1993	8,884	8,640	14,061	68,944	62,269	38,562	41,000	32,920	34,019	23,799	18,031	17,571	22,245
1994	16,631	13,299	16,153	15,099	23,819	18,236	14,021	12,173	16,869	20,296	20,137	11,144	11,939
1995	11,471	10,994	16,675	114,507	54,733	219,490	72,313	96,651	54,997	38,247	24,051	26,639	44,693
1996	18,153	16,837	29,320	51,389	132,788	80,616	48,408	52,952	24,958	20,914	17,834	21,233	31,096
1997	13,016	20,614	110,921	286,122	85,670	31,854	22,043	18,191	18,403	20,833	18,226	14,040	39,816
1998	13,296	15,216	22,736	75,085	230,891	94,111	67,622	64,523	87,869	44,535	26,785	32,734	46,783
1999	21,906	32,251	40,047	46,837	103,382	68,464	32,925	25,302	21,147	23,897	17,882	19,442	27,360
2000	15,766	16,882	14,839	36,990	120,483	72,349	25,649	22,761	19,824	23,414	18,481	16,640	24,379
2001	14,899	16,263	19,914	20,524	27,626	28,945	14,968	12,944	13,537	19,021	10,582	10,171	12,634
2002	11,286	13,427	34,802	53,240	27,792	21,721	19,441	14,917	17,143	22,422	18,014	11,877	16,054
2003	11,239	20,680	38,293	62,337	27,521	25,222	29,245	43,057	22,032	23,693	17,818	16,440	20,367
Avg	14,760	21,394	36,463	57,669	73,257	63,573	34,803	29,473	26,611	24,088	17,216	16,914	25,112

Table 3-19. CALSIM-Simulated Existing Monthly Combined CVP and SWP Export (cfs) for Water Years 1980–2003

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	taf
1980	8,162	10,927	11,314	12,725	10,113	8,241	7,259	5,493	6,979	9,365	8,418	11,000	6,636
1981	9,387	8,230	10,326	11,714	10,855	9,696	4,539	4,336	6,452	10,905	7,567	8,816	6,204
1982	9,800	10,929	11,307	12,001	11,158	9,931	8,513	9,936	9,680	11,280	11,251	11,170	7,660
1983	11,067	10,944	11,605	11,256	9,508	6,991	8,857	10,141	9,680	11,280	11,251	11,170	7,466
1984	11,067	10,944	10,634	8,488	9,050	9,061	4,495	3,758	6,258	10,303	11,185	10,206	6,362
1985	11,000	10,922	11,279	11,158	8,323	5,737	4,116	4,490	6,123	11,225	11,190	9,856	6,360
1986	8,638	8,997	11,300	11,549	12,741	10,129	8,058	8,383	6,018	8,004	9,864	11,140	6,928
1987	10,128	9,250	8,394	7,988	8,556	7,806	1,100	3,994	5,968	10,565	2,952	4,676	4,910
1988	6,049	5,706	11,205	11,448	2,103	1,569	3,066	1,686	4,297	8,697	1,500	4,370	3,722
1989	4,239	5,117	6,731	6,120	2,178	10,530	4,789	2,686	5,750	10,875	10,491	7,725	4,660
1990	7,791	7,369	7,761	11,350	3,231	4,825	1,100	2,341	4,460	7,497	3,859	5,212	4,030
1991	4,339	4,670	2,227	2,705	2,431	11,291	1,591	2,504	2,263	6,717	3,563	5,176	2,985
1992	5,074	2,876	4,365	4,525	11,682	7,499	1,952	1,100	3,420	3,815	6,160	5,351	3,488
1993	4,014	3,893	7,361	12,460	12,099	10,989	6,539	5,035	9,120	11,223	10,801	11,137	6,315
1994	10,810	7,909	9,420	9,439	10,719	5,978	2,648	3,204	5,904	11,257	10,346	6,047	5,652
1995	6,956	4,421	10,839	12,138	12,350	11,184	9,978	10,253	9,680	11,280	11,251	11,170	7,331
1996	11,067	10,944	11,314	11,010	9,616	8,060	7,859	6,895	7,018	7,871	10,136	11,152	6,814
1997	7,806	10,933	11,901	11,403	11,413	8,507	5,255	3,757	5,948	6,304	11,195	9,090	6,245
1998	7,941	9,891	11,295	11,195	11,380	8,694	8,866	9,765	9,680	11,280	11,251	11,170	7,385
1999	11,067	10,944	11,479	11,208	10,151	9,174	7,073	4,354	6,376	9,461	10,711	11,142	6,826
2000	10,246	10,927	8,857	11,466	11,316	10,509	6,707	5,282	6,938	7,653	11,207	10,651	6,743
2001	9,685	10,571	11,319	11,704	11,729	10,131	2,905	2,211	2,738	8,816	3,543	5,396	5,475
2002	5,687	7,727	11,278	11,717	1,100	4,600	4,168	3,925	6,000	11,055	9,975	6,684	5,063
2003	5,599	10,914	11,237	11,443	1,290	8,828	6,040	6,245	6,837	8,129	11,031	10,487	5,917
Avg	8,234	8,581	9,781	10,342	8,546	8,332	5,311	5,074	6,399	9,369	8,779	8,750	5,882

Table 3-20. CALSIM-Simulated Existing Monthly Delta Outflow (cfs) for Water Years 1980–2003

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	taf
1980	4,000	6,230	12,117	107,646	133,538	58,913	16,556	14,765	13,669	8,636	4,000	4,079	23,177
1981	4,000	4,500	5,787	19,782	19,667	20,531	11,934	7,523	7,113	6,372	3,661	3,000	6,870
1982	5,029	24,923	85,829	70,566	105,041	83,999	139,947	41,131	20,061	8,000	4,082	18,471	36,627
1983	17,696	41,570	82,737	103,574	177,494	258,182	84,000	76,159	70,931	33,710	17,194	22,702	59,486
1984	11,536	78,667	155,482	63,891	37,074	33,275	16,781	11,509	9,441	11,220	4,000	3,415	26,323
1985	4,933	25,124	13,090	6,155	9,865	10,837	10,527	10,198	6,452	6,523	4,573	3,774	6,760
1986	4,000	4,842	8,446	14,922	215,438	144,101	21,798	14,142	10,951	8,271	4,000	5,010	27,507
1987	4,000	4,500	4,500	8,117	12,939	23,056	10,643	8,585	6,605	6,367	3,991	3,000	5,810
1988	4,000	4,500	7,408	19,371	11,188	7,895	8,431	6,186	6,897	4,000	4,364	3,000	5,263
1989	3,293	4,943	3,701	8,553	7,857	42,925	16,676	10,357	6,118	7,093	4,341	3,001	7,171
1990	4,000	4,500	6,498	9,634	11,400	7,760	9,869	4,622	4,000	6,975	3,158	3,033	4,552
1991	3,858	3,504	5,091	4,500	6,627	22,380	11,193	4,826	4,006	5,031	4,244	3,039	4,724
1992	3,076	4,975	3,500	6,711	23,834	13,820	10,369	5,779	6,737	4,000	3,994	3,000	5,418
1993	3,570	3,628	6,877	62,690	53,555	27,624	32,967	25,768	20,846	8,000	4,000	4,311	15,315
1994	4,362	4,500	5,823	5,822	13,865	11,018	9,725	7,078	6,230	4,290	6,444	3,000	4,957
1995	3,000	5,764	5,240	109,342	41,766	211,701	61,010	84,316	41,329	22,571	9,574	13,396	36,743
1996	5,419	4,731	17,952	42,216	126,875	72,273	39,198	44,418	13,379	8,000	4,285	8,093	23,339
1997	4,000	8,823	100,039	280,126	73,734	22,042	14,678	11,455	7,994	9,830	4,000	3,000	32,563
1998	4,000	4,946	11,313	67,364	228,438	85,034	57,779	54,253	74,541	28,363	12,079	19,753	39,088
1999	9,530	20,398	27,624	36,625	94,842	58,841	24,744	18,723	10,367	10,037	4,162	6,378	19,444
2000	4,000	5,076	4,959	26,294	113,768	61,110	17,436	15,168	8,008	11,170	4,000	4,147	16,600
2001	4,362	4,659	7,513	9,277	17,101	18,237	10,824	7,592	6,082	6,034	3,882	3,000	5,947
2002	4,000	4,861	25,164	42,855	26,239	16,569	13,338	10,515	6,788	6,598	5,046	3,000	9,953
2003	4,000	8,892	28,377	51,316	26,080	15,852	22,831	34,689	10,362	10,591	4,051	3,962	13,334
Avg	5,153	12,044	26,461	49,056	66,176	55,332	28,052	22,073	15,788	10,070	5,297	6,273	18,207

Table 3-21. IDSM-Simulated Monthly Project Diversions to Storage (cfs) for Water Years 1980–2003

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	taf
1980	0	0	0	3,497	11	22	0	0	0	0	0	0	217
1981	0	0	0	2,629	0	878	0	0	0	0	0	0	216
1982	0	0	3,497	9	11	22	0	0	0	0	0	0	218
1983	0	0	3,497	9	11	22	0	0	0	0	0	0	218
1984	0	0	3,497	9	11	22	0	0	0	0	0	0	218
1985	0	0	3,272	0	0	0	0	0	0	0	0	0	201
1986	0	0	0	0	3,801	86	0	0	0	0	0	0	216
1987	0	0	0	0	0	3,013	0	0	0	0	0	0	185
1988	0	0	0	3,497	0	0	0	0	0	0	0	0	215
1989	0	0	0	0	0	3,497	0	0	0	0	0	0	215
1990	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	402	0	0	0	0	0	0	25
1992	0	0	0	0	3,121	0	0	0	0	0	0	0	180
1993	0	0	0	3,497	11	22	0	0	0	0	0	0	217
1994	0	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	3,497	11	22	0	0	0	0	0	0	217
1996	0	0	0	3,497	11	22	0	0	0	0	0	0	217
1997	0	0	3,497	9	11	22	0	0	0	0	0	0	218
1998	0	0	0	3,497	11	22	0	0	0	0	0	0	217
1999	0	0	3,497	9	11	22	0	0	0	0	0	0	218
2000	0	0	0	2,629	938	22	0	0	0	0	0	0	217
2001	0	0	0	0	703	0	0	0	0	0	0	0	39
2002	0	0	2,048	1,454	0	0	0	0	0	0	0	0	215
2003	0	0	3,497	9	0	0	0	0	0	0	0	0	216
Avg	0	0	1,096	1,156	361	338	0	0	0	0	0	0	180

Table 3-22. IDSM-Simulated Monthly Project Discharges for Export (cfs) for Water Years 1980–2003

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	taf
1980	0	0	0	0	0	0	0	0	0	0	2,067	158	136
1981	1,183	0	0	0	0	0	0	0	0	181	2,318	885	276
1982	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	392	0	929	76
1985	0	0	0	0	0	0	0	0	0	0	0	731	41
1986	1,475	0	0	0	0	0	0	0	0	1,980	1,331	0	294
1987	127	0	0	0	0	0	0	0	0	0	0	2,307	141
1988	0	0	0	0	0	0	0	0	0	722	2,620	0	205
1989	0	0	0	0	0	0	0	0	0	0	420	1,720	121
1990	323	0	0	0	0	0	0	0	0	0	0	0	20
1991	0	0	0	0	0	0	0	0	0	340	0	0	21
1992	0	0	0	0	0	0	0	0	0	2,687	116	0	172
1993	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	193	1,400	0	0	0	0	0	0	0	0	0	0	95
1995	0	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	1,861	1,081	0	181
1997	475	0	0	0	0	0	0	0	0	2,301	0	1,136	234
1998	0	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	1,632	0	0	100
2000	766	0	0	0	0	0	0	0	0	805	0	0	97
2001	1,337	293	0	0	0	0	0	0	0	572	0	0	135
2002	0	0	0	0	0	0	0	0	0	0	996	2,236	185
2003	0	0	0	0	0	0	0	0	0	550	0	0	0
Avg	245	71	0	0	0	0	0	0	0	584	456	421	105

Table 3-23. IDSM-Simulated Monthly Project Releases for Outflow (cfs) for Water Years 1980–2003

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	taf
1980	0	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	3,539	0	0	0	0	0	0	0	0	0	0	211
1984	0	3,539	0	0	0	0	0	0	0	0	0	0	211
1985	1,000	1,189	0	0	0	0	0	0	0	0	0	1,000	188
1986	1	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	655	38
1988	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	1,000	56
1990	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	1,000	901	0	0	0	0	0	0	0	0	0	0	115
1995	0	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	3,530	0	0	0	0	0	0	0	0	0	0	210
1997	0	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	3,530	0	0	0	0	0	0	0	0	0	0	210
2000	0	1,053	0	0	0	0	0	0	0	0	0	0	63
2001	1,000	0	0	0	0	0	0	0	0	0	0	0	61
2002	0	0	0	0	0	0	0	0	0	0	0	204	11
2003	0	0	0	0	0	0	0	0	0	0	0	0	0
Avg	125	720	0	0	0	0	0	0	0	0	0	119	57

Table 3-24. CALSIM-Simulated Existing End-of-Month X2 Location (km) for Water Years 1980–2003

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1980	87.7	84.0	77.6	58.8	51.0	54.7	65.7	70.1	72.2	76.4	83.7	85.9
1981	86.8	86.2	84.0	73.9	70.6	69.2	72.9	77.7	79.7	81.2	85.9	89.0
1982	86.0	72.8	59.0	56.0	51.9	52.3	48.5	56.7	64.8	74.6	82.9	74.1
1983	71.5	64.1	56.4	52.2	46.7	42.0	49.0	52.1	53.7	59.9	67.1	67.3
1984	72.6	59.6	50.1	53.8	59.2	61.8	67.9	72.8	75.9	75.6	83.4	87.2
1985	85.6	72.6	73.3	79.4	77.7	76.5	76.3	76.5	80.0	81.1	84.2	86.7
1986	87.0	85.7	81.0	75.1	52.7	48.4	61.5	69.1	73.6	77.2	83.9	84.4
1987	86.3	86.0	85.9	81.4	76.3	70.2	74.1	77.1	80.0	81.3	85.3	88.8
1988	87.7	86.5	82.2	73.5	74.8	77.9	78.5	81.0	81.0	85.2	85.9	89.0
1989	89.3	86.3	87.5	81.5	80.2	66.7	69.5	74.1	79.7	80.3	84.3	88.5
1990	87.6	86.4	83.2	79.2	76.5	78.6	77.5	82.9	85.8	82.5	87.5	89.4
1991	88.2	88.6	85.8	85.8	82.9	72.6	74.5	81.6	85.4	84.8	86.0	88.9
1992	89.8	86.4	88.0	83.5	72.3	72.8	75.2	80.5	81.0	85.2	86.6	89.2
1993	88.7	88.5	83.5	64.9	60.0	63.5	63.3	65.1	67.3	75.4	83.3	85.4
1994	85.9	85.9	83.9	83.2	76.4	75.9	76.7	79.4	81.3	84.7	82.7	88.0
1995	89.7	85.2	84.5	61.0	60.6	48.1	53.5	52.8	58.0	64.4	73.0	73.3
1996	80.3	83.7	74.5	65.0	53.4	54.0	58.8	59.5	68.9	75.9	83.0	80.4
1997	85.0	80.4	60.3	45.8	51.3	62.4	69.1	73.2	77.3	77.1	83.9	88.3
1998	87.6	85.7	78.7	62.8	48.2	51.0	54.9	56.6	54.8	61.6	70.3	69.4
1999	74.7	70.6	67.0	63.6	55.2	56.1	63.0	67.5	73.4	75.6	83.1	82.3
2000	85.6	84.9	84.8	72.0	56.6	56.3	65.8	70.0	76.2	75.7	83.5	85.7
2001	86.1	85.7	81.9	79.0	73.4	71.1	74.3	78.1	81.0	82.0	85.7	88.9
2002	87.8	85.9	72.7	64.3	65.3	69.1	72.1	74.8	79.1	80.7	83.3	88.1
2003	87.5	81.2	70.2	62.1	64.6	69.2	68.0	64.3	72.4	74.9	83.1	84.0
Avg	85.2	81.8	76.5	69.1	64.1	63.3	67.1	70.6	74.3	77.2	82.6	84.3

Table 3-25. IDSM-Simulated End-of-Month X2 Location (km) with Project for Water Years 1980–2003

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1980	87.7	84.0	77.7	59.1	51.1	54.8	65.7	70.1	72.2	76.4	83.7	85.9
1981	86.8	86.2	84.0	75.0	71.0	69.7	73.1	77.7	79.7	81.2	85.9	89.0
1982	86.0	72.8	59.3	56.1	52.0	52.3	48.5	56.7	64.8	74.6	82.9	74.1
1983	71.5	63.5	56.5	52.2	46.7	42.0	49.0	52.1	53.7	59.9	67.1	67.3
1984	72.6	59.2	50.2	53.8	59.2	61.8	67.9	72.8	75.9	75.6	83.4	87.2
1985	84.2	71.8	75.3	80.0	77.9	76.5	76.3	76.5	80.0	81.1	84.2	84.9
1986	86.4	85.5	80.9	75.1	52.8	48.5	61.5	69.1	73.6	77.2	83.9	84.4
1987	86.3	86.0	85.9	81.4	76.3	71.3	74.5	77.2	80.1	81.3	85.3	87.3
1988	87.2	86.3	82.2	75.0	75.3	78.1	78.5	81.0	81.0	85.2	85.9	89.0
1989	89.3	86.3	87.5	81.5	80.2	67.4	69.8	74.2	79.7	80.4	84.3	86.3
1990	86.9	86.2	83.2	79.1	76.5	78.6	77.5	82.9	85.8	82.5	87.5	89.4
1991	88.2	88.6	85.8	85.8	82.9	72.7	74.6	81.6	85.4	84.9	86.0	88.9
1992	89.8	86.4	88.0	83.5	73.4	73.2	75.3	80.5	81.0	85.2	86.6	89.2
1993	88.7	88.5	83.5	65.3	60.2	63.5	63.3	65.1	67.3	75.4	83.3	85.4
1994	84.4	84.0	83.3	83.0	76.3	75.9	76.7	79.4	81.3	84.7	82.7	88.0
1995	89.7	85.2	84.5	61.2	60.7	48.1	53.5	52.8	58.0	64.4	73.0	73.3
1996	80.3	79.4	73.1	65.2	53.5	54.0	58.8	59.5	68.9	75.9	83.0	80.4
1997	85.0	80.4	60.6	45.9	51.3	62.4	69.1	73.2	77.3	77.1	83.9	88.3
1998	87.6	85.7	78.7	63.2	48.3	51.0	54.9	56.6	54.8	61.6	70.3	69.4
1999	74.7	69.4	67.6	63.8	55.3	56.1	63.1	67.5	73.4	75.6	83.1	82.3
2000	85.6	83.4	84.3	72.6	56.8	56.4	65.8	70.0	76.2	75.7	83.5	85.7
2001	84.5	85.1	81.7	79.0	73.7	71.1	74.3	78.1	81.0	82.0	85.7	88.9
2002	87.8	85.9	73.3	64.7	65.4	69.2	72.1	74.8	79.1	80.7	83.3	87.6
2003	87.3	81.1	71.2	62.4	64.7	69.3	68.0	64.4	72.4	74.9	83.1	84.0
Avg	84.9	81.3	76.6	69.3	64.2	63.5	67.2	70.6	74.3	77.2	82.6	84.0

Table 3-26. IDSM-Simulated Change in End-of-Month X2 Location (km) with Project for Water Years 1980–2003

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1980	0.0	0.0	0.0	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1981	0.0	0.0	0.0	1.1	0.4	0.5	0.1	0.0	0.0	0.0	0.0	0.0
1982	0.0	0.0	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1983	0.0	-0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1984	0.0	-0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1985	-1.4	-0.8	1.9	0.6	0.2	0.1	0.0	0.0	0.0	0.0	0.0	-1.8
1986	-0.6	-0.2	-0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1987	0.0	0.0	0.0	0.0	0.0	1.1	0.4	0.1	0.0	0.0	0.0	-1.5
1988	-0.5	-0.2	-0.1	1.5	0.5	0.2	0.1	0.0	0.0	0.0	0.0	0.0
1989	0.0	0.0	0.0	0.0	0.0	0.7	0.2	0.1	0.0	0.0	0.0	-2.2
1990	-0.7	-0.2	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1991	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
1992	0.0	0.0	0.0	0.0	1.1	0.4	0.1	0.0	0.0	0.0	0.0	0.0
1993	0.0	0.0	0.0	0.4	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
1994	-1.6	-1.9	-0.6	-0.2	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1996	0.0	-4.3	-1.4	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1997	0.0	0.0	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1998	0.0	0.0	0.0	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1999	0.0	-1.2	0.6	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2000	0.0	-1.4	-0.5	0.7	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0
2001	-1.6	-0.5	-0.2	-0.1	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0
2002	0.0	0.0	0.7	0.5	0.2	0.1	0.0	0.0	0.0	0.0	0.0	-0.5
2003	-0.2	-0.1	1.0	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Avg	-0.3	-0.5	0.1	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	-0.3

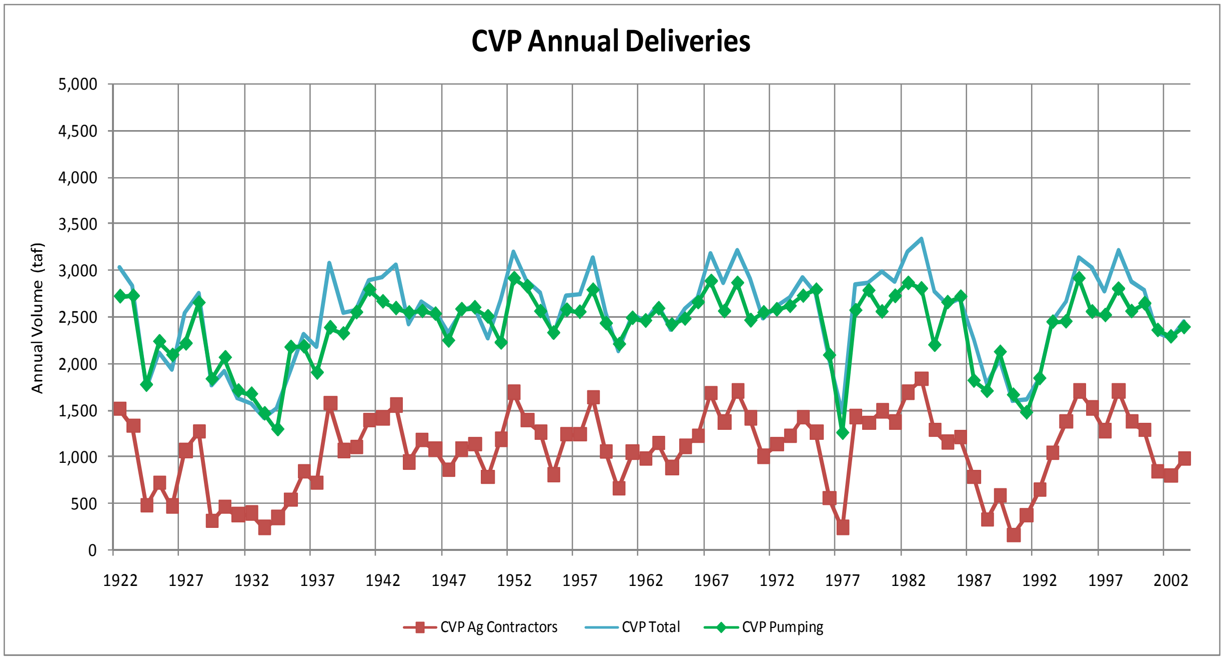


Figure 3-1. CALSIM-Simulated Annual CVP Deliveries (Total and Agricultural) for 1922–2003

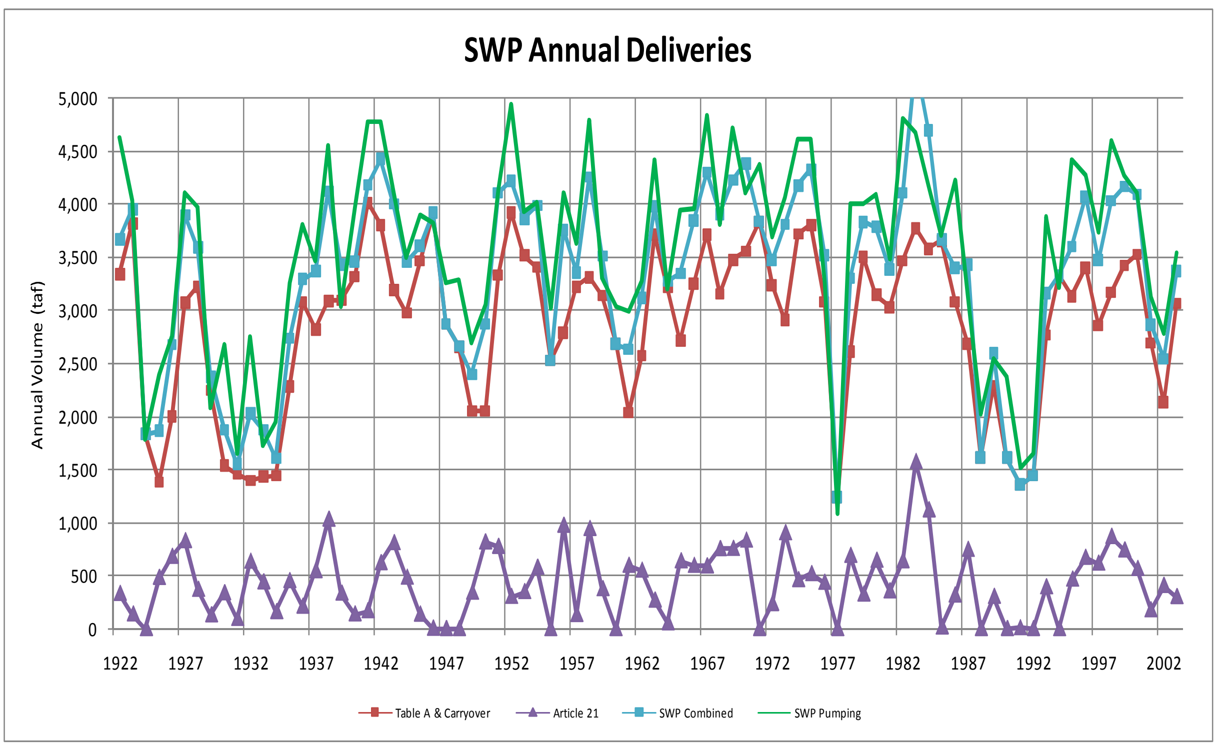


Figure 3-2. CALSIM-Simulated Annual SWP Deliveries (Total and Article 21) for 1922–2003

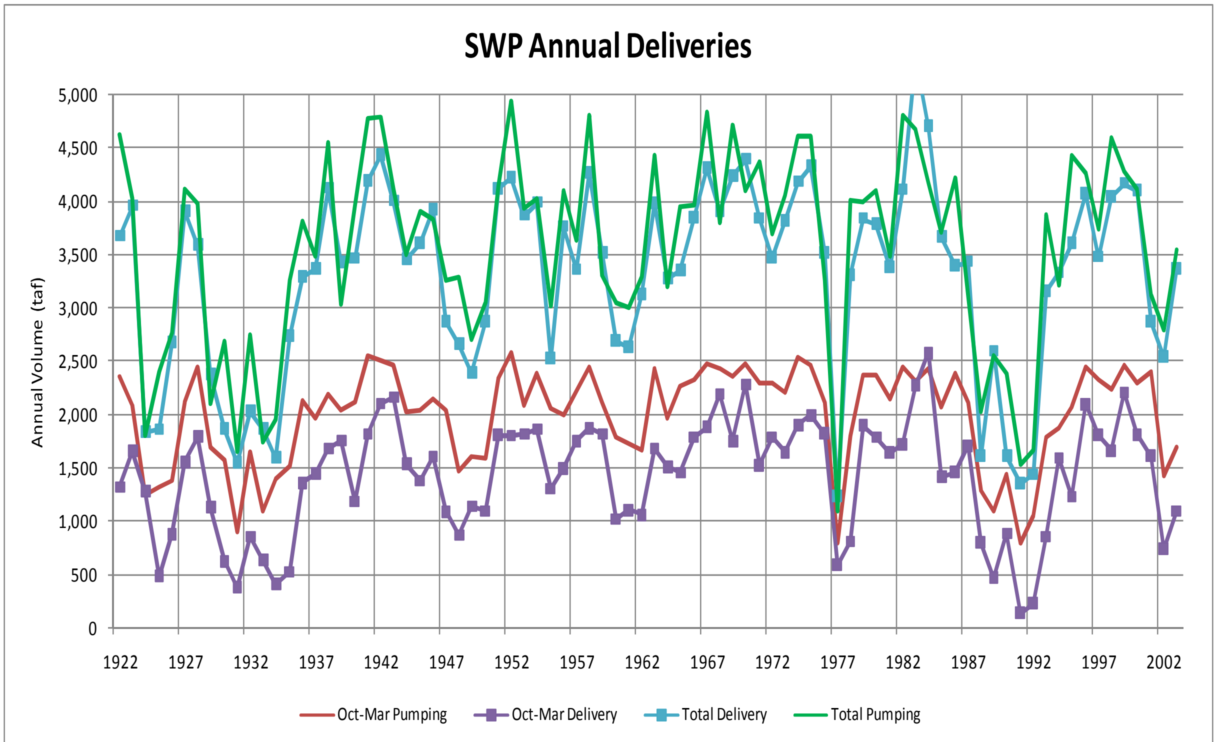


Figure 3-3a. CALSIM-Simulated Annual SWP Delivery and Pumping Compared to October–March SWP Delivery and Pumping for 1922–2003

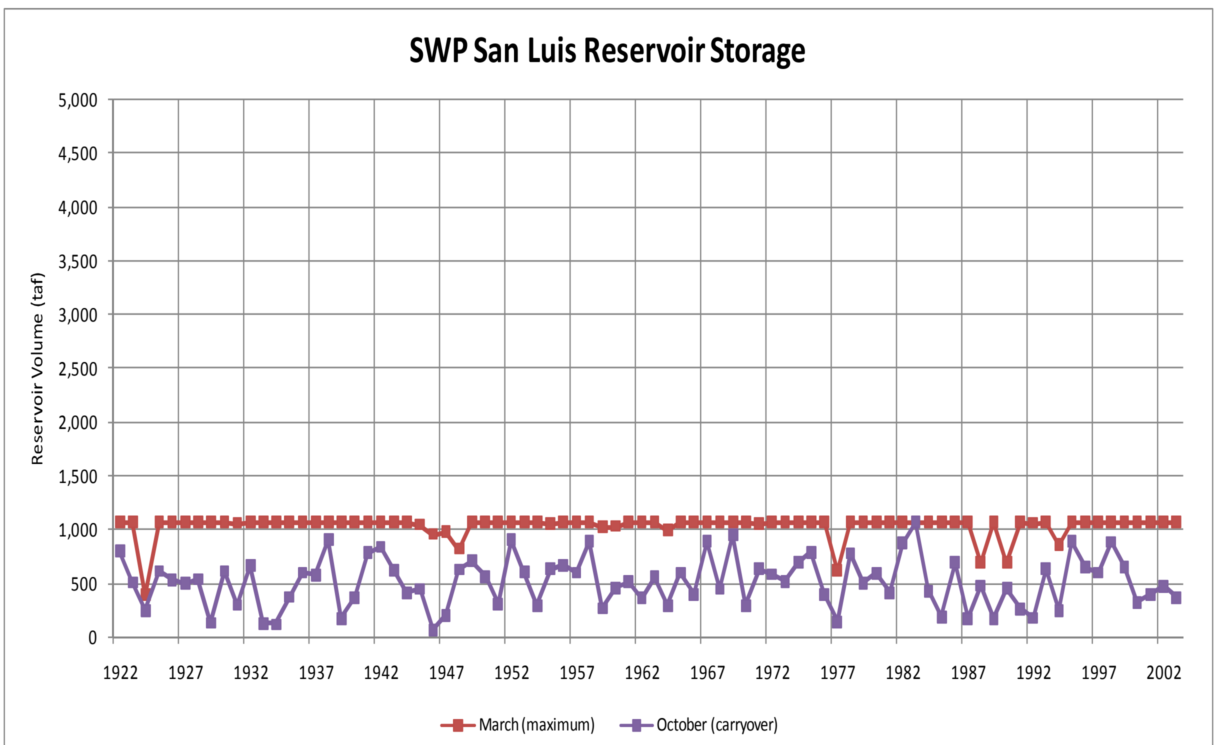


Figure 3-3b. CALSIM-Simulated SWP San Luis Reservoir Storage in March and September for 1922–2003

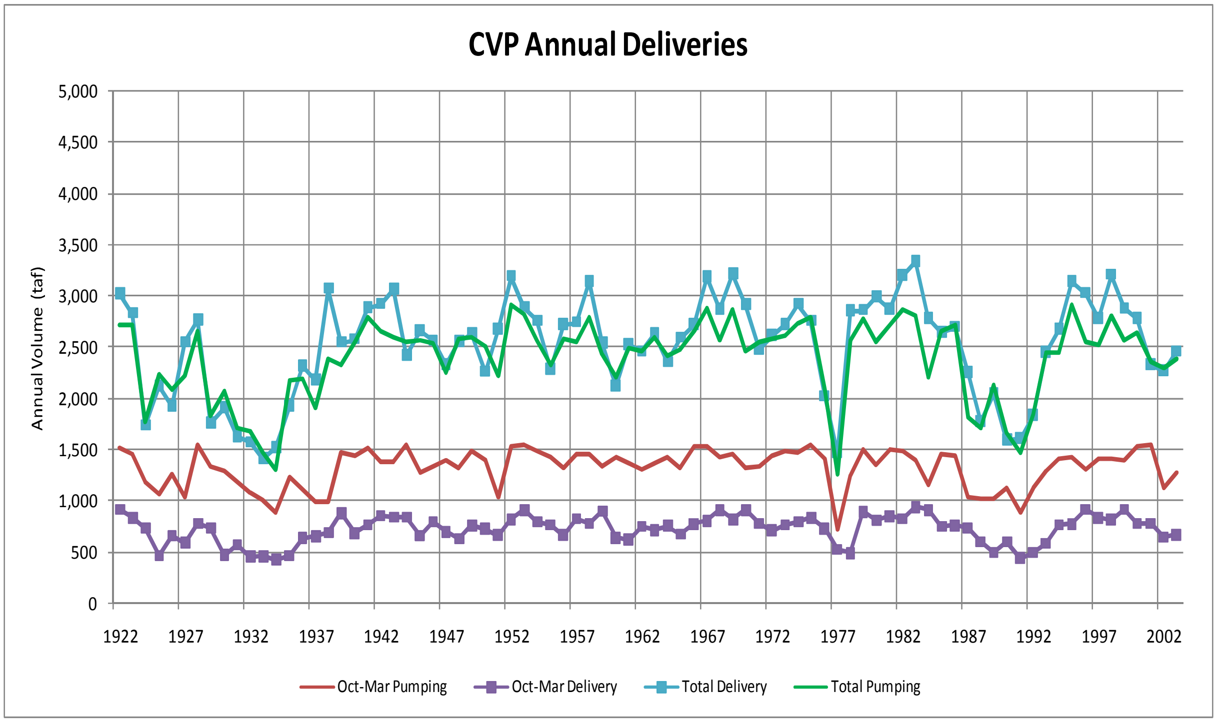


Figure 3-4a. CALSIM-Simulated Annual CVP Delivery and Pumping Compared to October–March CVP Delivery and Pumping for 1922–2003

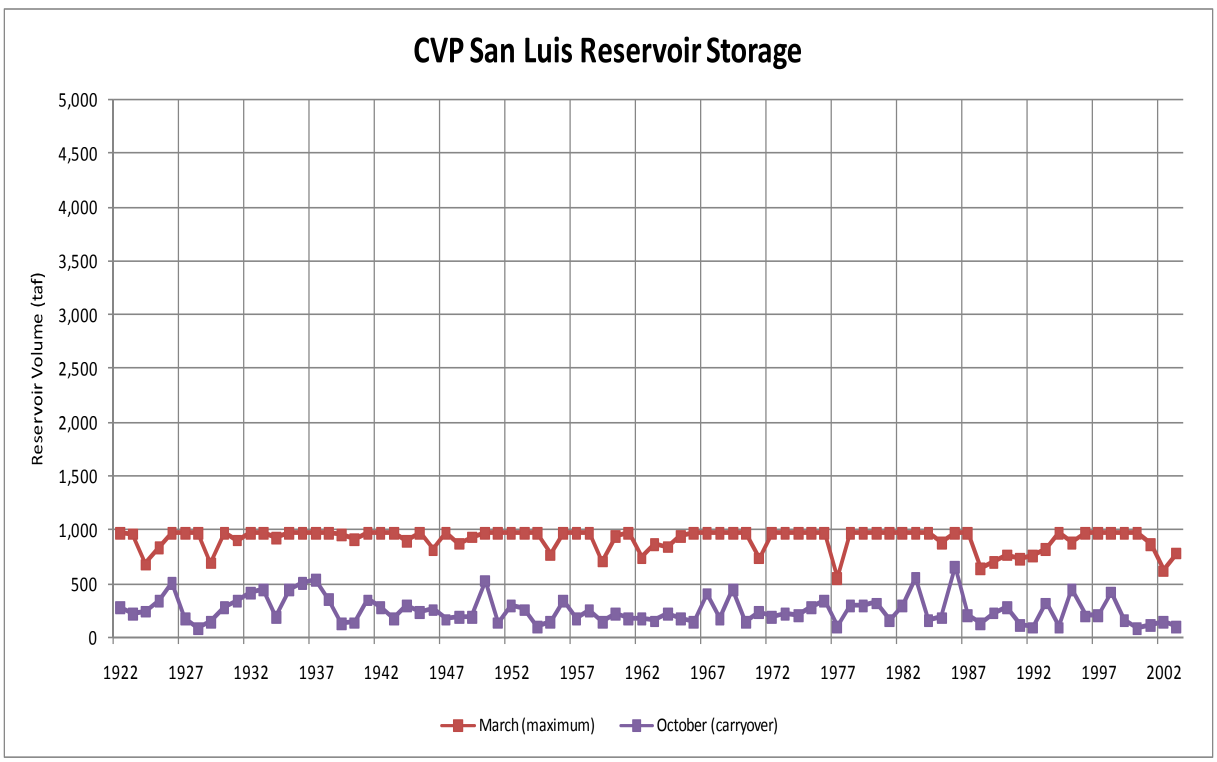


Figure 3-4b. CALSIM-Simulated CVP San Luis Reservoir Storage in March and September for 1922–2003

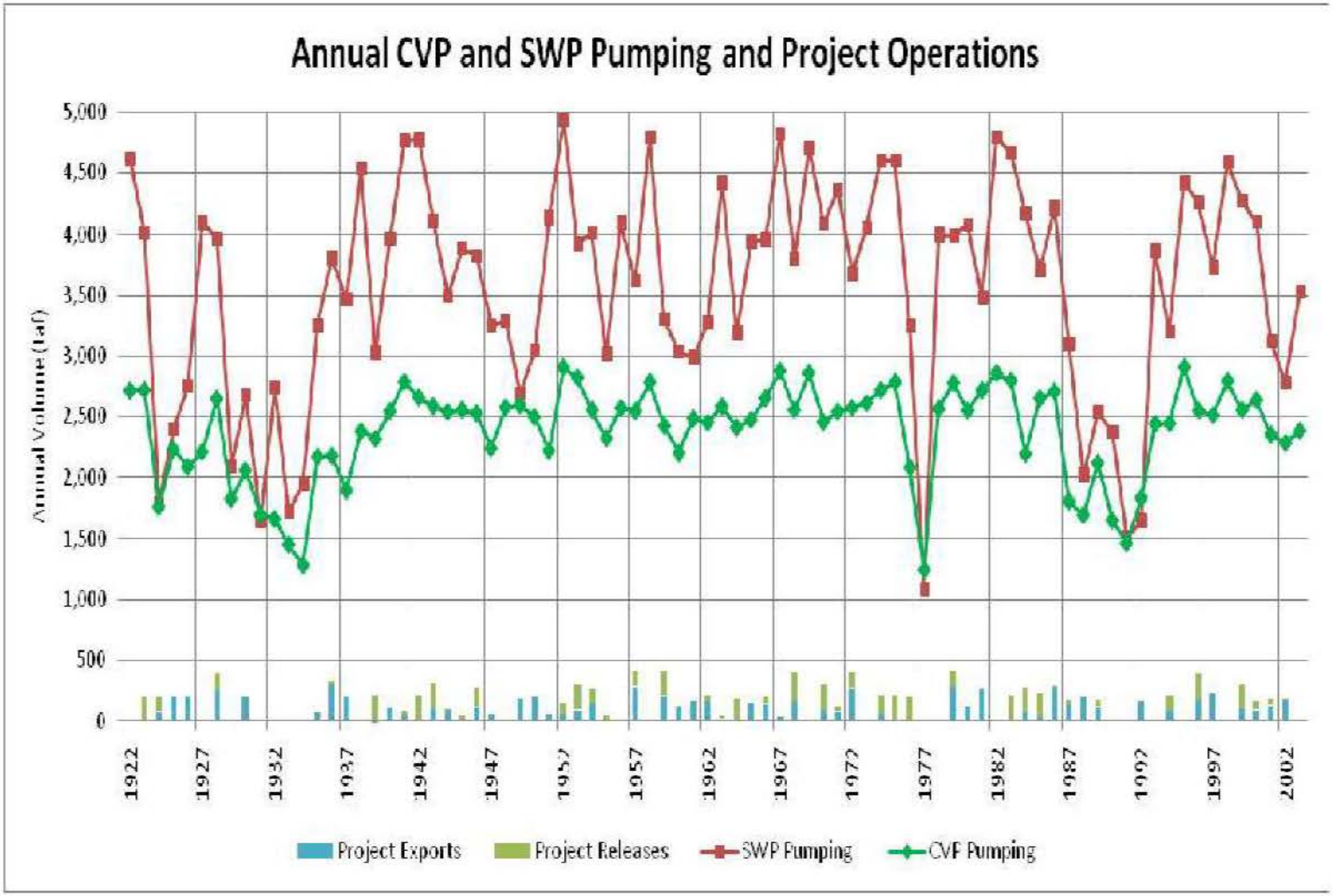


Figure 3-5. CALSIM-Simulated CVP and SWP Annual Export Pumping with IDSM-Simulated Project Export Pumping and Releases for Delta Outflow for 1922–2003

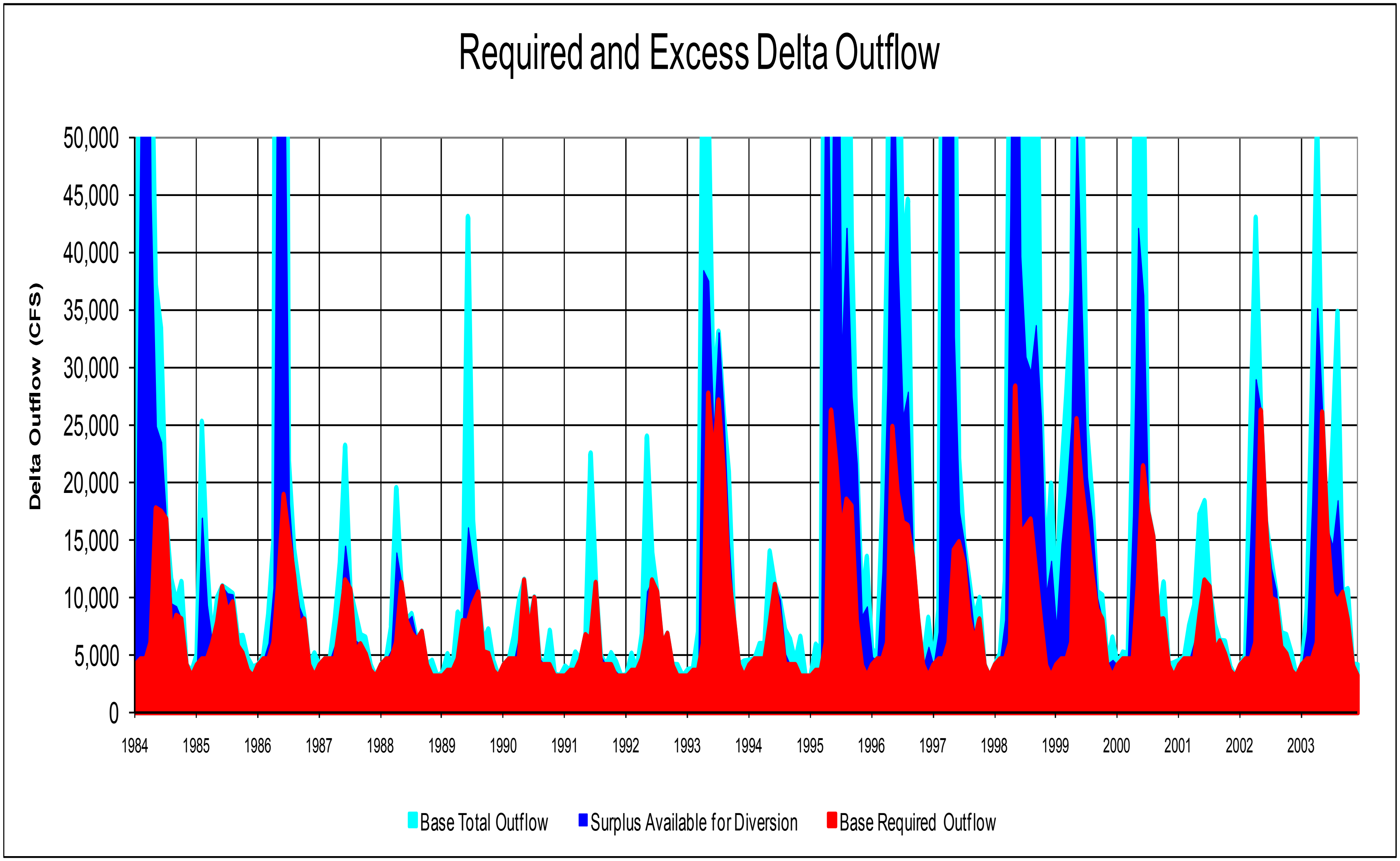


Figure 3-6. IDSM-Simulated Delta Outflow with Required Outflow, Surplus Outflow, and Available for Project Diversions (within E/I) for Water Years 1984–2003

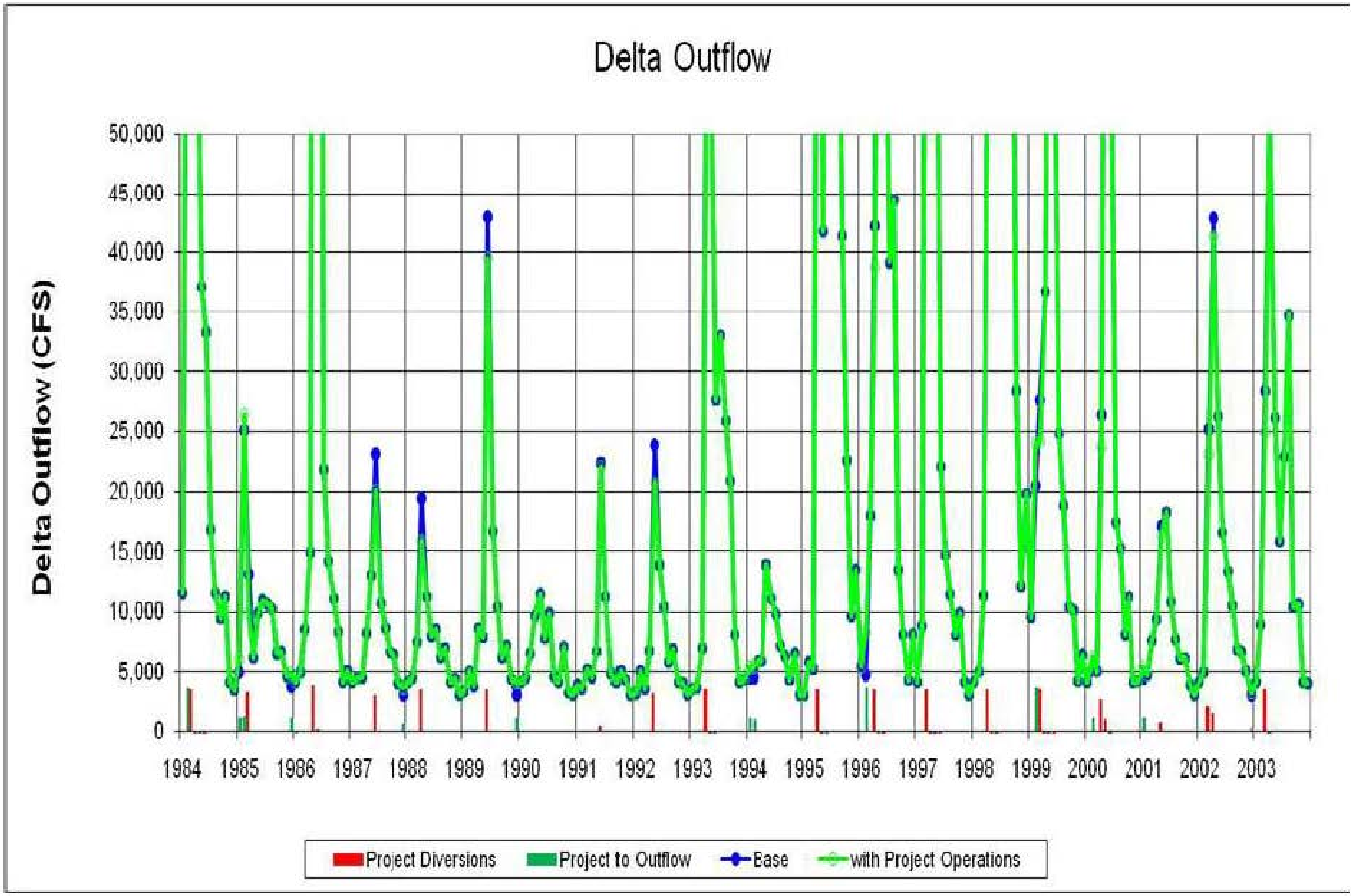


Figure 3-7. IDSM-Simulated Delta Outflow with Project Diversions and Project Releases for Increased Delta Outflow for Water Years 1984–2003

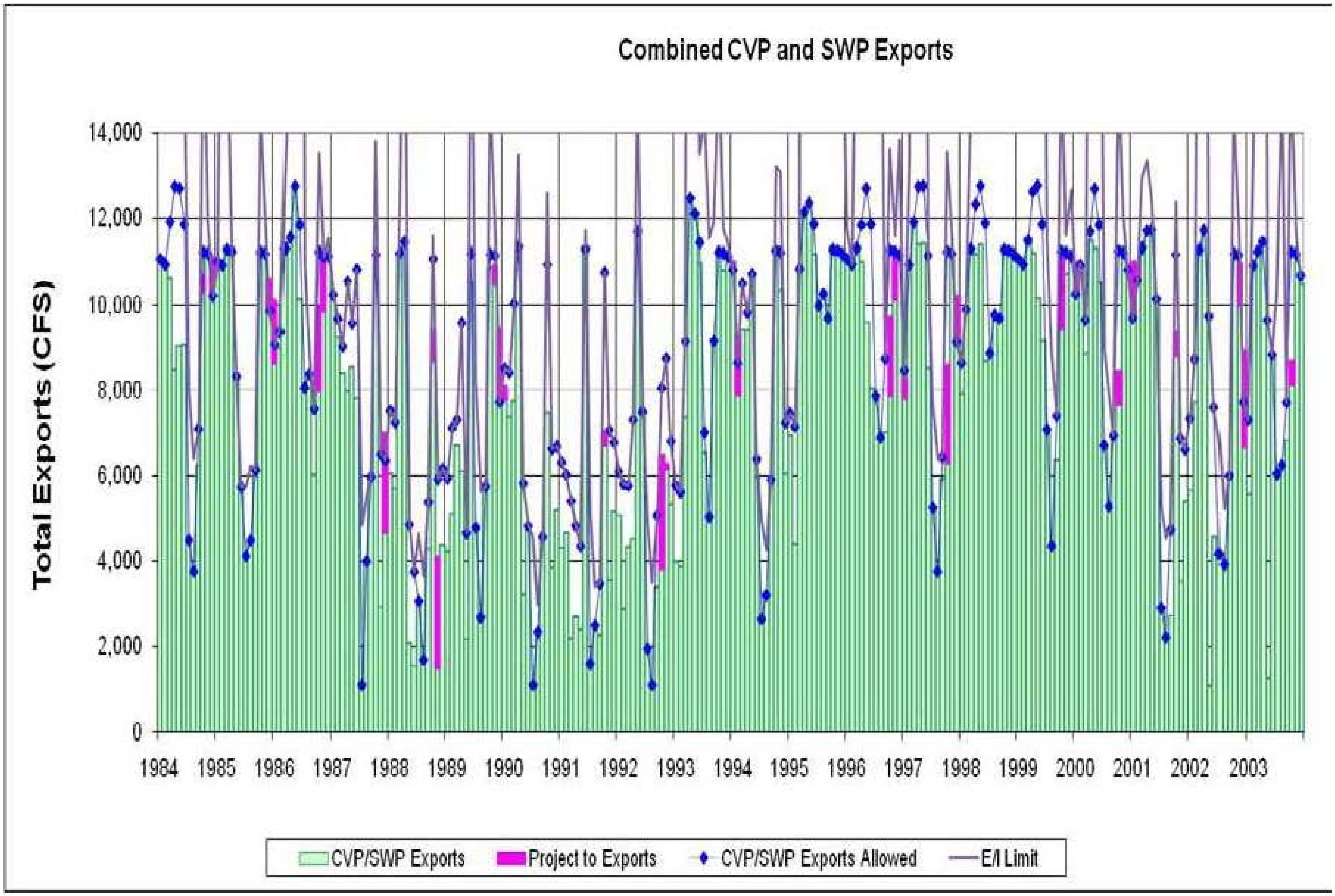


Figure 3-8. IDSM-Simulated Combined CVP and SWP Exports with Project Exports for Water Years 1984–2003
Note: The allowable exports and the E/I limits are shown for comparison.

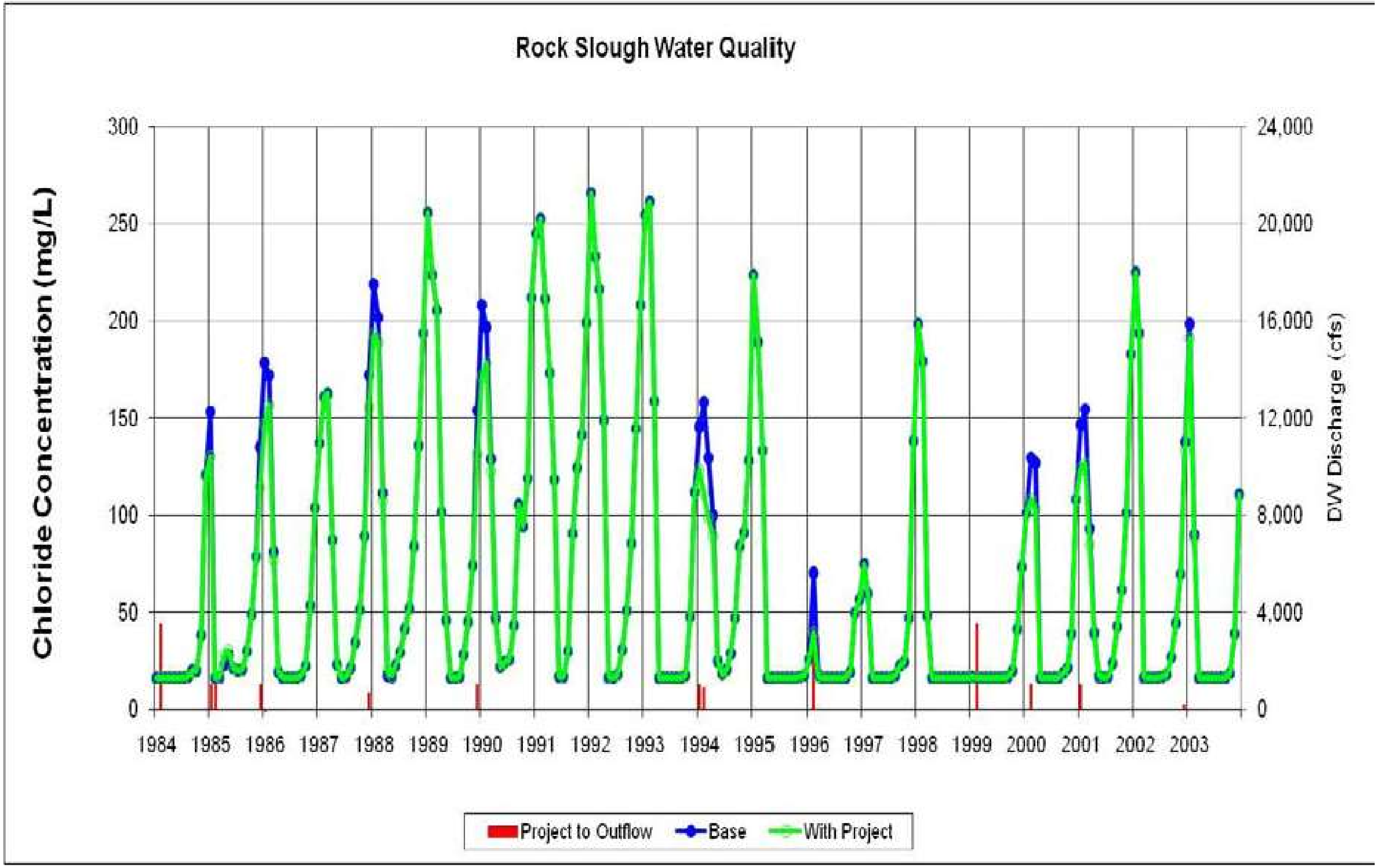


Figure 3-9. IDSM-Simulated CCWD Rock Slough Chloride Concentration with Project Releases for Increased Delta Outflow for Water Years 1984–2003

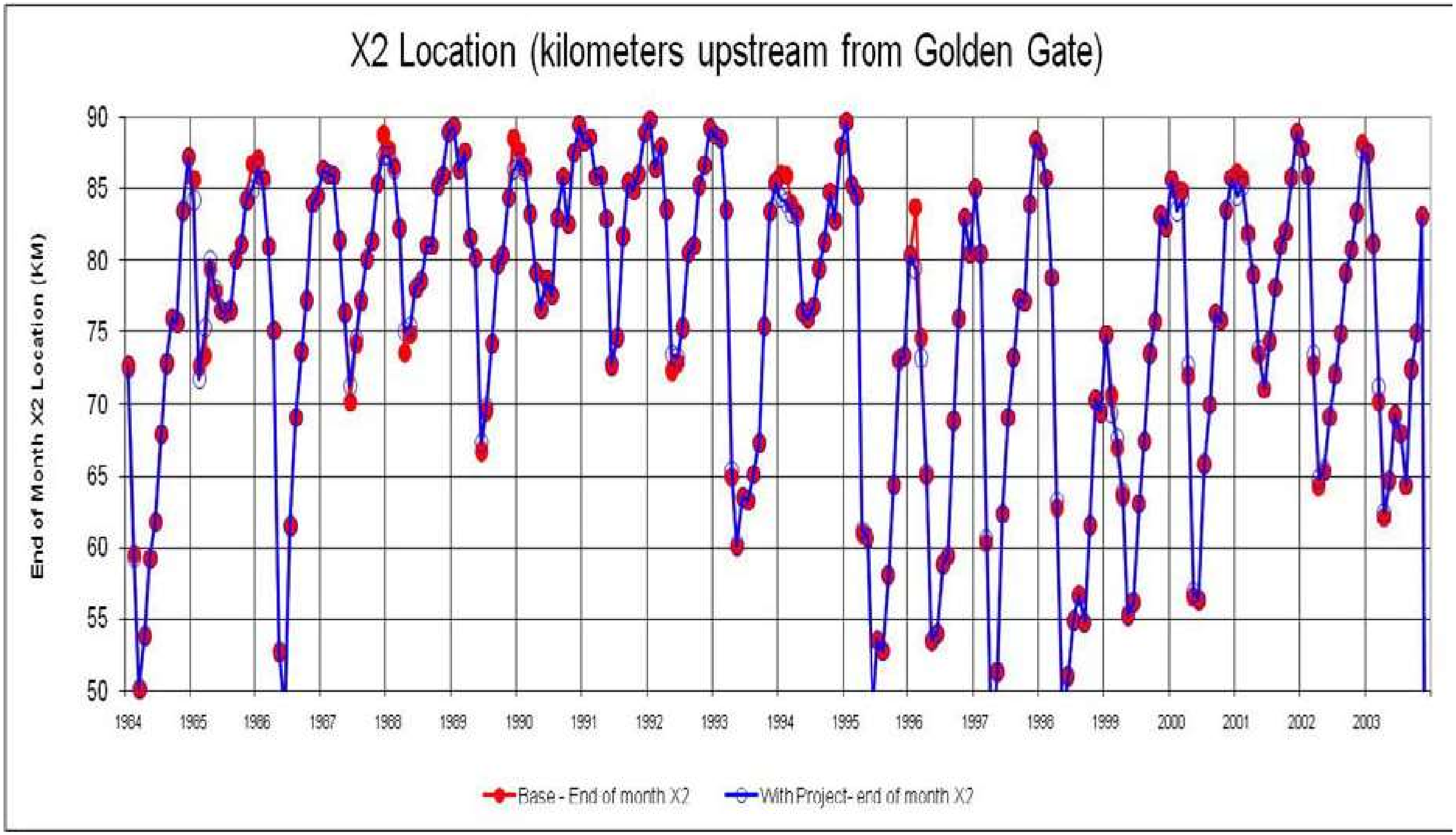


Figure 3-10. IDSM-Simulated End-of-Month X2 Location with Project Diversions and Releases for Increased Delta Outflow for Water Years 1984–2003

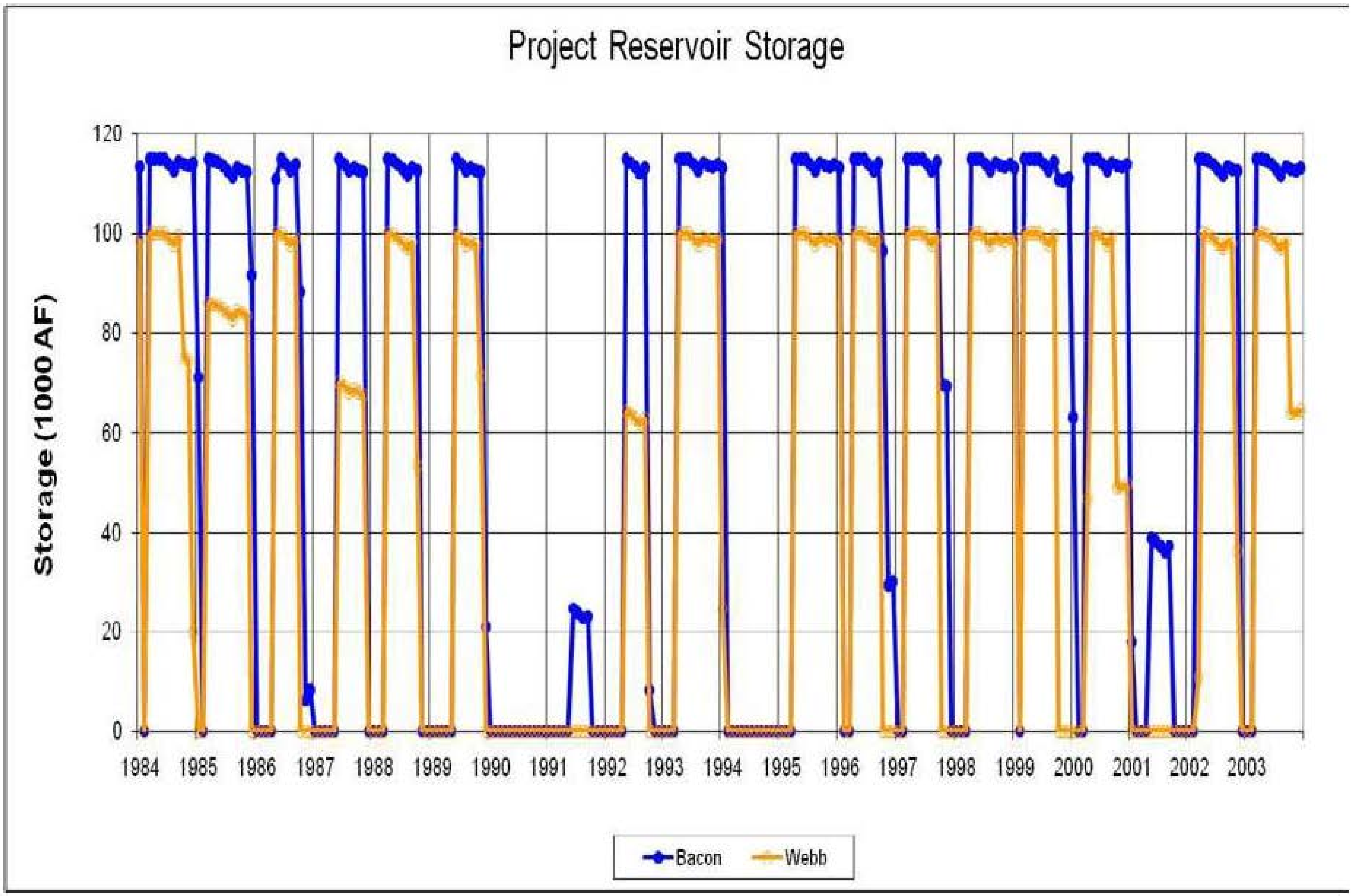


Figure 3-11. IDSM-Simulated Project Reservoir Storage on Bacon Island and Webb Tract for Water Years 1984–2003

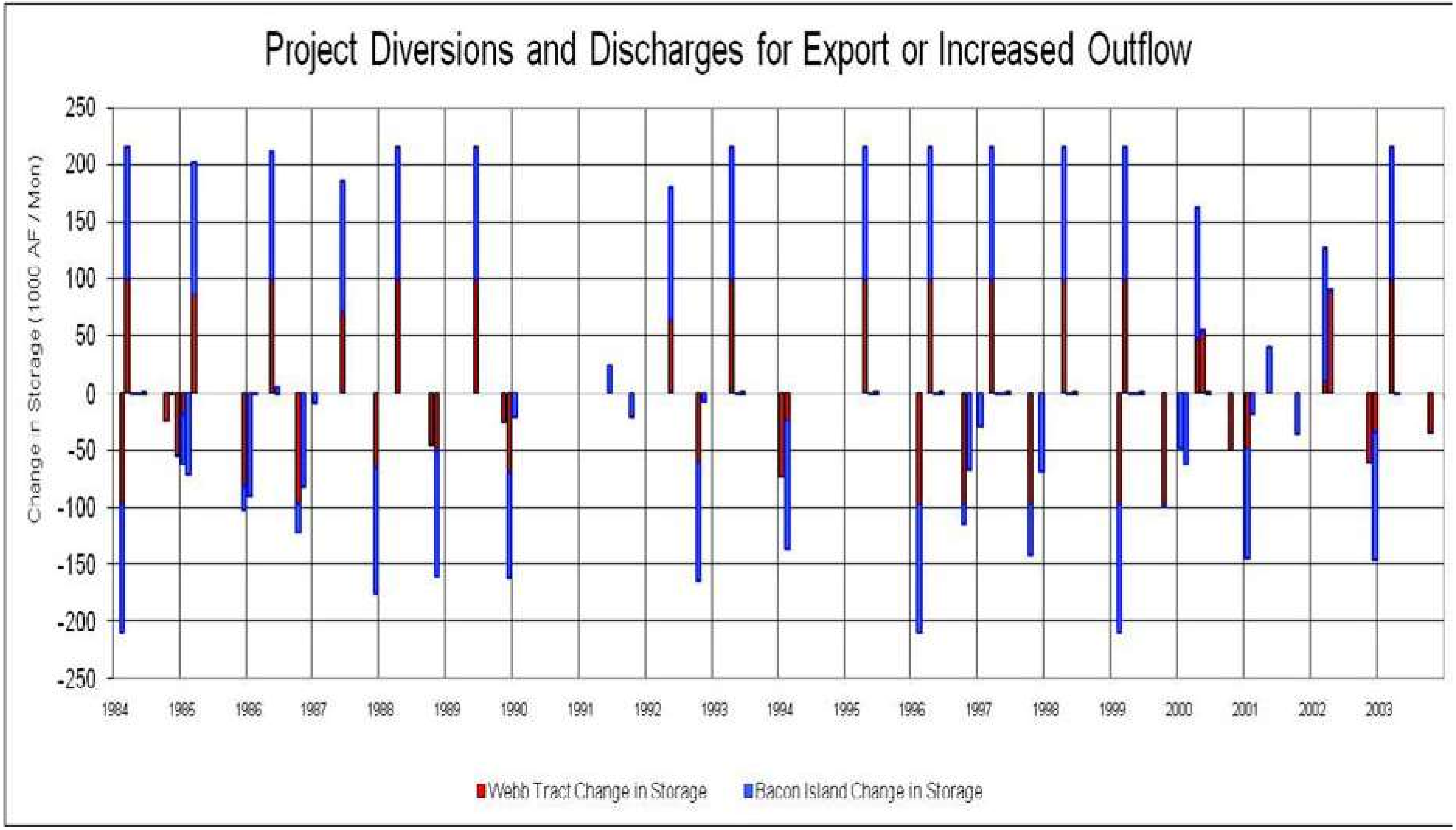


Figure 3-12. IDSM-Simulated Project Diversions or Discharges for Increased Export or Increased Delta Outflow for Water Years 1984–2003

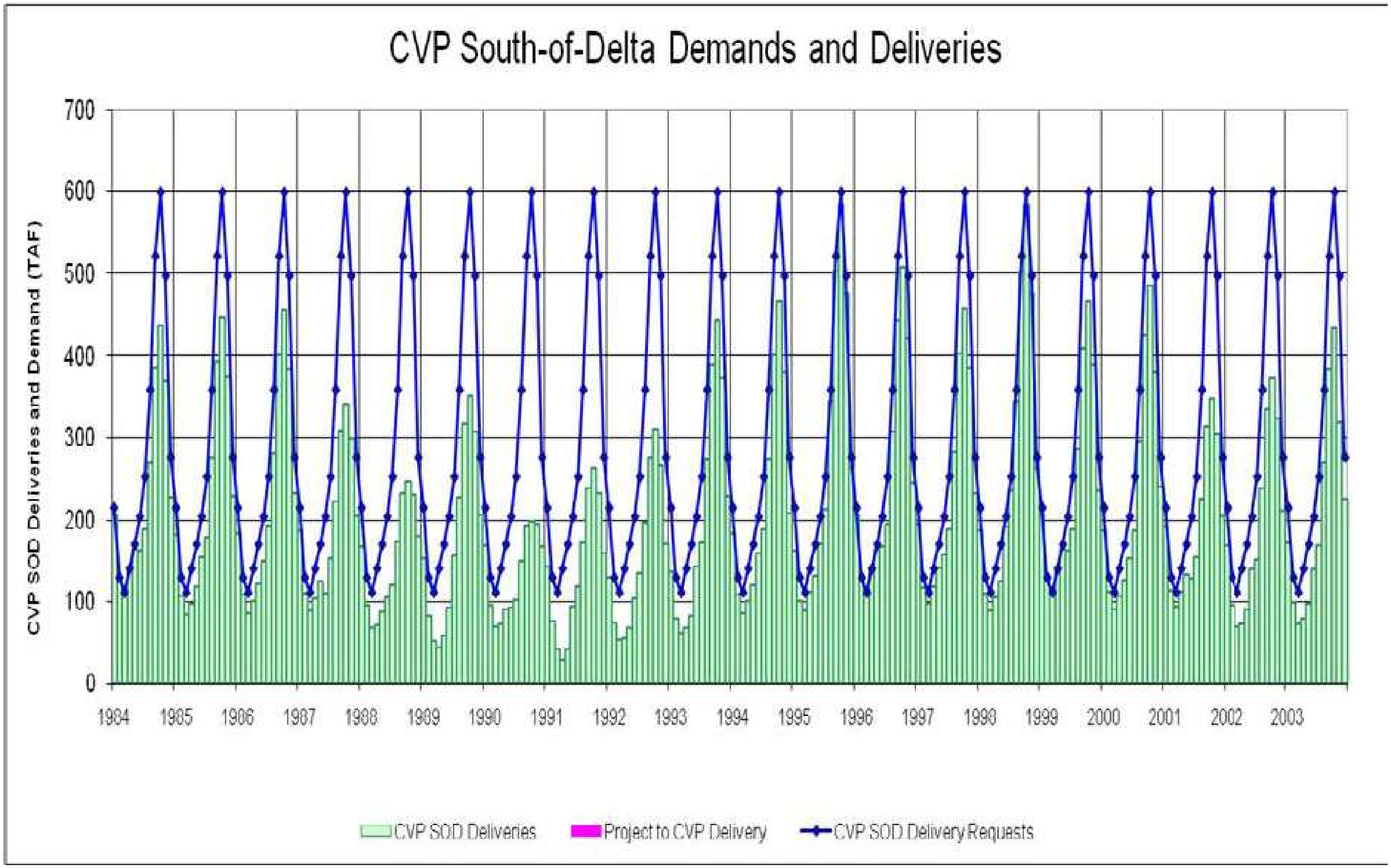


Figure 3-13. IDSM-Simulated CVP South-of-Delta Water Demands and Deliveries with Project Deliveries for Water Years 1984–2003

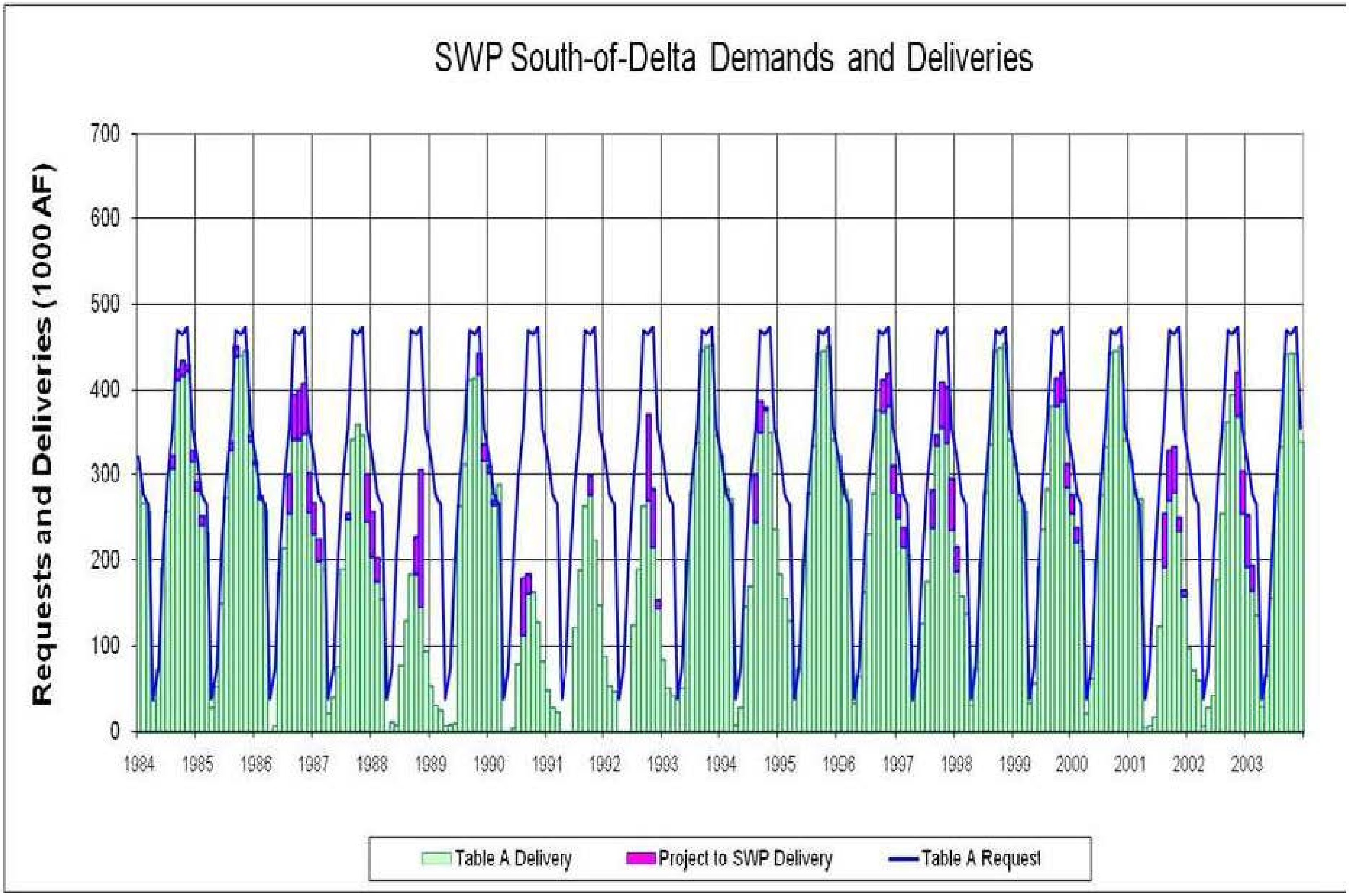


Figure 3-14. IDSM-Simulated SWP South-of-Delta Water Demands and Deliveries with Project Deliveries for Water Years 1984–2003

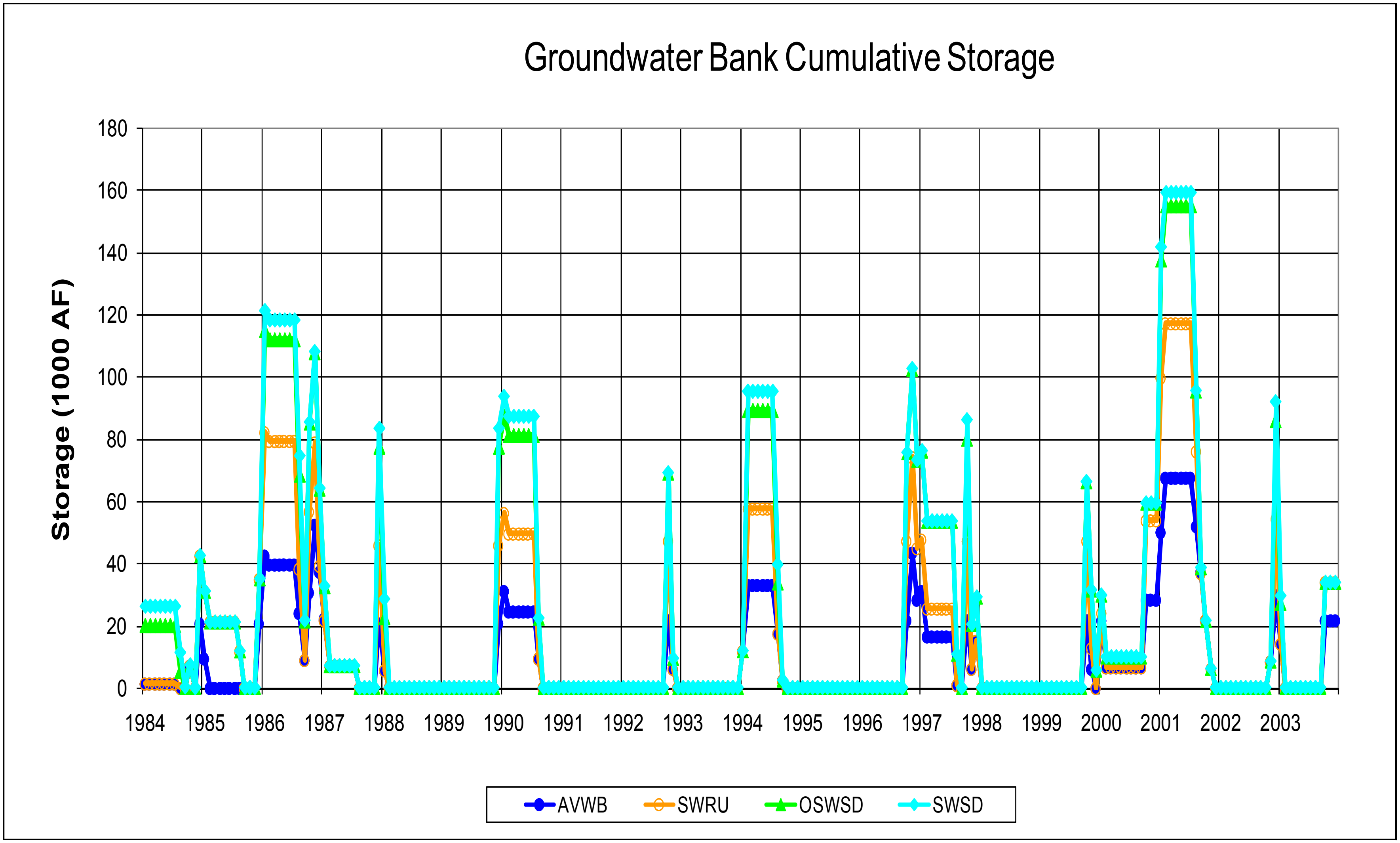


Figure 3-15. IDSM-Simulated Groundwater Bank Storage of Project Water for Water Years 1984–2003

Chapter 4
Analyses of Environmental Effects

This chapter provides environmental analyses of the Project alternatives on a resource-specific, topical basis. Components of each section typically include:

- an overview of differences from prior Project environmental documents;
- a summary of impacts;
- a summary of changes, new information, and new circumstances;
- existing conditions; and
- environmental effects, including methods and mitigation measures.

As described in Chapter 2, the Proposed Project is now represented by Alternative 2. As a result, the environmental effects discussions of each resource section present the impacts of Alternative 2 first, followed by the discussions of Alternative 1, Alternative 3, and the No-Project Alternative.

The environmental analysis from the 2001 EIR and 2001 EIS was substantially upheld from challenge. Consequently, as introduced in Chapter 1, the approach for this Place of Use EIR is to efficiently and appropriately apply the information from the preceding documents, while updating the sections where necessary according to the current Project, available information, and circumstances. The sections have been prepared to incorporate relevant information from those documents by reference while avoiding repetition to result in a focused environmental analysis.

The sections are organized as follows:

- Section 4.1, Water Supply
- Section 4.2, Water Quality
- Section 4.3, Flood Control and Levee Stability
- Section 4.4, Utilities and Highways
- Section 4.5, Fishery Resources
- Section 4.6, Vegetation and Wetlands
- Section 4.7, Wildlife
- Section 4.8, Land Use and Agriculture
- Section 4.9, Recreation and Visual Resources

- Section 4.10, Traffic and Navigation
- Section 4.11, Cultural Resources
- Section 4.12, Mosquitoes and Public Health
- Section 4.13, Air Quality
- Section 4.14, Climate Change
- Section 4.15, Noise

Section 4.1
Water Supply

Introduction

This section describes recent changes to the existing environmental conditions and regulatory setting of the Project area, summarizes the unchanged affected environment, and describes changed environmental effects related to water supply for the Project. This section contains a review and update of the 2000 RDEIR/EIS water supply impact assessment, incorporated by reference in the 2001 FEIR. The water supply impacts of the Project were analyzed most recently in the 2001 FEIS, which also served as a basis for this analysis.

This section considers impacts on the existing Delta water supply conditions that result from upstream reservoir operations and irrigation diversions for the full range of watershed rainfall and runoff, as represented by the historical 1922–2003 monthly runoff for the Central Valley tributaries to the Delta. All of the existing reservoirs and water demands for municipal, agricultural, and wildlife refuge uses are included in the CALSIM modeling described in Chapter 3. This section evaluates potential Project effects on the existing water supply conditions.

The Project is assumed to operate separately from the integrated CVP and SWP reservoir and export pumping. This allows the results from the current CALSIM modeling of the existing CVP and SWP facilities and reservoir operations and permitted Delta operations (D-1641) to be used as the existing baseline conditions for evaluating Project operations and potential impacts on Delta riparian water users, Delta appropriative water rights diverters (such as Antioch, CCWD, and the City of Stockton), and the CVP contractors and SWP contractors.

This section discusses Delta conditions related to water supply (the amount of water available for beneficial uses) and the possible effects of Project operations on the existing water supplies from the Delta. Beneficial uses of Delta water include in-Delta uses (e.g., crop irrigation, drinking water) by other riparian or water rights holders, protection of fish and wildlife habitat, and exports for contractors receiving water from the CVP or the SWP.

The water supply impact assessment focuses on the potential Project effects on existing water users in the Delta. The potential effects on CVP and SWP Delta operations or on CCWD operations are assumed to be avoided through adherence to the operational criteria and stipulated agreements and protest dismissal agreements described in Chapter 2. The simulated Project operations, fully described in Chapter 3, will not reduce the water supply of any CVP or SWP contractors.

The Project operations result in no water supply changes to any water users other than the proposed places of use, which are analyzed in Chapter 5, “Cumulative Effects,” and Chapter 6, “Growth Inducing Effects.” The small changes in Delta consumptive use (i.e., evaporation) from the Project islands evaluated in the 2001 FEIR and 2001 FEIS remain the same.

Summary of Impacts

Table 4.1-1 provides a summary and comparison of the impacts and mitigation measures for water supply from the 2001 FEIR, 2001 FEIS, and this Place of Use EIR.

Table 4.1-1. Comparison between Delta Wetlands Project 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts on Water Supply

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
PROPOSED PROJECT (ALTERNATIVE 2)	
Impact A-2: Reduction in Delta Consumptive Use (B) **Mitigation:** No mitigation is required.	**Impact WS-1:** Reduction in Delta Consumptive Use (B and LTS) **Mitigation:** No mitigation is required. No change.
ALTERNATIVE 1	
Impact A-1: Increase in Delta Consumptive Use (LTS) **Mitigation:** No mitigation is required.	**Impact WS-2:** Increase in Delta Consumptive Use (LTS) **Mitigation:** No mitigation is required. No change.
ALTERNATIVE 3	
Impact A-1: Increase in Delta Consumptive Use (SU) **Mitigation:** No mitigation is available.	**Impact WS-2:** Increase in Delta Consumptive Use (SU) **Mitigation:** No mitigation is available. No change.
Note: SU = Significant and unavoidable; LTS = Less than significant; LTS-M = Less than significant with mitigation; B = Beneficial.	

Delta consumptive use refers to water diverted from Delta channels for beneficial uses (e.g., irrigation of crops) or evaporated from the Delta channels. Standardized estimates of Delta evapotranspiration (ET) are used in the DAYFLOW Delta water budget (i.e., gross channel depletions).

The evaluation of the Project effects on consumptive use was based on the average monthly water budget for typical operations (i.e., reservoir storage volume). The four Project islands have existing riparian and appropriative water rights to use a reasonable quantity of water of about 44 thousand acre-feet (taf) from Delta channels for agricultural and other beneficial purposes.

Under Project operations, consumptive water use would shift from crop ET to evaporation during periods of storage on the Reservoir Islands and the seasonally flooded portions of the Habitat Islands, with reduced crop ET. These land use changes would shift ET slightly, depending on the length of storage on the Reservoir Islands. Total consumptive use for the Proposed Project was estimated to be about the same as under existing conditions. There is no change from the 2001 FEIR and 2001 FEIS conclusion that the Project would not have a significant impact on Delta consumptive use and that no mitigation is required.

Summary of Changes, New Circumstances, and New Information

Substantial Changes in the Project

Since the 2001 FEIR and 2001 FEIS was completed, there have been no substantial changes to the Project resulting in any new significant effects or substantial increase in the severity of effects on water supply. The 2001 FEIR and 2001 FEIS identified no significant impacts on other Delta water supplies or uses associated with Alternatives 1 and 2 and identified one significant effect (increased evaporation) for Alternative 3.

As described in Chapter 2, "Project Description," only Alternative 2 as amended by the incorporation of the BOs, FOC, WQMP, protest dismissal agreements, and other environmental commitments (Proposed Project), was simulated for evaluation of water supply impacts in the Place of Use EIR. The simulation of the Proposed Project encompasses the full range of impacts associated with Alternatives 1 and 2. Alternative 3 was modeled in the 2001 FEIR and 2001 FEIS, but is not simulated again for this Place of Use EIR because the impacts would be consistent with the 2001 FEIR and 2001 FEIS conclusions and because Alternative 3 would be inconsistent with the FOC and the existing BOs. This Place of Use EIR evaluates operations under D-1641, without OMR restrictions, to evaluate and assess the maximum potential water quality and fish impacts. The potential water supply impacts on CVP and SWP contractors are assumed to be eliminated by the operation of the Project independent of the CVP and SWP in accordance with the protest dismissal agreement terms discussed below. In-Delta water users similarly are assumed to be protected by the D-1641 Delta operations criteria, which limit exports and require minimum outflows to protect all Delta beneficial uses.

Agreements That Protect Prior Water Rights and State Water Project and Central Valley Project Delta Operations

In response to the 1997 State Water Board water right hearing, 18 parties filed protests with the State Water Board against the Project applicant's water rights applications. The Project entered into negotiations with some of these parties. The Project applicant entered into stipulated agreements with Reclamation, DWR, Amador County, the City of Stockton, and North Delta Water Agency that affirm the seniority of these parties' water rights. These agreements were summarized in Appendix A of the 2000 RDEIR/EIS. Following the 2000 water rights hearings, the Project applicant signed protest dismissal agreements with CCWD, which protects the Los Vaqueros Reservoir water rights and operations, including diversions for salinity control (reduction), and with CUWA and EBMUD. These stipulated agreements define how the Project will be operated independent of, and in a manner that does not adversely affect, the CVP and SWP Delta operations. These stipulated agreements provide the basis for assuming that the Project operations will not affect existing water rights and water supply in the Delta.

New Information and New Circumstances

The major Delta water rights decision controlling the existing CVP and SWP Delta operations continues to be D-1641, which implements the Delta objectives established by the State Water Board in the 1995 WQCP. The 1995 WQCP was reviewed and updated by the State Water Board in 2006, with no major changes in the Delta flow or salinity objectives for beneficial water uses or for fish and wildlife protection.

CCWD has begun construction on a new (alternative) water intake on Victoria Canal, and the City of Stockton is constructing a new intake on the San Joaquin River at Empire Tract. A water supply intake was constructed in 2007 near the SWP Harvey O. Banks Pumping Plant (SWP Banks) to service the Mountain House community.

Since 2001, several new investigations of Delta water supply conditions have been prepared by Reclamation and DWR or through CALFED-funded additional monitoring, research, and restoration efforts. The most relevant of these studies for the Project water supply circumstances in the Delta are summarized here.

In-Delta Storage Investigations

DWR investigated in-Delta storage as part of the ISI for CALFED. These studies evaluated the Project Reservoir Islands as a storage facility that would be integrated with the other CVP and SWP reservoirs. This integrated operation was somewhat different from the independent Project operations that are being evaluated in this section, but provide valuable information about potential Project operations and possible environmental impacts and benefits from in-Delta storage operations. These studies generally confirmed that there is unused surplus outflow in a majority of water years (about 75%) that could be diverted to an in-Delta storage facility without interfering with any existing CVP or SWP water supply or Delta water diversion. These studies confirm that San Luis Reservoir is filled to capacity in many years, so that additional in-Delta storage would increase the seasonal water supply.

State Water Project Water Supply Reliability

Another new source of information was the CALSIM modeling studies prepared by the DWR Bay-Delta Office on the SWP water supply reliability (California Department of Water Resources 2008). This water supply reliability report is updated on a 2-year cycle and discusses the SWP demands (i.e., Table A contract amounts) and the annual SWP allocations (percent of Table A delivery projections) that are based on hydrologic conditions and various Delta constraints. The CALSIM model results demonstrate that SWP water supplies are substantially reduced from Table A contract amounts in many years. The difficulties of delivering the full SWP Table A contract amounts with the existing facilities (including the 6,680-cfs limit on SWP Banks pumping) are described in the SWP water supply reliability report. The most recent reliability report describes the substantial reductions in SWP deliveries that would result from any limits on OMR flows during the January–June period for delta smelt or Chinook salmon protection.

Central Valley Project–State Water Project Operations Criteria and Plan Evaluations

The BA and BO documents for the CVP-SWP OCAP have been reviewed for new information about possible future water supply conditions. The BA for OCAP was expanded and updated (Bureau of Reclamation 2008) by Reclamation and DWR. The revised BO from USFWS for delta smelt was released (U.S. Fish and Wildlife Service 2008) and included new restrictions on reverse OMR during the months of December–June. The revised BO from NMFS for Chinook salmon, steelhead, and sturgeon was released (National Marine Fisheries Service 2009) and also included OMR restrictions that will limit the existing conditions for CVP and SWP export pumping. Whatever these new restrictions on CVP and SWP Delta operations may require, the Project will not interfere with or otherwise limit the existing water supply conditions.

The relationships between Delta flows or exports and biological conditions will continue to be controversial, and the effects of operations on biological resources will be monitored intensively by the IEP agencies. The effects of Delta operations will continue to be reviewed periodically, and the Delta objectives and export limits likely will be modified under adaptive environmental management principles. These OCAP evaluations have not included an in-Delta storage facility, so the basic operations of the Project cannot be determined from the OCAP studies. This Place of Use EIR continues to evaluate the Project as an independent facility and does not consider integrated operations with the CVP and SWP.

Future Delta Conditions Studies

Several future Delta planning studies have been completed since the 2001 FEIR and 2001 FEIS, and planning studies related to CVP and SWP operations are continuing. The OCAP studies appear to be ongoing, with revisions and changes every few years. The more recent BDCP is the major planning effort focused on alternative conveyance and habitat restoration (e.g., land conversion) options for protection and recovery of Endangered species in the Delta. These planning studies are briefly described in Chapter 2, “Project Description.”

The possible effects of changes in the future CVP and SWP Delta operations on Project operations are not considered in this Place of Use EIR. The potential for the Project to operate under the reverse OMR restrictions required in the 2008 USFWS and 2009 NMFS BOs is not discussed in this Place of Use EIR because the BOs did not consider in-Delta storage facilities. In any of these future Delta scenarios (i.e., configurations or operations), the basic assumption that the Project will not interfere with or limit the existing water users in the Delta, or reduce the water supply available for any existing water right or CVP or SWP contractor, remains valid.

Existing Conditions

This section discusses changes in the existing conditions or regulatory setting since the 2001 FEIR and 2001 FEIS.

Regulatory Setting

Federal, state, and local regulations are effectively integrated within the state water rights and water quality control planning framework, administered by the State Water Board, to control water supply in the Delta. Various water quality and flow objectives have been established by the State Water Board to ensure that the quantity and quality of Delta water are sufficient to satisfy all designated beneficial uses; implementation of these objectives in D-1641 requires various limitations on the operations of the south Delta SWP and CVP export pumps, which affect Delta outflow and corresponding salinity levels in the Delta.

The Project operations will not interfere with senior legal water diversions within the Delta or the existing CVP and SWP operations. The Project is evaluated as an independent project and is assumed not to change any existing CVP or SWP Delta operations that are controlled by the existing State Water Board objectives

(D-1641). These baseline Delta water supply operations and the simulated changes in Delta flows caused by the Project are fully described in Chapter 3, "Project Operations." These results are briefly evaluated for water supply impacts in this section and evaluated for impacts on water quality and fish habitat and abundance in subsequent sections.

Delta Water Rights

Numerous parties hold rights to divert water from the Delta and upstream tributaries. The reasonable beneficial requirements of existing riparian and senior appropriative users with regard to both water quantity and water quality must not be impaired by exercise of subsequent appropriative water rights. DWR's SWP and Reclamation's CVP and other water rights holders divert water from the Delta under appropriative rights. More than 1,000 siphons and pumps are used to divert water under riparian and appropriative rights from Delta channels. Project operations would be conducted under existing riparian and appropriative water rights and new appropriative rights.

Riparian water rights are entitlements to water that are held by owners of land bordering natural flows of water. A landowner has the right to divert a portion of the natural flow for reasonable and beneficial use on his or her land within the same watershed. If natural flows are not sufficient to meet reasonable beneficial requirements of all riparian users on a stream, the users must share the available supply according to each owner's reasonable requirements and uses.

Appropriative rights are held in the form of conditional permits or licenses from the State Water Board. These authorizations contain terms and conditions to protect prior water right holders and to protect the public interest in fish and wildlife resources. The State Water Board reserves jurisdiction to establish or revise certain permit or license terms and conditions for salinity control, protection of fish and wildlife, protection of vested water rights, and coordination of terms and conditions among the major water supply projects.

Various water quality and flow objectives have been established by the State Water Board to ensure that the quality of Delta water is sufficient to satisfy all designated uses; implementation of these objectives requires that limitations be placed on Delta water supply operations, particularly operations of the SWP and CVP, affecting amounts of fresh water and salinity levels in the Delta. The Project would be prohibited from affecting the ability of those holding prior water rights, such as DWR and Reclamation, to exercise those rights, and the Project would not be allowed to interfere with compliance with Delta water quality standards or protection of biological resources.

Diversion and storage of water in upstream reservoirs by California's two major water supply projects, DWR's SWP and Reclamation's CVP, and diversion and export of water from the Delta are authorized and regulated by the State Water Board under appropriative water rights. The SWP and the CVP store and release water upstream of the Delta and export water from the Delta to areas generally south and west of the Delta. Reclamation diverts water from the Delta through its

CVP Jones Pumping Plant (CVP Jones) to the DMC and San Luis Canal, and DWR pumps for export through the California Aqueduct and South Bay Aqueduct at its SWP Banks Pumping Plant. DWR also operates the North Bay Aqueduct, which diverts water at the Barker Slough Pumping Plant.

A third substantial diverter of Delta water is CCWD, which currently diverts water from Mallard Slough near Pittsburg (when outflow is high), from Rock Slough and from the Los Vaqueros intake on Old River. Several municipal users (e.g., Antioch, Mountain House) and many agricultural users also divert water from the Delta under riparian and appropriative rights. Stockton is constructing a water supply intake on Empire Tract.

Delta Regulatory Limits

The limits on SWP Banks and CVP Jones pumping sometimes restrict the Delta exports to less than the full CVP and SWP demands for Delta exports. These regulatory limits result from Delta outflow requirements, Delta salinity objectives, export/inflow limits, and permitted or physical export pumping capacity. The Project would provide additional water for summer and fall exports in July–November to supply some of the unmet SWP water demands (i.e., delivery deficit). The State Water Board Water Rights Division has primary regulatory authority over water supplies and issues permits for water rights specifying amounts and conditions for diversion and storage facilities.

1995 Water Quality Control Plan and D-1641

The State Water Board's 1995 WQCP (adopted May 1995) and the State Water Board's Final EIR for Implementation of the 1995 Bay/Delta Water Quality Control Plan (November 1999) incorporated several elements of the EPA, NMFS, and USFWS regulatory objectives for salinity and Endangered species protection. The changes from the previous regulatory limits for CVP and SWP Delta operations were substantial. The State Water Board fully implemented the 1995 WQCP with D-1641 in March 2000. The new provisions for X2, E/I ratio, and the VAMP that are implemented in D-1641 are summarized in Chapter 3, "Project Operations." The modeling of the Project assumed that none of the CVP or SWP Delta operations to meet these regulatory criteria would be changed with Project operations. The Project therefore was assumed to satisfy these regulatory limits and to cause no impacts on Delta water users or to CVP or SWP contractors.

Endangered Fish Species Protection

The ESA requires assessment of the effects of water project operations on fish species listed under the act as Threatened or Endangered. NMFS issued a revised (updated) BO on the effects of SWP and CVP operations on Chinook salmon, steelhead, and green sturgeon in June 2009. The USFWS issued a revised (updated) BO on the effects of SWP and CVP operations on delta smelt in December 2008. These BOs include reasonable and prudent measures (requirements) for Delta outflow, DCC gate closure, reverse OMR flow restrictions, and reduced export pumping for fish protection. These fish protection requirements impose additional constraints on Delta water supply operations. The Project will not interfere with CVP and SWP compliance with these measures. The Project will obtain revised (updated) BOs from NMFS and USFWS, as well as from DFG, that will specify constraints on Project operations for fish protection. These Project criteria are expected to be somewhat similar to the previously developed FOC included in the 1997 Project BOs. Chapter 3, "Project Operations," describes these FOC in more detail.

Delta Water Transfers

The California Legislature has passed several laws to encourage water transfers beyond the boundaries of historical water service areas. These laws protect water users who are not a party to the transfer and also protect fish and wildlife from impacts caused by the water transfer. The State Water Board has established a process to expand the place of use of those conducting a short-term (1-year) water transfer. Several long-term transfers also have been negotiated and permitted. The most recent is the Yuba Accord, which includes increased minimum flows for fish habitat protection, and a long-term transfer of about 60 taf to DWR for use by the Environmental Water Account (EWA) for fish entrainment reduction.

In previous drought years, substantial water transfers through the Delta have occurred. About 800 taf were purchased for transfer in 1991 as a part of DWR's Drought Water Bank, the largest water transfer year on record. The amount of additional water that was actually pumped at SWP Banks Pumping Plant in 1991 is more difficult to determine. Beginning in 1995, California experienced a series of higher-than-normal runoff years, and the need for water transfers decreased during the wet years. In 2001 (a dry year) the EWA purchased and transferred 105 taf, and other parties transferred about 360 taf, making use of the CVP and SWP pumping plants for diversion from the Delta. In 2002, the EWA transferred 142 taf from upstream of the Delta, and other parties transferred additional water through the Delta. The EWA made upstream purchases of about 100 taf in subsequent years (2003, 2004), but because there is no centralized reporting or accounting (i.e., neither the State Water Board nor DWR) for water transfers, the importance of this Delta water management activity is difficult to determine.

The Project would be a major new source of water transfers. The water diverted onto the Project storage islands would have flowed into Suisun Bay during relatively high-flow periods, when estuarine habitat benefits from outflow might be relatively small. Project storage water would be diverted when Delta outflow was high and the environmental effects of (fish-screened) diversions would be relatively small (See Section 4.5, Fish). Project storage water would be transferred to designated places of use when unused permitted SWP export capacity and aqueduct conveyance capacity were available in the months of July–November. The months of July–September have been identified in other water transfer evaluations (EWA, Yuba Accord, and OCAP) as months when additional export pumping may be the least harmful to fish. Project water transfers could be delivered directly to SWP contractors in some years, or stored in groundwater banks with delivery to designated places of use in subsequent water years.

Environmental Commitments

Changes in Project design and prior agreements with Delta water rights holders or agencies have resulted in the Project environmental commitments. These commitments minimize the impacts of the original Project design and operation on water supply.

In response to the 1997 State Water Board water right hearing, 18 parties filed protests with the State Water Board against the Project applicant's water rights applications. The Project entered into negotiations with some of these parties. As a result of these discussions, the Project applicant entered into stipulated agreements with Amador County and the City of Stockton that affirm the seniority of protesting parties' water rights. The Project applicant entered into stipulated agreements with Reclamation, DWR, and North Delta Water Agency to operate the Project in a manner that is consistent with the existing CVP and SWP Delta operations and follows the water quality objectives in the Delta that protect existing water users.

Environmental Effects

Methods

Project diversions to storage and releases for export or water quality enhancement could affect water supply in the Delta through changes in channel flow quantity, timing, and water quality.

The Reclamation, DWR, CUWA, and CCWD settlement agreements include provisions to ensure Project operations would not result in adverse effects on Project operations in the Delta or for CVP and SWP contractors. Those provisions have been incorporated into simulated Project operations, as described in Chapter 3. The monthly water supply simulation provided a quantitative approach for evaluating the Project operations—the diversions to storage, the discharge and export pumping and delivery to designated places of use or groundwater banks, and the release for increased Delta outflow. The operations of the groundwater banking facilities and delivery to designated places of use are simulated. The Project operations result in no water supply changes to any water users other than the proposed places of use, which are analyzed in Chapter 5, "Cumulative Effects," and Chapter 6, "Growth Inducing Effects." The small changes in Delta consumptive use (i.e., evaporation) from the Project islands evaluated in the 2001 FEIR and 2001 FEIS remain unchanged.

Significance Criteria

The water supply impact analysis considered several criteria for determining the significance of impacts related to this resource. The analysis took into account both relevant criteria contained in Appendix G of the State CEQA Guidelines (Association of Environmental Professionals 2009) and Project-specific criteria developed by the lead agency to address potential impacts unique to the Project's location and elements.

A project alternative is assumed to have a significant (detectable) impact on Delta consumptive use if it would cause an increase in Delta lowland ET exceeding 1% of the No-Project Alternative ET from Delta lowlands (of about 890 taf/yr). This assumed significance criterion also could be expressed as a change of more than 20% of the consumptive use on the Project islands (44 taf/yr) because the Project islands represent about 5% of the area of the Delta lowlands. A project is considered to have a beneficial effect on Delta consumptive use if it would cause a decrease in Delta lowland ET. Potential effects of the Project on increased water supply and resulting growth-inducing or cumulative impacts in the designated places of use are described in Chapter 5, "Cumulative Impacts," and Chapter 6, "Growth-Inducing Impacts."

Impacts and Mitigation Measures

The Project diversions, storage, discharge for exports, and releases for outflow would not interfere with any existing water users in the Delta and would not reduce the delivery to any CVP or SWP contractor. The Project releases for outflow would substantially reduce export salinity in some fall months of some years and provide a water quality benefit to many Delta water users and CVP and SWP contractors, as described more fully in Section 4.2, Water Quality. The simulated changes in water supply conditions for each Project Alternative are summarized below. The only mitigation measure for water supply impacts would be the required water accounting for Project implementation under the various protest dismissal agreements.

Proposed Project (Alternative 2)

Alternative 2 was simulated as the Proposed Project with the IDSM model, as described in Chapter 3. The simulated monthly Project diversions, discharges for export pumping, and releases for Delta outflow in the fall months were slightly different from the operations previously simulated for the 2001 FEIR and 2001 FEIS. However, the consumptive uses were assumed to be the same as for the 2001 FEIR and 2001 FEIS.

Under Alternative 2, Habitat Island ET is estimated to average 14 taf/yr, and evaporation of stored water would average approximately 23 taf/yr. Total consumptive use under Alternative 2 is estimated to average approximately

7 taf/yr less than under the No-Project Alternative. This is a beneficial impact, and no mitigation is necessary. Daily accounting of Project operations would be required under the protest dismissal agreements as described below.

Impact WS-1: Reduction in Delta Consumptive Use

This impact has not changed since the 2001 FEIR and 2001 FEIS. Conversion of the Project islands from agriculture to water storage and wildlife habitat management would reduce the Delta consumptive use of water (from evaporation and/or crop transpiration). This impact is considered beneficial and less than significant.

Mitigation

No mitigation is required.

Alternative 1

Under Alternative 1, land uses would change from irrigated agriculture to primarily water storage on the Reservoir Islands and to wildlife habitat and wildlife feed crops on the Habitat Islands. These land use changes would reduce ET from a total of 44 taf/yr to 14 taf/yr (2001 FEIR and 2001 FEIS estimated ET from the Habitat Islands) for the four islands. Additionally, an average of approximately 34 taf/yr of evaporation would be lost from stored water on the Reservoir Islands during periods of water storage, somewhat more than under Alternative 2 because of increases in storage duration. An unknown amount of evaporation from moist soil and possibly from seepage would continue to be lost on the Reservoir Islands directly after total drawdown. Also, an ET amount approximately equal to the ET for the Habitat Islands (14 taf) would be lost during periods when the Reservoir Islands are in a shallow-water wetland condition.

Total consumptive use on the four Project islands is expected to increase by approximately 4 taf/yr compared with use under the No-Project Alternative as a long-term average. This is less than significant, and no mitigation is required. Daily accounting of Project operations would be required under the protest dismissal agreements as described below.

Impact WS-2: Increase in Delta Consumptive Use

This impact has not changed since the 2001 FEIR and 2001 FEIS. Conversion of the Project islands from agriculture to water storage and wildlife habitat management would slightly increase the Delta consumptive use of water (from evaporation and/or crop transpiration). This impact is considered less than significant.

Mitigation

No mitigation is required.

Alternative 3

Under Alternative 3, evaporation of stored water from all four Project islands is estimated to average 54 taf/yr (2001 FEIR and 2001 FEIS). Because all four islands would be operated as Reservoir Islands, there would be essentially no Habitat Island ET as under Alternatives 1 and 2 except for ET from a small portion of Bouldin Island. Total consumptive use under Alternative 3 is estimated to average 54 taf/yr, approximately 10 taf/yr greater than under the No-Project Alternative. This increase in Delta consumptive use represents about a 1% increase in Delta lowland consumptive use and would be considered significant. However, the consumptive use under Alternative 3 would be supplied by Project diversions of surplus Delta outflow, whereas the No-Project Alternative consumptive use would be supplied by irrigation diversions in the summer. Although Alternative 3 is not considered a viable Alternative because of its wildlife and vegetation impacts, daily accounting of Project operations would be required under the protest dismissal agreements as described below.

Impact WS-2: Increase in Delta Consumptive Use

This impact has not changed since the 2001 FEIR and 2001 FEIS. Conversion of the Project islands from agriculture to water storage would increase the Delta consumptive use of water (from evaporation). This impact is considered significant and unavoidable.

Mitigation

No mitigation is available.

No-Project Alternative

The No-Project Alternative analysis is the same as it was presented in the 2001 FEIR and 2001 FEIS and is hereby incorporated by reference. Under the No-Project Alternative, consumptive use could increase, but not measurably so at the scale of monthly water supply modeling. The No-Project consumptive use was estimated for the four Project islands, located in the Delta lowlands (peat soils), to be about 44 taf/yr. This is the existing consumptive use for the four Project islands (17,500 irrigated acres) under existing riparian and appropriative water rights for agricultural and other beneficial purposes.

Delta Water Supply Accounting Procedures

During the 2000 water rights hearings, the Project applicant signed additional protest dismissal agreements with CUWA, CCWD, and EBMUD. These agreements include the WQMP, which provides several requirements for daily flow, salinity, and DOC monitoring, as well as modeling and accounting for the contribution of Project discharges and releases at the water supply intakes. Additional details about the water quality monitoring and modeling are given in Section 4.2, Water Quality.

The Project operations would be tracked with daily water accounting. DWR Division of Operations and Maintenance, in cooperation with Reclamation's Central Valley Operations Center (CVOC), maintains daily water budget estimates for the Delta and designates the Delta condition each day as being "in balance" or "in excess" relative to all State Water Board objectives and water right terms and conditions. When the Delta condition is designated by DWR and Reclamation to be in balance, all Delta inflow is determined to be required to meet Delta objectives and satisfy diversions by CCWD, the CVP, the SWP, other senior water right holders, and Delta riparian water users. Therefore, when the Delta is in balance, additional water would not be available for diversion by the Project.

When DWR (and Reclamation) determine the Delta condition to be in excess, the Project would be allowed to divert available excess water for storage on the Reservoir Islands. The daily quantity of available excess water would be estimated according to the normal Delta water supply accounting procedures. To provide extra protection for compliance with 1995 WQCP Delta objectives (D-1641) and for existing water right holders, the State Water Board may establish requirements for amounts of water within the designated excess water (buffers) that would be available for Project diversions. Even with additional State Water Board–established safeguards in place, excess Delta inflow is available for diversion during certain periods, especially major runoff events.

Project operations would not be permitted to interfere with senior appropriative water right holders or Delta riparian users. Following the 1997 water rights hearings, the Project applicant entered into stipulated agreements with Reclamation, DWR, Amador County, the City of Stockton, and North Delta Water Agency. These agreements affirm the seniority of these parties' water rights; they also outline general conditions under which the Project would operate to preclude interference with those water rights or with a party's ability to meet particular water quality criteria. Additional information about the terms of these agreements is available in Chapter 2, "Project Description."

The Project will submit timely reports to the State Water Board on the daily operations of each Reservoir Island, as well as the daily Delta conditions that may affect Project diversions and discharges for export or releases for Delta outflow. These monitoring and reporting requirements are similar to mitigation monitoring required for other water projects. Although there are no significant water supply impacts from Project implementation or operations, these monitoring and reporting requirements (under the protest dismissal agreements) will provide an accurate record of Project operations and water supply and water quality benefits.

Section 4.2
Water Quality

Introduction

This section describes recent changes to the existing environmental conditions and regulatory setting of the Project area, summarizes the unchanged affected environment, and describes changed environmental effects related to water quality for the Project. This section contains a review and update of the 2000 RDEIR/EIS water quality impact assessment, incorporated by reference in the 2001 FEIR. The water quality impacts of the Project were analyzed most recently in the 2001 FEIS, which also served as a basis for this analysis.

The 2001 FEIR and 2001 FEIS concluded that diverting water onto the Project islands would reduce Delta outflows and could increase salinity in Delta channels and at Delta exports and municipal and agricultural diversions. Discharges from the Project islands could contribute to changes in concentrations of water quality constituents and other variables in Delta channel receiving waters and at Delta exports and diversions. Variables that could be adversely affected by Project discharges are salinity, dissolved organic carbon (DOC), temperature, turbidity, dissolved oxygen (DO), and chlorophyll (algae). In drinking water supplies that originate from the Delta, increases in DOC and salinity could cause increased disinfection by-products following treatment. Also of concern are pollutants that may remain in some Project island soils as a result of past agricultural and waste disposal activities; if pollutants are present, they could contaminate stored water that is later discharged into Delta channels.

The 2001 FEIR and 2001 FEIS found that Project diversions under Alternative 1, 2, or 3 could result in significant salinity increases at Chipps Island, Emmaton, and Jersey Point and in Delta exports during periods of low Delta outflow. The incorporation of the Final Operating Criteria (FOC) terms into the Proposed Project (Alternative 2) would reduce the estimated salinity effects at Chipps Island and in Delta exports would be less than significant. All other salinity impacts would be reduced to less-than-significant levels through adjustments made to Project diversions based on salinity estimates at these locations with and without Project diversions.

The 2001 FEIR and 2001 FEIS analysis found that Project discharges under Alternative 1, 2, or 3 could result in significant increases of DOC concentrations in Delta exports and could cause increased trihalomethane (THM) concentrations in drinking water treated by chlorination. These impacts would be reduced to less-than-significant levels through adjustments of Project discharges based on measurements of DOC and estimated bromide (Br^-) in stored water during intended discharge periods and monitoring of channel receiving waters.

The 2001 FEIR and 2001 FEIS analysis found that Project discharges under Alternative 1, 2, or 3 could result in significant changes in water quality variables with potential fish effects (temperature, turbidity, DO, and chlorophyll) in Delta channel receiving waters. This impact would be reduced to a less-than-significant level through adjustments of Project discharges based on measurements of these variables in stored water during intended discharge periods and monitoring in channel receiving waters. Potential contamination of stored water by pollutant residues under Alternative 1, 2, or 3 also would be a significant impact. This impact would be reduced to a less-than-significant level through assessment and necessary remediation of soil contamination prior to Project implementation to eliminate sources of potential contamination.

Water quality in the Delta is important for the aquatic ecosystem, drinking water supply, and irrigation. This section contains a review and update of the 2001 FEIR and 2001 FEIS water quality impact assessment. For water quality constituents with little or no change in information or circumstances, a summary of the results of the analysis from the 2001 FEIR and 2001 FEIS is provided. A more detailed assessment is provided for water quality constituents with new information or regulations.

Identification of the Project's specific places of use as part of the affected environment does not affect water quality in any way that alters the conclusions of the 2001 FEIR and 2001 FEIS. The Project will not have any direct effects on water quality in the places of use; the effects on water quality, if any, associated with the provision of Project water to the places of use are addressed in Chapter 5, "Cumulative Impacts," and Chapter 6, "Growth-Inducing Impacts."

Summary of Impacts

Table 4.2-1 provides a summary and comparison of the impacts and mitigation measures for water quality from the 2001 FEIR, 2001 FEIS and this Place of Use EIR.

Table 4.2-1. Comparison between Delta Wetlands Project 2010 Place of Use EIR Impacts and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures for Water Quality

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
ALTERNATIVES 1 AND 2	
Impact C-1: Salinity (EC) Increase at Chipps Island during Months with Applicable EC Objectives (LTS) **Mitigation Measure C-1:** Restrict DW Diversions to Limit EC Increases at Chipps Island	**Impact WQ-1:** Salinity Increase at Chipps Island (LTS) **Mitigation:** No mitigation is required.

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	**Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures**
Impact C-2: Salinity (EC) Increase at Emmaton (LTS-M) **Mitigation Measure C-2:** Restrict DW Diversions to Limit EC Increases at Emmaton.	**Impact WQ-2:** Salinity Increase at Emmaton (LTS) **Mitigation:** No mitigation is required.
Impact C-3: Salinity (EC) Increase at Jersey Point (LTS-M) **Mitigation Measure C-3:** Restrict DW Diversions to Limit EC Increases at Jersey Point	**Impact WQ-3:** Salinity Increase at Jersey Point (LTS) **Mitigation:** No mitigation is required.
Impact C-4: Salinity (Chloride) Increase in Delta Exports (LTS) **Mitigation Measure C-4:** Restrict DW Diversions or Discharges to Limit Chloride Concentrations in Delta Exports	**Impact WQ-4:** Salinity Increase at Exports (LTS) **Mitigation:** No mitigation is required.
	Impact WQ-5: Beneficial Salinity Reductions at Exports (LTS) **Mitigation:** No mitigation is required.
Impact C-5: Elevated DOC Concentrations in Delta Exports (CCWD Rock Slough, SWP Banks, CVP Tracy) (LTS-M) **Mitigation Measure C-5:** Restrict DW Discharges to Prevent DOC Increases of Greater Than 0.8 mg/l in Delta Exports	**Impact WQ-6:** Elevated DOC Concentrations in Delta Exports (LTS) **Mitigation:** No mitigation is required.
	Impact WQ-7: Increased Methylmercury Loading in the Delta (LTS-M) **Mitigation Measure WQ-MM-1:** Follow Guidelines from Proposed Delta TMDL for Mercury **Mitigation Measure WQ-MM-2:** Incorporate Mercury Methylation Control Measures in Wetland Design
Impact C-6: Elevated THM Concentrations in Treated Drinking Water from Delta Exports (CCWD Rock Slough, SWP Banks, and CVP Tracy) (LTS-M) **Mitigation Measure C-6:** Restrict DW Discharges to Prevent Increases of More Than 16µg/l in THM Concentrations or THM Concentrations of Greater Than 72µg/l in Treated Delta Export Water	THM not evaluated. THM is a disinfection by-product. The formation of THM is dependent on concentration of DOC and processes used at the water treatment plant. Because control of DOC would control the formation of THM, THM is not evaluated separately.
Impact C-7: Changes in Other Water Quality Variables in Delta Channel Receiving Waters (LTS-M) **Mitigation Measure C-7:** Restrict DW Discharges to Prevent Adverse Changes in Delta Channel Water Quality	**Impact WQ-8:** Changes in Other Water Quality Variables in Delta Channel Receiving Waters (LTS) **Mitigation:** No mitigation is required.
Impact C-8: Potential Contamination of Stored Water by Pollutant Residues (LTS-M) **Mitigation Measure C-8:** Conduct Assessments of Potential Contamination Sites and Remediate as Necessary	**Impact WQ-9:** Potential Contamination of Stored Water by Contaminant Residues (LTS-M) **Mitigation Measure WQ-MM-3:** Conduct Assessments of Potential Contamination Sites and Remediate as Necessary
	Impact WQ-10: Water Pollution Caused by Construction Activities (LTS) **Mitigation:** No mitigation is required.

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
	Impact WQ-11: Increase in Pollutant Loading in Delta Channels Associated with Recreational Boating (LTS) No mitigation is required but the following will further reduce impacts: **Mitigation Measure WQ-MM-4:** Clearly Post Waste Discharge Requirements, Provide Waste Collection Facilities, and Educate Recreationists Regarding Illegal Discharges of Waste **Mitigation Measure REC-MM-1**: Reduce the Size or Number of Recreation Facilities
	Impact WQ-12: Reduction in Agricultural Pollutants (B and LTS). **Mitigation:** No mitigation is required.
ALTERNATIVE 3	
Impact C-9: Salinity (EC) Increase at Chipps Island during Months with Applicable EC Objectives (LTS-M) **Mitigation Measure C-1:** Restrict DW Diversions to Limit EC Increases at Chipps Island	**Impact WQ-1:** Salinity Increase at Chipps Island (LTS) **Mitigation:** No mitigation is required.
Impact C-10: Salinity (EC) Increase at Emmaton during April-August (LTS-M) **Mitigation Measure C-2:** Restrict DW Diversions to Limit EC Increases at Emmaton	**Impact WQ-2:** Salinity Increase at Emmaton (LTS) **Mitigation:** No mitigation is required.
Impact C-11: Salinity (EC) Increase at Jersey Point during April-August (LTS-M) **Mitigation Measure C-3:** Restrict DW Diversions to Limit EC Increases at Jersey Point	**Impact WQ-3:** Salinity Increase at Jersey Point (LTS) **Mitigation:** No mitigation is required.
Impact C-12: Salinity (Chloride) Increase in Delta Exports (LTS-M) **Mitigation Measure C-4:** Restrict DW Diversions or Discharges to Limit Chloride Concentrations in Delta Exports	**Impact WQ-4:** Salinity Increase at Exports (LTS) **Mitigation:** No mitigation is required.
	Impact WQ-5: Beneficial Salinity Reductions at Exports (LTS) **Mitigation:** No mitigation is required.
Impact C-13: Elevated DOC Concentrations in Delta Exports (CCWD Rock Slough, SWP Banks, CVP Tracy) (LTS-M) **Mitigation Measure C-5:** Restrict DW Discharges to Prevent DOC Increases of Greater Than 0.8 mg/l in Delta Exports	**Impact WQ-6:** Elevated DOC Concentrations in Delta Exports (LTS) **Mitigation:** No mitigation is required.
	Impact WQ-7: Increased Methylmercury Loading in the Delta (LTS-M) **Mitigation Measure WQ-MM-1:** Follow Guidelines from Proposed Delta TMDL for Mercury **Mitigation Measure WQ-MM-2:** Incorporate Mercury Methylation Control Measures in Wetland Design

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
Impact C-14: Elevated THM Concentrations in Treated Drinking Water from Delta Exports (CCWD Rock Slough, SWP Banks, and CVP Tracy) (LTS-M) **Mitigation Measure C-6:** Restrict DW Discharges to Prevent Increases of More Than 16 µg/l in THM Concentrations or THM Concentrations of Greater Than 72 µg/l in Treated Delta Export Water	THM not evaluated. THM is a disinfection by-product. The formation of THM is dependent on concentration of DOC and processes used at the water treatment plant. Because control of DOC would control the formation of THM, THM is not evaluated separately.
Impact C-15: Changes in Other Water Quality Variables in Delta Channel Receiving Waters (LTS-M) **Mitigation Measure C-7:** Restrict DW Discharges to Prevent Adverse Changes in Delta Channel Water Quality	**Impact WQ-8:** Changes in Other Water Quality Variables in Delta Channel Receiving Waters (LTS) **Mitigation:** No mitigation is required.
Impact C-16: Potential Contamination of Stored Water by Pollutant Residues (LTS-M) **Mitigation Measure C-8:** Conduct Assessments of Potential Contamination Sites and Remediate as Necessary	**Impact WQ-9:** Potential Contamination of Stored Water by Contaminant Residues (LTS-M) **Mitigation Measure WQ-MM-3:** Conduct Assessments of Potential Contamination Sites and Remediate as Necessary
	Impact WQ-10: Water Pollution Caused by Construction Activities (LTS). **Mitigation:** No mitigation is required
	Impact WQ-11: Increase in Pollutant Loading in Delta Channels Associated with Recreational Boating (LTS). No mitigation is required but the following will further reduce impacts: **Mitigation Measure WQ-MM-4:** Clearly Post Waste Discharge Requirements, Provide Waste Collection Facilities, and Educate Recreationists regarding Illegal Discharges of Waste **Mitigation Measure REC-MM-1**: Reduce the Size or Number of Recreation Facilities
	Impact WQ-12: Reduction in Agricultural Pollutants (B and LTS). **Mitigation:** No mitigation is required.

Note: SU = Significant and unavoidable; LTS = Less than significant; LTS-M = Less than significant with mitigation; B = Beneficial.

Summary of Changes, New Circumstances, and New Information

Substantial Changes in the Project

There have been no substantial changes in the Project resulting in new significant effects or substantial increase in the severity of effects on water quality. The Project now incorporates the WQMP that was prepared as part of the water right protest dismissal agreements as an environmental commitment. As the Revised 2000 DEIR/EIS water quality evaluation (i.e., modeling) did not include the specific WQMP provisions, water quality impacts of the Project are expected to be less than those described for the 2001 FEIR and 2001 FEIS.

New Information and New Circumstances

Three water quality constituents were selected for reassessment or first-time assessment based on new regulations, new information, or WQMP restrictions placed on the Project:

- The DOC analysis was updated because there have been new studies that may provide substantial new information, and the WQMP limits the potential impacts on DOC at the exports and drinking water diversions.
- The mercury analysis was updated because of the new draft TMDL regulations for mercury in the Delta (Wood et al. 2010a).
- The salinity (i.e., chloride, bromide, and electrical conductivity [EC]) analysis was updated because the WQMP places more restrictive conditions for diverting water onto the Reservoir Islands, and the salinity of the stored water therefore is expected to be lower. Several potential benefits associated with this low salinity water are considered in the Place of Use EIR analysis, including Project releases for increased Delta outflow that will lower salinity in the Delta during some fall months.

Affected Environment

This section discusses changes in the existing conditions or regulatory setting since the 2001 FEIR and 2001 FEIS.

Sources of New Information

The 1995 DEIR/EIS with appendices, the 2000 RDEIR/EIS with appendices, and the 2001 FEIR and 2001 FEIS were used as the basis to prepare this updated water quality section. The key sources of new data and information used to assess changes in the environmental setting and impacts following the publication of the 2001 FEIR and 2001 FEIS that relate to water quality are listed below.

- In-Delta Storage Program Draft Feasibility Study Report on Environmental Evaluations (California Department of Water Resources 2003a).
- 2006 Supplemental Report to the 2004 Draft Feasibility Study In-Delta Storage Project (California Department of Water Resources 2006). This includes a supporting document by Dr. K. R. Reddy, *Review of Delta Wetlands Water Quality: Release and Generation of Dissolved Organic Carbon from Flooded Peatlands—Final Report 2005*.

- Delta Wetlands Project Water Quality Management Plan.
- Jones Tract Flood Water Quality Investigations (California Department of Water Resources 2009).

Regulatory Setting

The following section summarizes regulations affecting Delta water quality.

Federal

Clean Water Act

The State Water Board is the state agency with primary responsibility for implementation of state and federally established regulations relating to water resource issues. Typically, all regulatory requirements are implemented by the State Water Board through regional boards established throughout the state. Both the State Water Board and the Central Valley Regional Water Quality Control Board (RWQCB) regulate water quality in the Delta.

The Clean Water Act (CWA) is the primary federal law that protects the quality of the nation's surface waters, including lakes, rivers, and coastal wetlands. It operates on the principle that all discharges into the nation's waters are unlawful unless specifically authorized by a permit; permit review is the CWA's primary regulatory tool.

Section 303

The State of California adopts water quality standards to protect beneficial uses of state waters as required by Section 303 of the CWA and the Porter-Cologne Water Quality Control Act of 1969.

Delta-specific beneficial uses protected through water quality objectives are municipal and domestic water supply, agricultural supply, industrial supply (process and service), recreation (water contact and non-contact), freshwater habitat (warm- and coldwater), fish migration (warm- and coldwater), fish spawning (warmwater fish), wildlife habitat, and navigation. Section 303(d) of the CWA established the total maximum daily load (TMDL) process to guide the application of state water quality standards. To identify candidate water bodies for TMDL analysis, a list of water quality–limited streams is generated by the State Water Board and RWQCB. The water quality impairment can include the presence of a pollutant, such as a heavy metal, pesticide, or excessive sediment, or a change in the physical property of the water, such as DO or temperature.

A TMDL is a quantitative assessment that specifies the allowable load of pollutants from individual sources to ensure compliance with water quality standards. Once the allowable load and existing source loads have been determined, reductions in allowable loads are allocated to individual pollutant sources.

For the Delta, TMDLs have been established for diazinon, chlorpyrifos, pathogens (for Stockton urban waterways), and low DO (in the Stockton Deep Water Ship Channel [DWSC]), and there is a draft TMDL for methylmercury.

The draft TMDL for methylmercury in the Delta is implemented through the Basin Plan Amendment process. The proposed Basin Plan amendments define the Delta Mercury Control Program. Major components of the Basin Plan amendments are:

1. Numeric objectives for methylmercury in fish tissue and an aqueous methylmercury goal that are specific to the Delta and an exposure reduction program;
2. An implementation plan for controlling methylmercury and total mercury sources; and
3. A surveillance and monitoring program.

The Project islands are predominantly located within the Central Delta sub-region of the Delta. Because the ambient methylmercury concentrations in the Central Delta subarea equal or approach the proposed aqueous methylmercury goal, a load allocation set at the existing average annual methylmercury load will ensure compliance with fish tissue objectives. However, the Draft TMDL documentation indicates that proponents of new wetlands and wetland restoration projects scheduled for construction must (a) participate in Control Studies or must implement site-specific study plans that evaluate practices to minimize methylmercury discharges, and (b) implement methylmercury controls as feasible. The draft TMDL documentation anticipates two phases of reducing methylmercury levels. Phase 1, which will continue through about 2019, emphasizes Control Studies and pilot projects to develop and evaluate management practices to control methylmercury and requires that all dischargers implement reasonable, feasible controls for inorganic mercury. Phase 2, which will last from 2019 until 2030, will require management practices to be implemented in accordance with the schedules adopted for Phase 2 activities.

Section 401

Section 401 of the CWA requires that an applicant pursuing a federal permit to conduct any activity that may result in a discharge of a pollutant obtain a Water Quality Certification (or waiver). Under the CWA, the state (State Water Board or RWQCB) must issue or waive Section 401 Water Quality Certification for the project to be permitted under Section 404. Water Quality Certification requires the evaluation of water quality associated with dredging or placement of fill materials into waters of the United States and may impose project-specific conditions on development.

Section 402

Section 402 of the CWA regulates discharges to surface waters through the National Pollutant Discharge Elimination System (NPDES) program, administered by the EPA. In California, the State Water Board is authorized by the EPA to oversee the NPDES program through the RWQCBs (see related discussion under Porter-Cologne Water Quality Control Act). The NPDES program provides for both general permits (those that cover a number of similar or related activities) and individual permits.

NPDES permits typically specify waste discharge requirements (WDRs) for controlling water pollution. However, the Project discharges would not require an NPDES permit because reservoir releases do not require NPDES permits.

Agricultural and Wetland Runoff

Agricultural return flows and water from managed wetlands (i.e., water from island drains) are considered nonpoint sources. Agricultural return flows and discharges from managed wetlands are covered by the Central Valley RWQCB irrigated land regulatory waiver program. Participants in the waiver program need to monitor water quality and implement practices to meet water quality objectives.

Construction Activities

Most construction activities that disturb 1 acre of land or more are required to obtain coverage under the NPDES General Permit for Construction Activities (General Construction Permit), which requires the applicant to file a notice of intent (NOI) to discharge stormwater and to prepare and implement a stormwater pollution prevention plan (SWPPP). The SWPPP includes a site map and a description of proposed construction activities, along with a demonstration of compliance with relevant local ordinances and regulations, and an overview of the BMPs that would be implemented to prevent soil erosion and discharge of other construction-related pollutants that could contaminate nearby water resources. Permittees are further required to conduct annual monitoring and reporting to ensure that BMPs are implemented correctly and effective in controlling the discharge of stormwater-related pollutants.

Dewatering Activities

While small amounts of construction-related dewatering are covered under the General Construction Permit, the Central Valley RWQCB also has adopted a General Order for Dewatering and Other Low Threat Discharges to Surface Waters (General Dewatering Permit). This permit applies to various categories of dewatering activities that would exceed the dewatering allowed by the General Construction Permit. The General Dewatering Permit contains waste discharge limitations and prohibitions similar to those in the General Construction Permit. To obtain coverage, the applicant must submit an NOI and pollution prevention and monitoring program (PPMP). The PPMP must include a description of the discharge location, discharge characteristics, primary pollutants, receiving water, treatment systems, spill prevention plans, and other measures necessary to comply with discharge limits. A representative sampling and analysis program must be prepared as part of the PPMP and implemented by the permittee, along with recordkeeping and quarterly reporting requirements during dewatering activities. For dewatering activities that are not covered by the General Dewatering Permit, an individual NPDES permit and WDRs must be obtained.

Section 404

Section 404 of the CWA regulates the discharge of dredged and fill materials into “waters of the United States,” which include oceans, bays, rivers, streams, lakes, ponds, and wetlands. Project proponents must obtain a permit from the Corps for all discharges of dredged or fill material into waters of the United States, including wetlands, before proceeding with a proposed activity. Before any actions that may affect surface waters are carried out, a delineation of jurisdictional waters of the United States must be completed, following Corps protocols.

Section 404 permits may be issued only for the least environmentally damaging practicable alternative. That is, authorization of a proposed fill is prohibited if there is a practical alternative that would have less adverse impacts and lacks other significant adverse consequences.

Safe Drinking Water Act

The federal Safe Drinking Water Act (SDWA) was passed in 1974 to protect drinking water quality. The EPA establishes the national standards for drinking water quality. Two amendments to the SDWA, the Stage 1 and Stage 2 Disinfectants and Disinfection By-Products Rules, establish rules to reduce health risks associated with disinfection by-products. These two amendments are balanced by the Enhanced Surface Water Treatment Rules that were established to minimize illness resulting from microbial contamination of drinking water, which can occur with inadequate disinfection.

Standards for total organic carbon (TOC) removal before treatment have been adopted under the SDWA. TOC consists of both DOC and particulate organic carbon (POC). The SDWA rules specify requirements for the removal of TOC by drinking water providers. Municipal water treatment plants may remove this substance by enhanced coagulation (e.g., using alum); water systems that obtain their water supplies from surface-water or groundwater sources and use conventional filtration processes may use enhanced softening to remove TOC.

Table 4.2-2 shows the percentage of TOC that must be removed based on the alkalinity and TOC concentrations in source water. Removal of TOC before chlorination generally will reduce the THM concentrations. Because Delta water generally has an alkalinity between 60 and 120 milligrams per liter (mg/l) as calcium carbonate ($CaCO_3$) with TOC concentrations between 2 mg/l and 8 mg/l, removal of 25% or 35% of the raw-water TOC will be required. This TOC would be removed before the water is chlorinated to reduce the necessary chlorine (Cl_2) dose and to reduce the subsequent formation of THMs. TOC concentrations and TOC removal is not as important for treatment plants using alternative disinfection technologies, such as ozone.

Table 4.2-2. Requirements for Percentage of Total Organic Carbon to Be Removed for Systems Using Conventional Treatment

Source Water Total Organic Carbon (mg/l)	Alkalinity (mg/l as $CaCO_3$)		
	0–60	60–120	>120
2–4	35%	25%	15%
4–8	45%	35%	25%
>8	50%	40%	30%

Source: U.S. Environmental Protection Agency. 2001. Stage 1 disinfectants and disinfection by-products rule. Available at: <http://www.epa.gov/safewater/mdbp/stage1dbprfactsheet.pdf>. Downloaded March 8, 2010.

DOC usually represents more than 90% of the TOC present in Delta waters (California Department of Water Resources 1994). For example, in a study of DOC emitted from peat inundated in tanks, DOC was found to be 93 to 98% of TOC. In an evaluation of the water on a flooded island (Jones Tract in 2004), DOC was found to be 84% of TOC (Reddy 2005: 2).

The EPA maximum contaminant level (MCL) for THM concentrations in treated drinking water is 80 micrograms per liter (µg/l). Because THM concentrations vary seasonally, the THM standard is applied to a moving annual average based on quarterly or monthly samples at the treatment plants. Many water treatment plants have responded to the TOC removal and THM regulations by using enhanced coagulation prior to disinfection or by changing the disinfection technology (e.g., ozone [O_3]). The water treatment alternatives for drinking water supplies from the Delta are reviewed in Appendix H, "Delta Drinking Water Quality and Treatment Costs," in the recent PPIC report (Public Policy Institute of California 2008).

State

Porter-Cologne Water Quality Control Act

In 1967, the Porter-Cologne Act established the State Water Board and nine RWQCBs as the primary state agencies with regulatory authority over California water quality and appropriative surface water rights allocations. Under this act (and the CWA), the state is required to adopt a water quality control policy and WDRs to be implemented by the State Water Board and nine RWQCBs. The State Water Board also establishes water quality control plans (WQCPs or basin plans) and statewide plans. The RWQCBs carry out State Water Board policies and procedures throughout the state.

WQCPs, also known as basin plans, designate beneficial uses for specific surface water and groundwater resources and establish water quality objectives to protect those uses. The basin plans define surface water quality objectives for multiple parameters, including suspended material, turbidity, pH, DO, bacteria, temperature, salinity, toxicity, ammonia, and sulfides. The 2006 WQCP is the most recent WQCP for the Bay-Delta. However, no changes in water quality objectives were made from the 1995 WQCP, which was the basis for the 1995 DEIR/EIS and the 2001 FEIR and 2001 FEIS assessment of the Project.

1995 Water Quality Control Plan and D-1641

The State Water Board's 1995 WQCP (adopted May 1995) and Final EIR for Implementation of the Flow and Water Quality Objectives in the 1995 WQCP (November 1999) incorporated several elements of the EPA, NMFS, and USFWS regulatory objectives for salinity and Endangered species protection. The changes from the previous regulatory limits for CVP and SWP Delta operations (D-1485) were substantial. The State Water Board implemented the 1995 WQCP with Water Right Decision 1641 (D-1641) in March 2000 (State Water Resources Control Board 1999). The new provisions of D-1641 are described in Section 4.1, Water Supply. D-1641 controls the existing baseline operations assumed in CALSIM and the In-Delta Storage Model (IDSM). The two basic objectives relating to water quality (salinity and X2) are described below.

Several Delta locations have specified salinity objectives. Some of these protect aquatic habitat conditions, some protect agricultural diversions within the Delta, and some protect diversions for municipal water supply. SWP and CVP operations are required to not violate these salinity objectives. The salinity objectives at Emmaton on the Sacramento River and at Jersey Point on the San Joaquin River often control Delta outflow (i.e., require upstream reservoir releases and/or reduction in south Delta export pumping) during the irrigation season from April through August. The compliance values as well as the period of compliance change with water year type. The CALSIM model uses an internal computation to estimate the export/outflow split for a monthly inflow that would protect these salinity objectives.

The location of the estuarine salinity gradient is regulated during the months of February–June by the average position of the 2 parts per thousand [ppt] salinity isohaline (X2 objective). The X2 position must remain downstream of Collinsville (81 kilometers upstream from the Golden Gate Bridge) for the entire 5-month period in most years. This requires a minimum outflow of about 7,100 cubic feet per second (cfs). The X2 objective specifies the number of days each month when the location of X2 must be downstream of Chipps Island (now Mallard Slough, at kilometer 75) or downstream of Port Chicago (opposite Roe Island, at kilometer 64). The number of days depends on the previous month runoff index value. Maintaining X2 at Chipps Island requires a Delta outflow of about 11,400 cfs, and maintaining X2 at Port Chicago requires a Delta outflow of about 29,200 cfs. The monthly CALSIM model estimates the monthly average required outflow, obtained by averaging the outflow required for the number of days at each X2 location.

California Toxics Rule and State Implementation Policy

The California Toxics Rule was promulgated in 2000 in response to requirements of the EPA National Toxics Rule. The National Toxics Rule and California Toxics Rule criteria are regulatory criteria adopted for inland surface waters, enclosed bays, and estuaries in California that are subject to regulation pursuant to Section 303(c) of the CWA. The National Toxics Rule and California Toxics Rule include criteria for the protection of aquatic life and human health. Human health criteria (water and organisms) apply to all waters with a Municipal and Domestic Supply beneficial use designation as indicated in the RWQCBs' basin plans. The Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California, also known as the State Implementation Plan, was adopted by the State Water Board in 2000 to establish provisions for translating California Toxics Rule criteria, National Toxics Rule criteria, and basin plan water quality objectives for toxic pollutants into the following:

- NPDES permit effluent limits,
- compliance determinations,
- monitoring for dioxin (2,3,7,8-TCDD) equivalents,
- chronic toxicity control provisions,
- initiating site-specific objective development, and
- granting exceptions.

Drinking Water Quality

The California Department of Public Health upholds the California safe drinking water act and other water regulations by establishing drinking water quality standards that are at least as stringent as the federal standards.

In addition, the Central Valley Water Board is in the process of developing a Central Valley Drinking Water Policy. The goals of this policy would be to protect the upstream sources of the Delta drinking water supply and to establish water quality objectives for some drinking water constituents of concern that are not already well-regulated. These regulations eventually will be incorporated into the Basin Plan.

Local

Bacon and Bouldin islands are located in San Joaquin County and Webb and Holland Tracts are located in Contra Costa County. The local regulations established by San Joaquin and Contra Costa Counties that pertain to the islands that fall within their respective boundaries are described below.

San Joaquin County General Plan 2010

The San Joaquin County General Plan includes several objectives, policies, and implementation measures that could pertain to water quality on the Project islands, although none of these are more detailed or restrictive than state and federal regulations (San Joaquin County 1992: Volume 1, VI-24 to VI-27). They include those following.

Objectives

- To ensure adequate quantity and quality of water resources for municipal and industrial uses, agriculture, recreation, and fish and wildlife.
- To prevent and eliminate contamination of surface water and groundwater supplies.

Policies

- Water quality shall meet the standards necessary for the uses to which the water resources are put.
- Surface water and groundwater quality shall be protected and improved where necessary.
- Water diversion projects shall…guarantee adequate Delta outflows for salinity repulsion.

Implementation

- The County shall continue to enforce its water quality regulations.
- The County shall continue to support State and federal programs for improving and maintaining water quality.
- The County shall actively support efforts to eliminate sources of pollution and clean-up efforts of the County's waterways and groundwater.
- Facilities and uses which cause water pollution shall not be permitted over substantial aquifer recharge areas or adjacent to waterways or reservoirs without adequate safeguards.
- The County shall support State monitoring of surface and ground waters and publicizing of results.

Contra Costa County General Plan 2005–2020

The Contra Costa County General Plan includes a few goals and policies that could pertain to water quality on the Project islands, although none of these are more detailed or restrictive than state and federal regulations (Contra Costa County 2005, 8-45, 8-46). They include those following.

Goal

- To conserve, enhance and manage water resources, protect their quality, and assure an adequate long-term supply of water for domestic, fishing, industrial and agricultural use.

Policies

- Preserve and enhance the quality of surface and groundwater resources
- Grading, filling and construction activity near watercourses shall be conducted in such a manner as to minimize impacts from increased runoff, erosions, sedimentation, biochemical degradation, or thermal pollution.

Environmental Setting

The Delta is a major habitat area for numerous species of fish and aquatic organisms, as well as a source of water for municipal, agricultural, recreational, and industrial uses. Dominant water quality variables that may influence habitat and food-web relationships in the Delta are temperature, salinity, turbidity (and associated light levels), DO, pesticides, pH, nutrients (nitrogen and phosphorus), DOC, chlorophyll, and mercury.

A summary of key Delta water quality values in Delta inflows and exports as well as potential water contaminants on the Project islands was provided in the 2001 FEIR and 2001 FEIS. Based on new information, a new summary for mercury and an updated discussion of DOC are included here.

The Delta export pumping plants (SWP Banks, CVP Tracy, and SWP North Bay Aqueduct) and CCWD diversions at Rock Slough and Old River intake supply a combination of agricultural and municipal users and some wildlife uses (water supply for refuges). The City of Antioch diverts water when salinity is low enough during high outflows, and the City of Stockton has just completed a new intake on the San Joaquin River at Empire Tract. CCWD has begun construction on a new intake located on Victoria Canal, which will connect to the Los Vaqueros pumping plant on Old River. Industrial intakes and discharges occur near Sacramento, Stockton, and Antioch. A wide variety of fish and wildlife inhabit or migrate through the Delta. Many public and private recreational facilities are located in the Delta.

Water quality conditions in the Delta are influenced by natural environmental processes, water management operations, and waste discharge practices. The Project would provide an additional method of water management in the Delta and thus would influence Delta water quality. Water quality variables that might be affected by Project operations have been identified and selected for impact assessment purposes. Some of the selected variables are assessed with impact assessment models and are discussed quantitatively in the impact assessment. Others cannot be assessed with impact assessment models and therefore are discussed qualitatively. Variables that have not been identified as current problems in the Delta and those that are not likely to be affected by Project operations were not selected as impact assessment variables.

Delta water quality conditions can vary dramatically because of year-to-year differences in runoff and upstream water storage releases, and seasonal fluctuations in Delta flows. Concentrations of materials in inflowing rivers are often related to streamflow volume and season. Transport and mixing of materials in Delta channels are strongly dependent on river inflows, tidal flows, agricultural diversions, drainage flows, wastewater effluents, exports, and power plant cooling water diversions and discharges.

Water quality objectives and concerns are associated with each beneficial use of Delta water. Beneficial uses in the Delta include agriculture, municipal (e.g., drinking) and industrial water supply, fish and wildlife, and recreation. Water is diverted for agricultural crop and livestock production at more than 1,800 siphons and pumps. Drainage water is returned to the Delta through about 200 larger pumping stations operated independently by farmers and reclamation districts.

Project operations could affect water quality in the same general ways as described and evaluated in the 2001 FEIR and 2001 FEIS. Diverting water onto the Project islands would reduce Delta outflows. As a result, brackish water from Suisun Bay would intrude into the central Delta and salinity in Delta channels and exports would increase. Releases from Reservoir Islands for increased Delta outflow in the fall of some years would reduce salinity intrusion and reduce export salinity. Possible water quality effects of the Project depend on flows in the Delta. An accurate assessment of possible Delta water quality effects therefore requires consideration of the patterns of Delta channel flows.

While water is stored on the Reservoir Islands, salinity and DOC concentrations would increase because of evaporative water losses, and DOC concentrations would increase also as a result of peat-soil leaching and aquatic vegetation or algal growth. Therefore, discharges from the Reservoir Islands would contribute to increased concentrations of salinity and DOC in Delta channels and in exports and diversions.

Mercury

The 2008 303(d) list of impaired waterways in California identifies the Delta as impaired by elevated levels of mercury. Mercury, particularly methylmercury, accumulates in aquatic organisms. In the Delta, fish tissues have been found to contain elevated levels of this neurotoxin. Much of the mercury in the Delta originates from sediments contaminated by historic mining activities in the tributaries to the Delta. These tributaries still contain elevated levels of mercury as a result of mining activities and continue to contribute to the elevated levels in the Delta.

Because methylmercury is of much greater concern for bioaccumulation than inorganic mercury, the production of methylmercury from inorganic mercury is considered detrimental. This conversion is most commonly performed by sulfate reducing bacteria. Conditions that affect these bacteria, such as temperature and pH, also affect the amount of methylation that occurs. (Wood et al. 2010a: 23.)

It has been estimated that 60% of the methylmercury in the Delta originates from tributary inflow and 40% originates from in-Delta sources. Of the in-Delta sources, most comes from the sediments of wetlands and open water. Relatively small amounts come from agricultural drains and wastewater treatment plants. (Wood et al. 2010b: 33.) However, the production of methylmercury is difficult to measure in the field, and there appears to be considerable variability in the estimates of methylmercury production by wetlands and agricultural land.

Methylmercury loads from Delta agricultural lands with high organic content recently have been estimated as being between 0.3 and 4.5 nanograms per square meter per day ($ng/m^2/day$) (Heim et al. 2009: 33; Wood et al. 2010a: 108). In contrast methylmercury loads from open water in the Delta have been estimated using benthic flux changers to be 10 $ng/m^2/day$ (Wood et al 2010a: 88). Mercury flux from some wetlands has been estimated to be similar to this rate. For example, a recent study from the Twitchell Island East pond estimated a mercury flux of 7.7 $ng/m^2/day$ (Sassone et al. 2008: 10) and even lower values have been estimated for wetlands on Grizzly Island (Stephenson et al 2008: 8). Measured values of methylmercury production on wetlands appear to be highly variable and dependent on many factors such as timing and nature of inundation (permanent, seasonal, or tidal). In some other cases, wetlands have been estimated to be methylmercury sinks (Wood et al. 2010a: 30).

The Central Valley RWQCB is in the process of developing and implementing a TMDL for the control of methylmercury in the Delta (Wood et al. 2010a). As part of the TMDL process, the Central Valley RWQCB has created draft recommendations to reduce methylmercury concentrations in the Delta.

In order to attain this TMDL goal, draft allocations have been assigned to the various sources of methylmercury in the Delta. The Project islands are mostly in the central Delta region. The draft methylmercury load allocation for the central Delta is to maintain the current estimated level of 37 grams per year (g/yr) for agricultural sources plus 210 g/yr for wetland sources and 370 g/yr for open water (Wood et al. 2010b: BPA18).

The proposed TMDL would be implemented in two phases. During phase 1, concentrations of methylmercury would continue to be measured at locations within the Delta and procedures for reducing methylmercury load would be assessed. After the completion of phase 1, load allocations would be re-assessed and approved control actions would be implemented to meet allocation targets.

Dissolved Organic Carbon

Minimizing DOC concentrations in the raw water source is a water quality goal to reduce the disinfection by-product (DBP) concentration in treated drinking water from the Delta. Project discharges may directly influence DOC concentrations in Delta channels and exports. The 2001 FEIR and 2001 FEIS evaluation has been updated with new DOC information from several recent DWR and U.S. Geological Survey (USGS) studies. Project effects on export DOC would be restricted through a program of measurements, modeling comparisons, and Project discharge adjustments in the WQMP to prevent any significant impacts.

DOC is a major concern because DOC may be produced and leached from peat soils into the stored water on the Reservoir Islands or into the wetlands on the Habitat Islands. The rate of DOC production and leaching that can be expected on flooded peat islands is uncertain. When a field becomes flooded, the initial release of DOC may be high because of high amounts of soluble DOC in the soil and the presence of dead plant material that could provide an additional source of DOC. DWR has investigated DOC as part of its Integrated Storage Investigation of In-Delta storage. One report concluded that the maximum DOC leaching would occur when islands are first flooded, and that the rate of DOC leaching would decrease over time (Reddy 2005: 3).

DOC loading rates (grams of DOC per land area per time) from peat soils are controlled by various factors, such as temperature, anaerobic conditions, soil peat content, and vegetation. Agricultural crop production, wetland habitat, and flooded island conditions may result in different DOC loadings.

Summary of Dissolved Organic Carbon Loading Information from the 2001 FEIR and 2001 FEIS

DOC measurements and DOC loading rates evaluated for the 2001 FEIR and 2001 FEIS showed that DOC concentrations at the export locations averaged 3.7 mg/l, with 85% of the measured values in the range of 2.5 to 6 mg/l.

The 2001 FEIR and 2001 FEIS summarized the loading estimates for agricultural drainage, seasonal wetland, and flooded island conditions that were presented in the 1995 DEIR/EIS. This information was obtained from the Twitchell Island and Special Multipurpose Applied Research Technology Station (SMARTS) experiments, and presented at the State Water Board water right hearing for the Project by expert witnesses. For purposes of comparison, all estimates have been reported as grams of DOC per square meter per year ($g\text{-}C/m^2/yr$).

Agricultural Drains

The purpose of the agricultural drainage DOC data analysis was to estimate annual loading of DOC from existing agricultural operations. These estimates provide a baseline DOC loading level for the Project impact analysis.

There are two general ways to estimate the observed DOC loads (expressed as g-C/m^2/yr) from the agricultural islands in the Delta:

1. Multiply the annual drainage volume (expressed as water depth in meters [m]) by the average DOC concentration (mg/l) of the drainage water to estimate the DOC load.
2. Multiply the DOC concentration increase observed between the Sacramento and San Joaquin River inflows and the export locations by the export flow to estimate the increased mass of DOC. This increased mass (g) of DOC then is divided by the area of the Delta agricultural islands contributing to the export water to estimate the average load of DOC.

Both methods have been used to evaluate the DOC load from Delta agricultural islands under existing conditions. Appendix G, "Water Quality Assessment Methods," of the 2000 RDEIR/EIS presents detailed information on agricultural drainage water quality for Bacon Island, Webb Tract, Bouldin Island, Holland Tract, and Twitchell Island. Based on these estimates and on model calibration results, an average of 12 g-C/m^2/yr was used in the 2001 FEIR and 2001 FEIS for the DOC loading estimate for existing agricultural drains in the Delta.

Seasonal Wetlands and Flooded Islands

Several experiments were conducted for the Project to assess DOC loading under seasonal wetland and reservoir operations (see Appendix C3 of the 1995 DEIR/EIS). The methods and results of these experiments were challenged at the water right hearing and in comments on the 1995 DEIR/EIS. Because this is very important for assessing the likely DOC impacts from the Project, a summary of the measurements and a discussion of challenges to those results are provided here.

In the wetland demonstration experiment, a portion of Holland Tract was flooded, and a shallow flooded wetland habitat (0.5 meter deep) was created. Water samples were collected for approximately 3 months, and a DOC load was estimated. The wetland demonstration project estimated a total DOC load of 7 to 17 g-C/m^2/yr. In addition, a second experiment was conducted to ascertain the DOC load generated from the decay of wetland plants. Wetland plant decay experiments suggested a load of 5.1 to 7.5 g-C/m^2/yr. Compared to agricultural conditions, wetlands may provide lower DOC loads because the peat soil of wetlands generally will be moister and less aerobic than that of agricultural soils. However, a seasonal wetland loading of 12 g-C/m^2/yr was assumed, equivalent to the assumed agricultural drainage load.

Additional experiments were conducted to assess DOC loading under Project reservoir operations. At the demonstration wetland on Holland Tract, loading was estimated for an extended period of time when a seasonal wetland was deep-flooded (to approximately 0.8 m) to characterize possible reservoir operations. In this experiment, the overall DOC load was estimated from the combined flooded wetland and water storage periods at the Holland Tract wetland demonstration project. The result was an estimated DOC load of 21 g-C/m^2/yr.

In 1991, Tyler Island was flooded for approximately 1 month. DOC loading was estimated based on collected water samples. The Tyler Island experiment resulted in an estimated total DOC load of 30 to 36 g-C/m^2/yr. Much of the DOC loading was probably the result of the cornfield vegetation residue and oxidized surface peat soil.

Parties to the water right hearing questioned the validity of these experimental results. CUWA, CCWD, and others argued that the Holland Tract flooded wetland experiment was too short; they said that it was unclear whether DOC had started to level off or not, and that the reported DOC loading was therefore underestimated.

DWR conducted several DOC investigations at SMARTS, a peat soil DOC testing facility managed under the MWQI program. The facility was constructed in 1988 consisting of eight large tanks for conducting inundated peat soil water quality studies under static or water-flow conditions. Two reports from SMARTS studies have been prepared (California Department of Water Resources 1999a, 1999b) and are referred to below as SMARTS 1 and SMARTS 2. Results from SMARTS 1 and 2 were evaluated in the 2001 FEIR and 2001 FEIS and are summarized here.

SMARTS1 was a 12-week experiment (July 15 to October 7, 1998), and SMARTS 2 was a 27-week experiment (January 21 to September 15, 1999). The experiments used two water-flow conditions: “static” and “flushing.” The flushing tanks were not evaluated in the 2001 FEIR and 2001 FEIS because of difficulties associated with measuring small concentration changes in these tanks. The four static tanks were refilled as needed to compensate for evaporation losses, so the water level was held constant. The surface water in the static tanks was mixed with submersible pumps. The water and peat depth for the four static tanks varied; the water depth was either 2 feet (0.6 meter) or 7 feet (2.1 meters), and the peat depth was either 1.5 feet or 4 feet.

Because the water depth was held constant in the static tanks, the load (grams per square meter [g/m^2]) for a static tank can be estimated as the change in DOC concentration (mg/l [equivalent to g/m^3]) times the depth of water (m). These calculations result in loading estimates of 24 to 32 g/m^2 for the static tanks with 1.5 feet of peat (tanks 1 and 7) and 53 to 54 g/m^2 for the static tanks with 4 feet of peat in SMARTS 1 (tanks 3 and 5). The SMARTS 2 experiment resulted in a wider range of DOC load estimates because the peat soil pore-water DOC concentrations varied considerably. The SMARTS 2 experiment data for week 27 indicated that the DOC load from the higher DOC peat soil (tanks 1 and 3) was 73 to 121 g/m^2, and the DOC load from the lower DOC peat soil (tanks 5 and 7) was 23 to 42 g/m^2. The SMARTS-2 experiments showed that the peat soil (pore-water) DOC and the surface-water DOC concentrations do not continue to increase during longer submergence as rapidly as during the initial 3-months of submergence.

The SMARTS-2 peat soil DOC concentrations were considerably higher (ranging from 350 to 600 mg/l) than DOC concentrations that have been measured in Delta peat soils. Samples of pore water collected at the soil surface and at a depth of 2 feet from the demonstration wetland site on Holland Tract in 1992 yielded DOC concentrations between 24 and 71 mg/l with an average of 55 mg/l (n=9). Soil-water samples collected from an agricultural field on Holland Tract in 1992 included measured DOC concentrations between 41 and 240 mg/l with an average of 141 mg/l (n=9). The observed DOC loads in the SMARTS experiments were proportional to the depth of the peat soil and the DOC concentration of the peat-soil pore water. DOC loading of flooded agricultural peat soils on the Project islands likely would be proportional to the depth of oxidized peat soil on the islands.

New Dissolved Organic Carbon Loading Information

Additional information about DOC loading from wetlands and flooded islands is directly pertinent to the Habitat Islands. Additional studies at the SMARTS facility from 2002-2005 and measurements from the June 2004 Jones Tract flooding provide new information about DOC release rates for situations similar to the Project Reservoir Islands.

Because DOC is measured in the Sacramento River, San Joaquin River, and at the Delta exports, it is possible to estimate how much of the DOC originating at the Delta exports originates within the Delta. In one study (Stepanauskas et al. 2005: 139), it was estimated that an average of 30% of the DOC at the exports originates from within the Delta. The agricultural drainage flow and DOC concentrations can be measured or estimated; the open water and wetlands contributions must be estimated as the incremental DOC at the exports that cannot be explained by the measured sources (river inflow and agricultural drainage).

Under current conditions, the Project islands contribute moderately to the total DOC load from agricultural drains at the exports. The four Project islands are within the area that DWR considers as having relatively high concentrations of DOC in their agricultural drains (15–36 mg/L). DWR has used the DSM2 model and estimates of island drain flows and DOC concentration to determine that island drains contribute an average of about 35% of the DOC at the SWP and CCWD intakes, and about 25% at the CVP intake (California Department of Water Resources 2003b). The average DOC concentration estimated for the SWP from assumed river inflow DOC concentrations without any Delta DOC sources was 2.6 mg/l. The simulated increase in DOC at the SWP pumps with the assumed agricultural drainage DOC concentrations and drainage flows (from DICU sub-model) was 1.3 mg/l. Some of the Delta sources of DOC also would flow out of the Delta.

A good summary of DOC load rates evaluated in various studies of agricultural drains was provided in another recent study (Deverel et al. 2007). Summer DOC loading rates for Orwood Tract, Sherman Island, and Twitchell Island ranged from 0 to 10 g-C/m^2. Summer DOC loading rates for Jersey Island were considerably higher (75 g-C/m^2 /yr), presumably because the field was not drained completely until summer. Winter loading rates, December–April, were recorded at fewer locations and varied from 2-45 g-C/m^2. The annual loading rate measured from Staten Island during water year 2006 (DiGiorgio et al. 2006) was 8.5 g-C/m^2/year. These are also similar to the 12 g-C/m^2 assumed in the 1995 and the 2000 RDEIR/EIS assessments.

Wetlands

In a 2001–2003 study of wetlands on Twitchell Island (Fleck et al. 2007), DOC concentrations in surface water were found to be less than the DOC concentrations in water moving through the soil into the drainage system, despite the presence of anaerobic conditions in the soil. This study used a water and DOC balance approach to account for inflow, inflow DOC, outflow, and outflow DOC. The estimated loading rate from the surface water was estimated to be 25 g-C/m^2/yr from the surface drainage compared to 100 g-C/m^2/yr for the subsurface drainage. The Twitchell Island study found that the DOC in the surface water was derived mostly from plants and algae, with plants being the more likely source (Fleck et al. 2007: 12–13). This determination was based on the difference in chemical properties between the shallow pore-water and the surface water.

Flooded Peat Soil

Two sets of measurements provide relevant new information for estimating DOC loading rates from flooded peat islands. One was the analysis of data collected from Jones Tract after it was flooded in June 2004, and the other was a series of multi-year tank experiments at the DWR SMARTS facility from 2002 to 2005.

The 2002–2005 SMARTS experiments measured the release of TOC and DOC from the same peat soil for multiple years, allowing an assessment of how flooded Delta islands DOC release loads may decrease through time. Peat soil from a field on Bacon Island was placed in the tanks to a depth of 0.5 m and covered with 1.4 m or 2.8 m of water in March 2002. The results from the first year were described in a DWR report (California Department of Water Resources 2003a: Chapter 3), and the results from the first 2½ years were evaluated for the In-Delta Integrated Storage Investigations (Reddy 2005). The 2002–2005 SMARTS experiment data were obtained from DWR to further evaluate for this Place of Use EIR.

During the first 2 years of the experiment, water levels in the tanks were adjusted periodically to reflect the expected seasonal storage on in-Delta Reservoir Islands. Because a substantial portion of the water was removed in both 2002 and

2003, the DOC loading estimates (water depth x concentration) are more uncertain than for static tanks. TOC and DOC measurements were made for the first 3 years, but only TOC was measured in 2005. DWR reported that DOC was about 95% of TOC in the 2002 and 2003 measurements. DWR recorded the water depth in each tank, as well as the water removed and added (or exchanged in 2003) to track the cumulative TOC loading.

Figure 4.2-1 shows the measured water depths and the exchange depths (tank water replaced with river water) for each TOC measurement date. TOC concentrations measured at each sampling date are shown in the bottom panel. The reported depths were always the same in the four deep and four shallow tanks. Slight variations in depths (especially for the shallow tanks) might account for some of the variations in TOC concentrations and corresponding TOC release loads. Nevertheless, the 4 years of TOC measurements provide the best available demonstration of long-term peat soil TOC release rates.

The measured TOC was about 3 mg/l on March 12, 2002 after the tanks were filled with 0.5 m of peat soil and with Sacramento River water. The TOC concentrations increased to about 25 mg/l in the deep tanks (2.5 m) and to about 50 mg/l in the shallow tanks (1.25 m) by July 17 (after 4 months). Then most of the water was removed from the tanks (to a depth of about 0.3 m). TOC concentrations increased rapidly during the summer months because of the shallow depth and high temperatures of the tanks. The water depth was held constant by adding river water to balance evaporation, but the summer TOC concentrations in the shallow water increased to maximum concentrations of 100 to 200 mg/l, as measured on October 1. The seasonal TOC release pattern was determined from the cumulative TOC release load, calculated as the depth times the concentration (plus the removed TOC loads when the water depth was reduced in 2002 and 2003).

Figure 4.2-2 shows the cumulative TOC release load (g-C/m^2) calculated by DWR, accounting for the removal and exchange of water from each tank. The changes in TOC release loads during the 4-year experiment are shown in the bottom graph, by starting the annual TOC release load at zero on the first measurement date for each year. The decreasing annual TOC release loads demonstrate the basic results from the 4-year SMARTS experiment, suggesting that there was a large initial TOC release from the accumulated DOC in the oxidized peat soil (pore water), but that the release of TOC from the flooded peat soil was substantially reduced in subsequent years.

The TOC release load decreased substantially from 2002 to 2005. The calculated annual TOC release loads were about 80 to 100 g-C/m^2 for the eight tanks during the first year (2002). The experiment did not begin until March 12, so the possible TOC release in January and February is unknown. There were five sample dates but no additional TOC release loads from October to December of 2002. In this first year, the TOC release rate appeared to follow a seasonal pattern, with a much lower release rate in the October–December period (colder) than in the April–September period. The variable water depths and uncertain water exchanges during 2003 make the TOC release loads uncertain. However, the annual TOC release loads calculated by DWR for 2003 (with exchange depth in meters) ranged from about 40 to 80 g-C/m^2. The TOC concentrations and calculated release loads were most variable in 2003 after the water depths were reduced. The TOC release rates measured in October–December of 2003 were again low.

The annual estimated TOC release loads were reduced substantially in 2004 (third year) to about 20 to 40 g-C/m^2. The estimated annual TOC release loads for 2005 were again very low and were uncertain because the water level (and TOC concentrations) fluctuated from rainfall and evaporation, with some added water in the summer months. The TOC concentrations in the deep tanks (2.8 m) remained about 25 mg/l throughout the year, and the TOC concentrations in the shallow tanks (1.4 m) remained about 50 mg/l throughout the year. The annual TOC release loads calculated from the changes in TOC concentration in 2005 were about 10 to 20 g-C/m^2. These calculated TOC release loads in the fourth year of the flooded peat soil experiment were similar to the measured DOC loads from existing agricultural drainage in the Delta.

Determining what portion of the annual TOC release loads was caused by leaching of the initial soluble pore water DOC and what portion was new production of DOC from the microbial decay of flooded peat soil material was not possible from this experiment. However, it appeared that the majority of the cumulative TOC release loads occurred during the first 2 years. Much lower TOC release loads were measured in the third and fourth years, suggesting that TOC release loads would likely decrease with time as the in-Delta Reservoir Islands are converted from agricultural production and become inundated. Maintaining shallow wetlands or saturated conditions on the Reservoir Islands likely will minimize the production and release of DOC from the peat soil.

Flooded Jones Tract Measurements

On June 3, 2004, a section of the Middle River levee on the western side of Upper Jones Tract failed, opening a 300-foot-wide levee breach. Within a week, both upper and lower Jones Tracts were flooded. By late June, the breach in the levee was mostly filled and the tidal exchange of water with Middle River ceased. Pump-off of the flooded water began on July 12, and most water was removed by early December 2004. The DWR water quality data from the Jones Tract flooding event recently have been reported and discussed (California Department of Water Resources 2009). The available Jones Tract data were obtained from DWR to further evaluate for this Place of Use EIR.

TOC, DOC, and EC data (and many other parameters) were collected by DWR from flooded Jones Tract throughout this Delta peat soil island flooding event. The evaluation of these water quality data provides important new information about potential DOC release rates from the Project storage islands. The DOC release rates on Jones Tract may have been higher than those that would be expected from the Project storage islands because the Jones Tract flood inundated soils and crops that had been recently plowed and planted. Nevertheless, the DOC measurements collected during this 2004 peat soil island flooding event can be used to better estimate the likely DOC release loads from the Project Reservoir Islands. Bacon Island is across Middle River channel from Lower Jones Tract, and Webb Tract has similar subsided elevations and peat soil depths.

An initial DWR modeling report was prepared in 2005 to assess potential increases in DOC at the SWP exports resulting from the pump-off of Jones Tract water (Mierzwa and Suits 2005: 3-2). The DSM2 Delta hydrodynamic and water quality model was used by DWR for this investigation. A constant DOC release rate of 0.5 g-C/m^2/day was assumed for June–October (with 0 g-C/m^2/day release rate for November and December). The total assumed DOC release load therefore was about 75 g-C/m^2 for this DSM2 modeling study. This assumed constant DOC release rate of about 15 g-C/m^2/month produced simulated DOC concentrations in Jones Tract that were lower than the measured DOC data in June and July, roughly matched the measured DOC in August and September, but were higher than the measured DOC concentrations in October and November. A maximum concentration of 30 mg/l was assumed for October and November. Pump-off was completed in mid-December.

Figure 4.2-3a shows the most representative DOC data from Jones Tract, which were 24-hour composite samples from the Upper and Lower Jones Tract pumps, collected 1–3 days each week from mid-July to late November. The increase in these measured DOC concentrations combined with the estimated water depth (decreasing with pump-off) were never used by DWR to estimate the Jones Tract DOC release rates through time (i.e., monthly). The Jones Tract Flood water quality report (California Department of Water Resources 2009) discussed seasonal DOC release rates, but never estimated the Jones Tract monthly DOC release loads. The DOC load (g-C/m^2) on a flooded island (or tank) is calculated as the DOC concentration (mg/l) times the water depth (m). The DSM2-simulated DOC release rate of 0.5 g-C/m^2/day for the June–October period gave DOC concentrations that were too high as the water depths on Jones Tract were reduced during the pump-off period. The Jones Tract Flood water quality report also describes this initial DOC release rate, without clearly describing the reduction in release load that was observed as the water depths decreased.

A daily spreadsheet model for the Jones Tract flooding DOC release and pump-off was developed for this Place of Use EIR, based on the initial DSM2 modeling and additional information about the Jones Tract area and volume, based on 2007 Lidar (topography) data collected by DWR for the Delta islands. DWR also collected water surface elevation data during the pump-off, which was used to calculate the daily drawdown volume. The actual geometry data and daily drawdown elevation allowed several adjustments in the initial DSM2 modeling. The combined volume of Upper and Lower Jones Tract at the average tidal elevation of about 1.5 feet above mean sea level (msl) when pump-off began was about 150,000 acre-feet (af) rather than the 180,000 assumed in the DSM2 modeling. This reduced the assumed initial mean depth from about 15 feet (4.6 m) to about 12.5 feet (3.8 m). The measured Jones Tract DOC concentrations therefore represent a lower DOC release rate during the flooded period.

Figure 4.2-3b shows the estimated mean depth, evaporation, and discharge for Jones Tract during the pump-off. The DSM2 modeling did not consider evaporation from Jones Tract. Some of the measured DOC concentration increase was caused by evaporation and not by DOC release from the peat soil. Evaporation for July–November was calculated from daily DWR California Irrigation Management Information System (CIMIS) (meteorological station) estimates and the daily water surface area of Jones Tract as it was pumped-off to be about 18,500 af, about 12% of the flooded volume of 150,000 af.

Figure 4.2-4a shows the measured EC on Jones Tract and the calculated EC for the estimated evaporation during the Jones Tract pump-off period. The evaporation estimate was confirmed by the EC measurements which increased by about 20% from about 350 microSiemens per centimeter (μS/cm) when the pump-off began in mid-July to about 425 μS/cm at the end of October. This suggests that a similar 20% increase in the initial DOC of about 10 mg/l (when the breach was closed) would have resulted from evaporation, slightly reducing the estimated DOC release load. This evaporation volume would not have been discharged to the export pumps.

Figure 4.2-4b shows the estimated monthly DOC release rates (g-C/m^2/day) and the corresponding DOC concentrations for Upper and Lower Jones Tract during the 2004 flooding and pump-off period. The daily spreadsheet model accounts for the effect of tidal exchange during June, before the levee breach was repaired. The tidal flows would have exchanged some of the Upper Jones Tract DOC with Middle River DOC (of about 3 mg/l), reducing the apparent DOC release rate for Upper Jones Tract. Based on the tidal fluctuation of about 4 inches, a daily exchange of about 10% of the Upper Jones volume was assumed. The Lower Jones Tract DOC increased more rapidly during June, which may have been caused by this tidal exchange (i.e., reduction) of DOC from Upper Jones Tract. This tidal exchange increased the DOC release rate estimated for June to match the measured Upper Jones Tract DOC concentrations.

The results from the daily spreadsheet calculations of Upper and Lower Jones Tract DOC from assumed monthly DOC loading and the actual elevation, volume, area, evaporation, and pump-off discharge flow match the measured DOC data quite well. The monthly DOC release rates shown in Figure 4.2-4b were assumed to be the same for Upper and Lower Jones Tract. The DOC release rates (g-C/m^2/day) were estimated (by matching the measured DOC concentrations) to be 0.75 in June, 0.5 in July, 0.25 in August, 0.15 in September, 0.10 in October, and 0.05 in November and December. The total estimated release of DOC from Jones Tract during this 7-month period was 56 g/m^2/day. This estimated Jones Tract DOC release was only about 75% of the DWR DOC release load estimate of 75 g/m^2 used in the initial DSM2 modeling, and much less than the 8-month growing season DOC release rate of 0.5 g-C/m^2/day (corresponding to a seasonal load of 120 g-C/m^2) described in the Jones Tract flood water quality report (California Department of Water Resources 2009). The major differences in the initial DSM2 modeling were the high volume and depth estimates, and the neglecting of evaporation. The estimated Jones Tract DOC release load for June–November of about 56 g-C/m^2 was considerably less than the first year DOC release load of 80–100 g-C/m^2 calculated from the SMARTS tanks in 2002.

Figure 4.2-5a shows the daily CVP and SWP combined export pumping and the corresponding TOC increments that were estimated from the Jones Tract discharge, calculated as the Jones Tract DOC minus the export DOC without the Jones Tract discharge times the fraction of the exports from the Jones Tract discharge. Because the DSM2 modeling assumed a volume of 180,000 af, the estimated DOC increment at the pumps was about 2 mg/l in October, November, and the first half of December. The daily spreadsheet model indicates that the most likely DOC increment would have been about 1 mg/l in September, October, and November. The fraction of the exports coming from Jones Tract would have been about 8% in July and would have decreased to about 5% in November.

Figure 4.2-5b shows the measured DOC at the SWP Banks export pumps during June–December 2004. DWR operates elaborate "wet-chemistry" field measurement equipment for DOC and TOC at this important location. Multiple measurements are collected each day, and grab samples are analyzed for confirmation of the field equipment. The DOC concentrations were generally about 3 mg/l in July and increased slowly to about 4 mg/l in November. These are very uniform export DOC measurements, reflecting the Sacramento River DOC concentrations (not shown) that were about 2 mg/l from June through mid-October, and then increased to about 3 mg/l in late October and November, following the first runoff event. The DOC concentrations measured in the San Joaquin River (not shown) were 3–4 mg/l from June through mid-October, and increased slightly to between 3 and 5 mg/l (more variable) in November and December. The DOC at the exports was a blend of Sacramento River water, San Joaquin River water, and some Delta agricultural drainage water. Natural variations in these source water DOC concentrations cause considerable variation in the export DOC concentrations.

The Jones Tract DOC release load that was observed in 2004 of about 56 g-C/m^2 provides the best estimate of the likely first-year DOC release from Bacon Island and Webb Tract during water storage of about 6 months. This Jones Tract flooding event, with a storage volume of 150 taf and a discharge volume of about 130 taf, was very similar to the DOC release and incremental DOC concentrations that likely would occur at the export pumps during the first year of Project storage water that is discharged for export. However, because the water depth on Bacon and Webb Tract will be deeper, the expected DOC concentrations (for the same Jones Tract DOC release rate of 56 g/m^2) would be lower. The initial Jones Tract mean depth (at elevation of 1.5 feet msl) was about 12.5 feet (3.8 m). The mean depth for Bacon Island (filled to a maximum elevation of 4 feet msl) would be about 5.5 m, and the mean depth of Webb Tract would be about 6.25 m. Therefore, the discharge DOC likely would be about 13 mg/l for Bacon Island (i.e., 56/5.5 + 3) and about 12 mg/l for Webb tract (56/6.25 + 3).

These are moderate DOC concentrations for the Project storage water that can be discharged for exports within the WQMP criteria and guidelines. An estimated

DOC increment of 1 mg/l from Project discharges is the major DOC criterion in the WQMP; higher DOC increments require additional evaluation and approval. The actual Jones Tract flooding and discharge produced DOC increments at the export pumps that were similar to what might be expected for the first-year Project discharges. As demonstrated by the SMARTS results, the initial DOC release rate from flooded peat soil likely will be reduced considerably in subsequent years of operation.

If the initial DOC release rates from Bacon Island and Webb Tract actually are higher than the Jones Tract flooding data would indicate, some discharge of the Project storage water for Delta outflow after the first year of inundation might be necessary to reduce the DOC effects at the exports. These possible first-year operating procedures to reduce the DOC impacts were anticipated in the WQMP. The Jones Tract DSM2 and spreadsheet modeling described above and included in Figure 4.2-5b are representative of the methods required by the WQMP monitoring and operating procedures for tracking and managing the incremental DOC effects of the Project.

The 2001 FEIR and 2001 FEIS considered a large range of potential DOC release rates, based on available measurements and testimony. Values used in the impact assessment ranged from about 120 g/m^2/year for initial reservoir operations (first years) to 24 g/m^2/year for long-term reservoir operations. These recent results from the 2002–2004 SMARTS measurements and the Jones Tract flooding DOC data indicate that the first year DOC release from Jones Tract was less than 60 g/m^2/year, about half the assumed first year value of 120 g/m^2/year. By the third year of the SMARTS experiment (2004), the loading rate had dropped to less than 40 g/m^2/year. Long-term use of the Reservoir Islands might reduce the DOC release to below 40 g/m^2/year, but the long-term DOC release load remains uncertain. The SMARTS tanks were filled with agricultural peat soil scraped from the surface, and the Jones Tract flooded following spring disking and planting, whereas the Project storage islands would be flooded with minimal vegetation and without disturbing the soil of the reservoir surface; Project operations should result in lower DOC levels.

Environmental Commitments

Changes in Project design and prior agreements with Delta water rights holders or agencies have resulted in the Project environmental commitments. These commitments minimize the impacts of the original Project design and operation on water quality.

The WQMP and Operations Criteria are two environmental commitments that would reduce or eliminate some impacts on water quality. Water quality impacts also would be reduced by a planned reduction in boat slips and the implementation of best management practices (BMPs) during construction.

Water Quality Management Plan

The WQMP was developed as part of the protest dismissal agreement between the Project and the California Urban Water Agencies (CUWA) during the 2000 Project water right hearing. The WQMP also was included as a condition of the protest dismissal agreement with CCWD. The WQMP was addressed in the 2001 FEIR and 2001 FEIS but was not included in the monthly modeling of the Project operations described in the 2000 RDEIR/EIS. Many of the monitoring and modeling provisions of the WQMP are likely to affect the daily operations but may not change the monthly simulation results substantially.

A key principle of the WQMP is that “Project operations shall minimize and mitigate for any degradation in the quality of drinking water supplies.” The major provisions of the WQMP address salinity and DOC concentrations at Delta export facilities. The WQMP requires the establishment of a water quality management board to review, approve, and implement the annual water quality operating plan. The operating plan will establish maximum Reservoir Island concentrations for salinity (total dissolved solids [TDS]), chloride, bromide, and TOC. Measures to control impacts on exports and diversions will be established and implemented when Project storage concentrations approach these maximum allowable concentrations. These measures generally involve adjusting discharges for export or releasing storage water during periods of high outflow to minimize potential impacts on exports and municipal water quality.

A monitoring program will be established to support and implement the WQMP for the Project. Available CDEC data will be incorporated into the water quality monitoring and reporting program to implement the water quality control measures. Hydrodynamic and water-tracking modeling will be used to calculate the effects of Project discharges on water quality at CVP, SWP, CCWD, and other urban intakes. The WQMP covers short-term impacts as well as a long-term accounting of the effects of Project operations on exports and municipal water quality.

Short-term impacts will be minimized using operational criteria. A short-term impact is defined by the WQMP as any adverse health effects, contribution to any non-compliance with drinking water regulations, and any increase in treatment or operation cost caused by increased concentrations of TOC or salinity. Project operations criteria are established for TOC, bromide, and chloride, based on existing DBP regulations. These criteria would limit Project discharges, unless the treatment plant operators agree that the additional water supply or other benefit of the Project would compensate for the increased treatment expenses.

Project operations are not to cause the TOC concentration at an export or diversion to increase more than 1 mg/l, or to cause the TOC concentration to exceed 4 mg/l. If the TOC concentration were greater than 4 mg/l, a treatment plant may be required to provide more TOC removal (35% rather than 25%) prior to disinfection to minimize formation of DBP. This might increase the treatment costs, although DBP concentrations might be reduced accordingly.

Project operations are not to cause an increase in chloride of more than 10 mg/l, nor should any increase result in chloride exceeding 90% of the established chloride objective (e.g., 250 mg/l at Rock Slough). These operations criteria would limit Project discharges to less than 20% of the exports if the Project storage chloride concentration was more than 50 mg/l higher than the baseline chloride concentration. Because the Project operations simulated for the Place of Use EIR would divert water to storage only when outflow was greater than 11,400 cfs (X2 downstream of Chipps Island), the EC at Jersey Point likely would be less than 200 µS/cm, and the chloride likely would be less than 50 mg/l. Bromide can be estimated as 0.0035 times the chloride, so the bromide concentration would be 175 µg/l. The difference between the Project chloride and the baseline export chloride would not be more than 50 mg/l.

The WQMP includes operations criteria for estimated effects at treatment plants. Project operations are not to cause the modeled THM or bromate concentrations (e.g., using regression equations for TOC and bromide) at any treatment plant using Delta water to be greater than 80% of the established MCL. Higher TOC or bromide concentrations might require higher treatment levels with associated cost.

Operations Criteria

The Delta Wetlands Operations Criteria document (Jones & Stokes 2001, Appendix B) was created for the purpose of protecting fish. The FOC were included in the 2001 FEIS assessment of water quality. As a result of its inclusion, some significant water quality impacts became less than significant. The FOC incorporate the following water quality concerns:

- X2—Movement of water onto and off of the Delta islands potentially could affect the salinity of the Delta and the position of X2. The 1997 X2 criteria restrict diversions to storage to times when the position of X2 is at or downstream of particular locations. These restrictions are present in the 1997 Operations Criteria because it is believed that keeping the Delta more fresh as indicated by an X2 location closer to the ocean, would help special-status fish species. Under the Proposed Project, the criteria for X2 would be modified to be more restrictive than what is stated in the 1997 operations criteria. The Proposed Project would restrict diversions to storage to times when X2 is located at or downstream of Chipps Island. This restriction would have two benefits. It would ensure that the water diverted to storage is of low salinity and it would ensure that diversions to storage are unlikely to have deleterious fish effects associated with potential upstream movement of the X2 location.
- Water Temperature—In order to protect fish, the 1997 Operations Criteria make the following temperature restrictions on the release of water from storage:
    - The Project shall not discharge reservoir water for export if the temperature differential between the discharge and the adjacent channel temperature is greater than or equal to 20°F.

- ❑ If the natural receiving water temperature of the adjacent channel is greater than or equal to 55°F and less than 66°F, Project discharges for export shall not increase the channel temperature/by more than 4°F.
- ❑ If the natural receiving water temperature of the adjacent channel is greater than or equal to 66°F and less than 77°F, Project discharges for export shall not cause an increase of more than 2°F.
- ❑ If the natural receiving water temperature of the adjacent channel is greater than or equal to 77°F, Project discharges for export shall not cause an increase of more than 1°F.

- Dissolved Oxygen—In order to protect fish, the 1997 Operations Criteria make the following DO restrictions on the release of water from storage:
  - ❑ The Project shall not discharge reservoir water for export if the discharge DO level is less than 6.0 mg/l without authorization from the resource agencies and notice to the responsible agencies.
  - ❑ The Project shall not discharge reservoir water for export if the discharge would cause channel water DO levels to fall below 5.0 mg/l.

The FOC will likely need to be modified to account for the simulated and more restrictive operations of the Proposed Project. However the restrictions pertaining to X2, DO, and temperature are not likely to be modified substantially.

Permits and Best Management Practices

Construction activities have the potential to introduce contaminants into nearby water bodies. The Project applicant would implement BMPs to minimize water pollution associated with construction. Some BMPs would be specified in permits required for construction activities.

Erosion

In order to obtain coverage under the NPDES General Construction Permit, a SWPPP is required. Site-specific erosion control measures would be developed as part of the SWPPP. A SWPPP typically contains, but is not limited to, the following described BMPs:

- **Timing of construction.** Conduct earthwork during dry months.
- **Staging of construction equipment and materials.** Stage construction equipment and materials on the landside of construction areas. To the extent possible, stage equipment and materials in areas that already have been disturbed.
- **Soil and vegetation disturbance.** Minimize ground and vegetation disturbance during construction by establishing designated equipment staging areas, ingress and egress corridors, spoils disposal and soil stockpile areas, and equipment exclusion zones prior to the commencement of construction.

- **Grading spoils.** Stockpile soil and grading spoils on the landside of the subject levee reaches, and install sediment barriers (e.g., silt fences, fiber rolls, straw bales) around the base of stockpiles to intercept runoff and sediment during storm events. If necessary, cover stockpiles with geotextile fabric to provide protection against wind and water erosion.
- **Sediment barriers.** Install sediment barriers on graded or otherwise-disturbed slopes as needed to prevent sediment from leaving the Project site and entering nearby surface waters.
- **Site stabilization.** Install native plant materials to stabilize cut and fill slopes and other disturbed areas once construction is complete. Plant materials may include an erosion control seed mixture or shrub and tree container stock. Temporary structural BMPs, such as sediment barriers, erosion control blankets, mulch, and a mulch tackifier, may be installed as needed to stabilize disturbed areas until vegetation becomes established.

Pollutants

Other BMPs may be established to minimize the potential for and effects from spills of harmful substances during construction and operation activities. These may include practices such as double-walled tanks, containment berms, emergency shut-offs, drip pans, fueling procedures, and spill response kits, as well as ensuring training in proper handling procedures and spill prevention and response procedures.

Dewatering

Before discharging any dewatered effluent to surface water, the Project applicant or its contractors would obtain a Low Threat Discharge and Dewatering NPDES permit from the Central Valley RWQCB. Depending on the volume and characteristics of the discharge, coverage under the Central Valley RWQCB's NPDES General Construction Permit or General Dewatering Permit is possible. As part of the permit, the permittee would design and implement measures as necessary so that the discharge limits identified in the relevant permit are met.

As a performance standard, these measures would be selected to achieve maximum sediment removal and represent the best available technology that is economically achievable. Implemented measures may include the retention of dewatering effluent until particulate matter has settled, use of infiltration areas, and other BMPs.

Environmental Effects

All potential water quality effects were evaluated to be less than significant in the 2001 FEIR and 2001 FEIS, based on previous evaluation or by the incorporation of the WQMP in the Project operations. The previous evaluation of water quality effects is summarized and the provisions of the WQMP to reduce any significant effects from Project operations on EC and DOC are described here. Quantitative assessments of the reduced effects of the Project on salinity, and the benefits likely from Project releases for increased Delta outflow in the fall of some years are presented, using monthly simulated Project operations from the IDSM model. The range of potential effects of Project discharges on export and municipal intake DOC concentrations also are given, based on the IDSM-simulated Project operations. These methods generally confirm that all potential impacts on water quality have been reduced to less-than-significant levels with the revised operations simulated with the IDSM model for this Place of Use EIR.

Methods

Project operations may cause water quality effects in the Delta by two primary mechanisms:

1. Project discharges may contain concentrations of water quality constituents, such as Cl^-, Br^-, or DOC, that may affect water quality in Delta channels and exports.
2. Project diversions or discharges may change Delta outflow or Delta channel flows, which might influence salinity intrusion or shift the contributions of water quality constituents from different Delta inflow sources. These changes may affect water quality in Delta channels and exports.

1995 Draft Environmental Impact Report/ Environmental Impact Statement Assessment Methods

Before the 1995 DEIR/EIS was prepared, no model existed for estimating the relationship between the water budget for Delta agricultural islands (diversions, ET, and drainage) and the salinity (EC) and DOC concentration patterns in agricultural drainage. The Delta drainage water quality model DeltaDWQ was developed to estimate the monthly contribution of the Project islands to levels of EC, DOC, Cl^-, and Br^- at Delta channel locations and in Delta diversions and exports under No-Project conditions and under Project operations. DeltaDWQ combined monthly calculations of monthly channel flows (based on the RMA Delta hydrodynamic model) with estimates of monthly diversion, storage, and discharge volumes for the Project islands (based on specified monthly Project operations criteria) to simulate water quality concentrations of EC and DOC in monthly agricultural drainage flows and Project discharges. Delta agricultural drainage water quality was estimated by simultaneously accounting for water, salt, and DOC budgets. Appendix C4 in the 1995 DEIR/EIS gives a description of the model. DeltaDWQ results for salinity generally were found to be similar to historical data and results from the RMA Delta salinity model. Estimated agricultural drainage DOC and export DOC were similar to the measured DOC values for the 10-year calibration period of 1982–1991 (DOC data available for 1987–1991).

Water quality impacts of Project operations were assessed by comparing conditions under simulated Project operations with conditions under the simulated baseline conditions. The simulated baseline represents Delta water quality conditions that are likely to exist in the absence of Project operations (i.e., continued farming operations on the four Project islands), with a repeat of the historical hydrologic conditions, but with existing facilities, water demands, and Delta standards (D-1641).

2000 Revised Draft Environmental Impact Report/ Environmental Impact Statement Assessment Methods

For the 2000 RDEIR/EIS, the DeltaSOS monthly Delta water operations model was modified to incorporate the equations for predicting the water quality of agricultural drainage and Project Reservoir Island storage that initially had been developed for the Delta DWQ model. The revised model was used to calculate the effects of Project discharges on constituent concentrations in Delta channels and exports. This modification of DeltaSOS to include water quality calculations was called the DeltaSOQ model. The Q model calculations generally were confirmed by comparing historical water quality measurements of Delta inflows, agricultural drainage, and exports. The calculated monthly EC and DOC at the exports, based on the measured inflow concentrations and calculated agricultural drainage concentrations, were similar to the measured EC and DOC values for the 1972–1994 period (DOC data available for 1987–1994).

The full 1922–1994 Delta water operations period was used in the 2000 RDEIR/EIS assessment of water quality changes. The results from the most recent 23-year period of the hydrologic record (1972–1994) were shown graphically to illustrate the model calculations and results. The assumptions used for these assessment methods are described in Appendix G of the 2000 RDEIR/EIS.

Four locations in the Delta (Chipps Island, Emmaton, Jersey Point, and Delta exports) were selected for assessment of impacts related to Delta salinity conditions. A representative Delta export location was used because the impact assessment methods cannot distinguish reliably between water quality conditions at the major export or diversion locations (CVP exports at Tracy, SWP exports at Banks, and CCWD diversions at Rock Slough or Old River intakes).

DOC impacts were evaluated at the representative export location. The DOC impacts are dependent on the assumed DOC loading rate from the inundated Project peat-soil islands. Export DOC concentrations were evaluated with the DeltaSOQ model for a range of estimates of DOC loading from the Project Reservoir Islands. The initial filling of the islands likely would result in high DOC loading from the initial source of DOC in the oxidized peat soil. But in the long term, repeated fillings of the Reservoir Islands likely would leach out most of the DOC from the peat soils, and fresh DOC formation from the inundated peat soils would likely be lower than for agricultural uses. The analysis presented three simulations of potential Project effects on DOC in Delta exports: an assumption for long-term DOC loading (1 g/m^2/month of storage), an assumption for initial-filling DOC loading (4 g/m^2/month of storage), and an assumption for high initial-filling DOC loading (9 g/m^2/month of storage).

Adjustments to Assessment Methods for this Place of Use Environmental Impact Report

The general assessment methods for this Place of Use EIR are similar to those used in the 2001 FEIR and 2001 FEIS. Simulated operations for the Proposed Project (Alternative 2 with FOC, WQMP and other environmental commitments incorporated) are similar but more restrictive than those proposed for Alternatives 1 and 2 in the 2001 FEIR and 2001 FEIS. As a result, water quality impacts of the Project are expected to be similar to or less significant than those described in the 2001 FEIR and 2001 FEIS for Alternatives 1 and 2. Simulated use of some Project storage water for releases to increase Delta outflow in the fall months of some years will provide salinity benefits.

This Place of Use EIR does not calculate these expected DBP concentrations, as was done for the 2001 FEIR and 2001 FEIS. This Place of Use EIR uses DOC and EC to track the impacts of Project operations on drinking water quality. These raw water quality parameters can be used by individual treatment plant operators to estimate DBP concentrations, based on their treatment processes and applicable drinking water regulations. The WQMP restrictions on DOC and EC should be adequate to protect against elevated DBPs at the water treatment plants. However, should treatment plant operators have concerns about DBPs, the WQMP would enable them to restrict Project releases.

This Place of Use EIR includes a new assessment of potential methylmercury impacts. Methylmercury was evaluated quantitatively using information provided in analyses and proposed regulations from the Central Valley RWQCB.

Simulated Project Operations

The 2000 RDEIR/EIS included the FOC provisions for limiting Project diversions and discharges for export to protect ESA-listed and CESA-listed fish. This reduced or eliminated some of the salinity impacts that were simulated in the 1995 DEIR/EIS evaluation. Additional restrictions to protect the water quality of Delta exports and diversions of municipal water supplies were required in the WQMP. The provisions of the WQMP were included qualitatively in the 2001 FEIR and 2001 FEIS, but the effects of these required monitoring and modeling comparisons, and potential Project discharge restrictions were not included in the Project operations modeling. The major provisions in the FOC and WQMP are summarized here to describe the linkage between these fish and water quality protection measures and the revised operations of the Proposed Project evaluated in this Place of Use EIR.

The Project water right decision D-1643 includes several restrictions on the monthly Project diversions and discharges for export pumping. These provisions, called FOC, were developed in 1997 during consultation with USFWS, NMFS, and DFG for the Project BOs. A combined limit of 250 taf per water year was placed on Project diversion to storage and direct diversion. The combined diversion limit eliminated the occasional filling, discharging, and refilling potential that was simulated in the 1995 DEIR/EIS evaluation. Most of the FOC restrictions were included in the 2000 RDEIR/EIS modeling. The Place of Use EIR simulates Project diversions in the December–March period and Project discharges for export in the July–September period. These generalized monthly Project operations eliminate the need for several monthly FOC restrictions and provide a more realistic representation of typical Project operations.

Most of the FOC diversion restrictions are satisfied with a December–March diversion period with a minimum Delta outflow of 11,400 cfs. The IDSM model used to simulate Project operations include monthly criteria that match these FOC measures. However, the measures related to the FMWT index for delta smelt abundance cannot be simulated and are therefore not included in IDSM. Most of the FOC discharge restrictions are satisfied with the July–September water transfer period. The FOC also includes monitoring and discharge adjustment requirements for temperature and DO. While these requirements cannot be modeled in IDSM, compliance with these provisions in real-time daily operations are assumed to prevent any significant impacts from these variables that may have effects on fish habitat conditions.

Dissolved Organic Carbon

The increased DOC from Project discharges can be estimated from the Project storage DOC and the baseline DOC at the export or diversion intake, together with the fraction of the water from the Project discharge. The most conservative assumption is that all Project discharge will be mixed with the baseline export flow and the increased DOC from Project discharges would be:

> DOC increase (mg/l) = [DW DOC – Export DOC] x Project discharge / [Exports + Project discharge]

For the maximum assumed monthly Project discharge of 2,000 cfs at the maximum permitted combined CVP and SWP pumping of 11,280 cfs, the fraction of Project discharge water in the exports would be about 20% (i.e., 2,000/11,280). The DOC increase at the exports would be 20% of the difference between the storage DOC and the baseline DOC. The WQMP operations criteria of 1 mg/l would be exceeded (and require short-term impact assessment by treatment plant operators) if the Project storage DOC was more than 5 mg/l higher than the baseline export DOC. If the storage DOC was 10 mg/l higher than the baseline TOC, the WQMP operations criteria might limit Project discharges to less than 10% of the exports, unless the short-term DOC increase was determined by the treatment plant operators to be acceptable for the existing treatment conditions.

Significance Criteria

The water quality impact analysis considered several criteria for determining the significance of impacts related to this resource. The analysis took into account both relevant criteria contained in Appendix G of the State CEQA Guidelines (Association of Environmental Professionals 2009) and Project-specific criteria developed by the lead agency to address potential impacts unique to the Project's location and elements. Only those criteria that are relevant to this analysis are listed below. Impacts on hydrology and water quality may be considered significant if the Proposed Project would:

- violate water quality standards or waste discharge requirements;
- substantially degrade water quality; or
- alter regional or local hydrology, resulting in substantial increases in erosion or sedimentation.

For the potential impact of substantially degrading water quality, more specific criteria were used. The criteria used to determine the significance of impacts of Project operations on water quality are mostly unchanged from the 2001 FEIR and 2001 FEIS and are described below. For Delta water quality variables for which no regulatory objectives or numerical standards have been set, the selected significance threshold was a percentage change from existing measured monthly values that encompasses natural variability in water quality constituents.

Significance thresholds for variables with numerical water quality criteria were established at 90% of the specified monthly water quality standards. If simulated Project operations caused the value for a water quality variable to exceed 90% of the numerical standard for that variable, the effect is considered to be a significant water quality impact. Maximum significance criteria were not set for constituents that do not have numerical regulatory standards.

A second significance criterion was based on the assumption that some changes may be substantial compared with the natural variability of the water quality variable under existing conditions. Natural variability was assumed to be at least 10% of the specified numerical limit or 10% of the mean value for variables without numerical limits. Measurement errors and modeling uncertainties likewise were assumed to be at least 10% of the measured or modeled values. These two sources of variability were assumed to establish a monthly significance criterion for any change caused by Project operations that was more than 20% of the established standard or more than 20% of the mean value for variables without numerical limits. These significance criteria were applied to the monthly sequence of simulated Project operations determined with the IDSM model.

In some cases, the water quality criteria of the WQMP are slightly less restrictive than the thresholds of significance used in the original 2001 FEIS. In these instances, the rules of the WQMP are used as thresholds of significance. For example, in the original FEIS, a change in DOC of more than 0.8 mg/L at the intakes was considered significant (20% of average baseline DOC concentration), whereas in the WQMP, an increase of more than 1.0 mg/L at the urban intakes could trigger potential restrictive action by the water users.

Impacts and Mitigation Measures

The impacts of the Project on salinity, DOC, and DBP are reduced from the 2001 FEIR and 2001 FEIS. The salinity impacts have been reduced to less than significant because the higher minimum outflow (11,400 cfs) assumed for Project diversions would greatly reduce the effects of salinity intrusion. A salinity benefit was identified for the simulated releases of Project storage water in the fall months of some years.

DOC impacts have been identified as significant for the higher DOC loading rates that may occur during the initial years of Project operations. These potential impacts will be reduced to less than significant by the WQMP requirements for monitoring, modeling comparisons, and Project discharge restrictions. The DOC effects are expected to diminish with time, as the initial sources of DOC from the agricultural soils are flushed from the Reservoir Islands.

Water quality impacts caused by the Proposed Project operations are evaluated quantitatively in the following sections. Water quality impacts for Alternatives 1 and 2 in the 2001 FEIR and 2001 FEIS were determined to be nearly identical and are considered to be the same as those impacts described below for the Proposed Project (Alternative 2). Water quality impacts for Alternative 3 (Four-island storage) were qualitatively found to be slightly greater than the impacts for Alternatives 1 and 2, but would be mitigated to less-than-significant levels with the same mitigation requirements as described for Alternative 1 and 2 in the 2001 FEIR and 2001 FEIS. These water quality impacts are summarized in Table 4.2-1.

Proposed Project (Alternative 2)

The Proposed Project, Alternative 2 with the WQMP, FOC, and other environmental commitments incorporated, represents water storage operations on two Reservoir Islands (Bacon Island and Webb Tract) with two Habitat Islands (Bouldin Island and most of Holland Tract). Significant water quality impacts of Project operations may occur during months for which Project diversions or discharges are simulated. The impacts described below are generally the same as were described for Alternative 2 in the 2001 FEIR and 2001 FEIS. A new impact discussion has been added for methylmercury, and potential salinity benefits from Project releases for increased Delta outflow are described.

Salinity

The WQMP criteria for salinity are more stringent than the thresholds of significance. Therefore, Project compliance with the WQMP will ensure that salinity impacts are less than significant. The simulated Project operations for the Place of Use EIR require a minimum outflow of about 11,400 cfs (i.e., X2 downstream of Chipps Island) during diversions. The EC changes at several Delta locations will be tracked as part of the required WQMP monitoring program. Both the short-term (monthly) and long-term (annual) changes will be calculated and tracked as part of the WQMP.

Impact WQ-1: Salinity Increase at Chipps Island

Because the simulated Project operations for the Place of Use EIR require a minimum outflow of about 11,400 cfs (i.e., X2 downstream of Chipps Island) during diversions, the simulated EC changes at Chipps Island would be smaller than simulated in the 2001 FEIR and 2001 FEIS.

Figure 4.2-6a shows the historical Delta outflow for water years 1976–1991 with the effective Delta outflow calculated using the CCWD G-model equation (See Appendix G of 2000 RDEIR/EIS). The effective outflow is very similar to a 3-month moving average outflow, although the effective outflow changes more rapidly and is closer to the measured outflow when the outflow is high, and changes more slowly when the outflow is low. The effective outflow is generally higher than the lowest monthly outflow values. Figure 4.2-6b shows the measured Chipps Island EC for 1976–1991. The effective Delta outflow largely controls the measured EC patterns in the Delta. The estimated Chipps Island EC using the negative exponential relationship between effective Delta outflow and monthly average EC at Chipps Island for the 1976–1991 period is shown in comparison.

Figure 4.2-7a shows the strong negative exponential relationship between effective Delta outflow and Chipps Island EC. The estimated EC at Chipps Island is about 5,000 µS/cm when the Delta outflow is about 4,500 cfs. The estimated EC at Chipps Island is about 2,000 µS/cm when the effective outflow is about 11,000 cfs. This relationship was included in the IDSM model so that the Chipps Island EC for the baseline and Project conditions could be evaluated. The change in the EC caused by Project diversions is much less at high outflows than at low outflows.

Table 4.2-3a gives the monthly cumulative distributions of simulated EC at Chipps Island for the baseline conditions. Table 4.2-3b gives the monthly cumulative distributions of simulated EC at Chipps Island with Project operations (diversions and releases for outflow). Table 4.2-3c gives the monthly cumulative distributions of simulated changes in EC at Chipps Island with Project operations. The data indicate that the maximum increases in Chipps Island EC were always less than the 20% significance criteria. Project operations never cause the Chipps Island EC to exceed 90% of the D-1641 objectives, which would be 2,640 µS/cm in months when X2 was required to be downstream of Chipps Island (February and March of some years). This impact is less than significant.

Mitigation

No mitigation is required.

Impact WQ-2: Salinity Increase at Emmaton

Because the simulated Project operations for the Place of Use EIR require a minimum outflow of about 11,400 cfs during diversions, the simulated EC changes at Emmaton will be smaller than simulated in the 2001 FEIR and 2001 FEIS. Diversions would only occur in the months of December-March when there are no established salinity objectives at Emmaton.

Figure 4.2-7b shows the relationship between effective Delta outflow and monthly average measured EC at Emmaton for the 1976–1991 period. There is a strong negative exponential relationship that can be estimated from the historical Delta outflow and EC data. The Emmaton EC is less than 2,000 µS/cm when the outflow is greater than 5,000 cfs. The Emmaton EC is less than 250 µS/cm when the outflow is 12,000 cfs. This relationship was included in the IDSM model so that the Emmaton EC for the baseline and Project conditions could be evaluated.

There are essentially no salinity intrusion effects at Emmaton for outflow greater than 10,000 cfs. Therefore, the monthly salinity change at Emmaton caused by Project diversions (i.e., outflow reduction) will never be greater than 20% of the average Emmaton EC. Table 4.2-4a gives the monthly cumulative distributions of simulated EC at Emmaton for the baseline conditions. Table 4.2-4b gives the monthly cumulative distributions of simulated EC at Emmaton with Project operations. Table 4.2-4c gives the monthly cumulative distributions of simulated changes in EC at Emmaton with Project operations. The maximum monthly increases in Emmaton EC caused by Project operations (i.e., diversions) were always much less than 20% of the average baseline EC, calculated to be 747 µS/cm in the IDSM model for 1922–2003. This impact is less than significant.

Mitigation

No mitigation is required.

Impact WQ-3: Salinity Increase at Jersey Point

Because the simulated Project operations for the Place of Use EIR require a minimum outflow of about 11,400 cfs during diversions, the simulated EC changes at Jersey Point will be smaller than simulated in the 2001 FEIR and 2001 FEIS. Diversions would occur only in the months of December–March when there are no established salinity objectives at Jersey Point.

Figure 4.2-7c shows the relationship between effective Delta outflow and monthly average measured EC at Jersey Point for the 1976–1991 period. There is a strong negative exponential relationship that can be estimated from the historical Delta outflow and EC data. The Jersey Point EC is about 2,000 µS/cm when the outflow is 4,000 cfs and the Jersey Point EC is about 1,000 µS/cm when the outflow is 6,000 cfs. This relationship was included in the IDSM model so that the Jersey Point EC for the baseline and Project conditions could be evaluated.

There are essentially no salinity intrusion effects at Jersey Point for outflow greater than 10,000 cfs. Therefore, the monthly salinity change at Jersey Point caused by Project diversions (i.e., outflow reduction) will never be greater than

20% of the average Jersey Point EC. Table 4.2-5a gives the monthly cumulative distributions of simulated EC at Jersey Point for the baseline conditions. Table 4.2-5b gives the monthly cumulative distributions of simulated EC at Jersey Point with Project operations. Table 4.2-5c gives the monthly cumulative distributions of simulated changes in EC at Jersey Point with Project operations. The maximum monthly increases in Jersey Point EC from Project operations (i.e., diversions) were always much less than 20% of the average baseline EC, calculated to be 628 µS/cm in the IDSM model for 1922–2003. This impact is less than significant.

Mitigation
No mitigation is required.

Impact WQ-4: Salinity Increase at Exports

Because the simulated Project operations for the Place of Use EIR require a minimum outflow of about 11,400 cfs during diversions, the simulated chloride changes at Delta exports (including CCWD intakes at Rock Slough and Old River) would be smaller than simulated in the 2001 FEIR and 2001 FEIS. Diversions would occur only in the months of December–March when the minimum chloride objective would be 150 mg/l.

Figure 4.2-7d shows the relationship between effective Delta outflow and monthly average measured chloride and EC at CCWD Rock Slough intake. The Rock Slough EC is generally about half of the Jersey Point EC because it is farther upstream in the Delta. The Rock Slough EC is about 1,000 µS/cm when the outflow is 4,000 cfs and about 500 µS/cm when the outflow is 6,000 cfs. The chloride is about 25% of the EC at high EC values, because the highest EC values are influenced by seawater intrusion. The chloride is a smaller fraction of the EC at lower EC values because the river chloride content (i.e., Cl/EC ratio) is lower.

The salinity at Rock Slough generally would be higher than the salinity at the Old River intake or at the SWP and CVP export pumps. The Rock Slough intake would have a larger impact from Project operations than the other drinking water intakes. There is a much weaker relationship that can be estimated from the historical Delta outflow and salinity (i.e., EC and chloride data). This relationship was included in the IDSM model so that the Rock Slough EC and chloride for the baseline and Project conditions could be evaluated.

There are essentially no salinity intrusion effects at Rock Slough for outflow greater than 10,000 cfs. Therefore, the monthly salinity changes at Rock Slough caused by Project diversions (i.e., outflow reduction) will never be greater than 20% of the minimum chloride objective of 150 mg/l. The WQMP further requires that Project impacts be less than 10 mg/l, unless compensated for by Project benefits. Table 4.2-6a gives the monthly cumulative distributions of simulated chloride concentration at the Rock Slough intake for the baseline conditions. Table 4.2-6b gives the monthly cumulative distributions of simulated chloride at the Rock Slough intake with Project operations. Table 4.2-6c gives the monthly cumulative distributions of simulated changes in chloride at the Rock Slough intake with Project operations. The maximum monthly increases in

Rock Slough chloride caused by Project operations (i.e., diversions) were always less than 20% of the chloride objective (30 mg/l). This impact is less than significant.

Mitigation
No mitigation is required.

Impact WQ-5: Beneficial Salinity Reductions at Exports

Because the simulated Project operations for the Place of Use EIR simulate the release of Project storage water in October and November in years when the water could not be exported for delivery to designated places of use or to the groundwater banks, there are substantial increases in Delta outflow that reduce the export salinity. This potential benefit from Project releases to improve fish and wildlife habitat uses in the Bay-Delta was discussed in the 2001 FEIR and 2001 FEIS but was not simulated.

Table 4.2-6c indicates that the monthly chloride concentrations at Rock Slough were frequently (i.e., in about 20% of the years) reduced by more than 10 mg/l in October and November. Salinity benefits often were simulated in December because the increased outflow in October and November also would increase the effective outflow in December if the baseline December outflow was low. The average simulated Rock Slough chloride concentration was reduced from 64 mg/l for the baseline to 62 mg/l with Project operations. Because the minimum chloride (without seawater intrusion) was assumed to be 17 mg/l, the reduction of 2 mg/l represents about 4% of the seawater intrusion at Rock Slough. This is considered to be a substantial benefit.

There is an additional salinity benefit that could be provided with the Project. Delta levee failures can affect in-Delta and export water quality by drawing brackish water into the Delta from downstream. The Jones Tract flooding allowed about 150 taf from Suisun Bay to move into the central Delta. If a downstream island or multiple levees failed during relatively low Delta outflow (e.g., during an earthquake), the volume and salinity of the intrusion water would be greater. The levee improvements of the Project would reduce the risk of levee failure and the subsequent seawater intrusion.

While not in the Project description, the Project could provide an emergency response during a Delta island flooding event. If the Project islands were filled at the time, the stored water could be released to provide about 200 taf of flushing water to move the salinity intrusion water downstream. This emergency response could be a benefit. This impact is less than significant.

Mitigation
No mitigation is required.

Dissolved Organic Carbon

The WQMP criteria for DOC are more stringent than the thresholds of significance. Therefore, Project compliance with the WQMP will ensure that

DOC impacts are less than significant. As described above, the annual DOC loading (i.e., g-C/m^2) during storage from the time of diversion to the time of discharge for export is uncertain. If the DOC loading were the same as observed on Jones Tract in 2004 (about 60 g-C/m^2), the storage water DOC concentration would be about 12–15 mg/l, because the storage islands have a mean depth of about 5.5 m or 6 m (because concentration [mg/l] = load [g-C/m^2]/depth [m]). This would limit the discharge from the storage islands to about 8% of the total exports, unless the DOC increase was determined by the treatment plant operators to be acceptable. In accordance with the WQMP, actual Project operations would require a water quality model (e.g., DSM2) to account for DOC changes at the exports. The results of a more sophisticated model would be less than the conservative methods described above, which assumed that all Project water ended up at the export facilities.

Impact WQ-6: Elevated DOC Concentrations in Delta Exports

Discharges from the Project islands may have relatively high DOC concentrations that may significantly increase DOC concentrations in Delta exports. However, implementation of the WQMP would use monitoring and possible restrictions on storage island releases to minimize DOC impacts on water quality at the urban intakes. Operational criteria of more than 1 mg/l DOC net increase or exceeding the 4 mg/l DOC threshold were established in the WQMP. Adherence to the WQMP ensures that this impact is less than significant.

The potential DOC loading rate from the storage islands remains uncertain. However, treatment plant operations may not be quite as sensitive to the raw water DOC concentration as when chlorination was the initial treatment process. The WQMP allows treatment plant operators to specify the maximum permissible DOC increase from the Project. Regardless of the potential DOC loading (i.e., peat soil leaching) rates, adherence to the WQMP procedures will assure that there are no significant DOC impacts.

The 2001 FEIR and 2001 FEIS evaluated the contribution of DOC and salinity (bromide) from Project operations to the treated water DBP concentrations. Because each municipal treatment plant uses different treatment processes to provide treated drinking water that meets all applicable drinking water regulations, the Place of Use EIR does not evaluate DBP concentration impacts. The WQMP includes procedures for each treatment plant operator to evaluate the effects of Project discharges and approve the annual operating plan as well as short-term effects caused by increased DOC or bromide concentrations in the Project storage water. This impact is less than significant.

Mitigation

No mitigation is required.

Mercury

Impact WQ-7: Increased Methylmercury Loading in the Delta

The draft mercury TMDL limits for methylmercury loading in the Delta require that there be no increase in methylmercury load in the central Delta. Any project that could increase methylmercury loading above existing conditions could cause a violation of the proposed TMDL amendment to the Basin Plan. Most of the Project area falls in the central Delta.

Recent methylmercury studies in the Delta have produced estimates of methylmercury loading rates from agricultural land, open water, and wetlands. The estimated loading rates are similar but quite variable. Low and high estimates were applied to the acres for each land use type for each alternative to produce low and high estimates of loading rates associated with the Project alternatives (Table 4.2-7).

If the high estimate of methylmercury production for the No-Project Alternative is compared to the low estimate of methylmercury production for Alternatives 1 and 2, there would be no increase in methylmercury production associated with the Project. Some studies have indicated that some wetlands do not produce methylmercury or could be methylmercury sinks. If this assumption was used for the wetlands and open water of the Project, the conclusion would be that the Project would reduce the production of methylmercury in the central Delta.

However, because wetlands and open water of the Delta may produce slightly more methylmercury than agricultural practices on peat soils, the Project may have a significant impact on methylmercury loading in the central Delta. Therefore, this impact is considered significant.

Implementing Mitigation Measures WQ-MM-1 and WQ-MM-2 would reduce Impact WQ-7 to a less-than-significant level. Mitigation Measure WQ-MM-1 would allow the Project to be in compliance with the Delta methylmercury TMDL implementation plan.

Mitigation Measure WQ-MM-1: Follow Guidelines from Proposed Delta TMDL for Methylmercury

The proposed TMDL Basin Plan amendments for mercury contain requirements for organizations that propose to create wetlands within the Delta. After the mercury TMDL is finalized, the Project applicant would follow the requirements of the TMDL, which likely will include:

- Participate in a management effort to evaluate and minimize health risks associated with eating fish contaminated with mercury (Wood et al. 2010b: BPA-15, BPA-16).
- For phase 1 of the TMDL, participate in a monitoring program to evaluate methylmercury loading and procedures to minimize methylmercury loading from wetlands (Wood et al. 2010b: BPA-3).
- For phase 2 of the TMDL, implement approved methylmercury control actions. These potential actions and their effectiveness are uncertain at this

time. Other possible mitigation might involve an offset program (Wood et al. 2010b: ES-3, BPA-13).

Mitigation Measure WQ-MM-2: Incorporate Mercury Methylation Control Measures in Wetland Design
Certain actions such as permanent inundation or fall/winter inundation may help to reduce the formation of methylmercury in wetlands. As phase 1 of the TMDL is being implemented, knowledge about procedures to reduce methylmercury formation may improve. the Project applicant would use any feasible procedures to reduce methyl mercury formation on the reservoir or habitat islands. This could include modifying the final HMP design or making changes later in response to new information. Proposed techniques (Wood et al. 2010a: 31; Wood et al. 2010b: 108) include taking the following actions:

- modify wetland design (e.g., depth, period of inundation, and vegetation),
- reduce discharge of water with high concentrations of methylmercury, and
- trap sediment with actions such as creating settling basins or planting appropriate types of vegetation (in order to reduce discharge of methylmercury attached to sediment).

Other Water Quality Variables

Impact WQ-8: Changes in Other Water Quality Variables in Delta Channel Receiving Waters
Discharges of stored water from the Project Reservoir Islands may adversely affect channel water quality near the discharge locations. The FOC for fish protection identified discharge limits for temperature and DO. Implementing the FOC as part of the USFWS, NMFS, and DFG BOs will ensure that these impacts would be less than significant.

Mitigation
No mitigation is required.

Contaminants

The 2001 FEIR and 2001 FEIS identified sites of potential soil contamination resulting from historical agricultural operations or waste disposal practices on the Project islands. Mitigation was identified and required. The impact and mitigation remains the same.

Impact WQ-9: Potential Contamination of Stored Water by Contaminant Residues
Water storage on the Reservoir Islands could mobilize soil contaminants from historical pollution sites. If the contaminant concentrations are high, mobilization of the dissolved fraction of the contaminants could cause a significant impact on Delta channel water quality from discharged water. This impact is considered significant.

Implementing Mitigation Measure WQ-MM-3 could reduce Impact WQ-9 to a less-than-significant level.

Mitigation Measure WQ-MM-3: Conduct Assessments of Potential Contamination Sites and Remediate as Necessary

The Project applicant will conduct site assessments at potential contamination sites, including sites associated with agricultural airstrip operations. If the results of a site assessment indicate that contamination is likely to mobilize into the stored water, the Project applicant shall develop plans for site remediation. Such site assessments and remediation typically would be performed under the supervision of the RWQCB. All required assessments and remediation would be completed prior to the beginning of Project water storage.

Impact WQ-10: Water Pollution Caused by Construction Activities

Construction activities could introduce contaminants into adjacent water bodies. Primary construction-related contaminants that could reach groundwater or surface water include increased sediment and oil and grease.

Project actions would require construction-related earth-disturbing activities that potentially could cause erosion and sedimentation of adjacent water bodies. Furthermore, some activities may require in-water work that could result in greater sedimentation and increased turbidity in comparison to activities that are primarily landside.

In addition, Project actions may involve storage, use, or discharge of toxic and other harmful substances near Delta channels. Construction activities would involve the use of heavy equipment, cranes, compactors, and other construction equipment that uses petroleum products (e.g., fuels, lubricants, hydraulic fluids, coolants). All of these materials may be toxic to fish and other aquatic organisms. An accidental spill or inadvertent discharge of these materials could affect the water quality of the river or water body. Furthermore, any dewatering of the construction area (e.g., trenches may fill with water) could result in the release of contaminants to surface or groundwater.

The environmental commitment to use BMPs (see above) would reduce the likelihood that construction-related water quality effects would occur, or would reduce any effect that does occur. With adherence to the BMPs, construction-related impacts on water quality would be less than significant.

Mitigation

No mitigation is required.

Impact WQ-11: Increase in Pollutant Loading in Delta Channels Associated with Recreational Boating

The recreational boat use associated with the Project could result in periodic pollution problems in Delta waters. This pollution could result from spills, exhaust, and waste discharges. This impact is considered less than significant. In addition, implementation of Mitigation Measures WQ-MM-4 and REC-MM-1 would further reduce the impact of Project-related recreational boating on water quality.

Mitigation Measure WQ-MM-4: Clearly Post Waste Discharge Requirements, Provide Waste Collection Facilities, and Educate Recreationists Regarding Illegal Discharges of Waste
Prior to operation of the Project recreation facilities, post notices at all Project recreation facilities describing proper methods of disposing of waste. WDRs will be posted and enforced in accordance with local and state laws and ordinances. Prior to operation of the Project recreation facilities, provide waste collection receptacles on and around the boat docks for the boaters using the Project recreation facilities. Prior to operation of the Project recreation facilities, provide educational materials to inform recreationists about the deleterious effects of illegal waste discharges and the location of waste disposal facilities throughout the Delta.

Mitigation Measure REC-MM-1: Reduce the Size or Number of Recreation Facilities
The Project will reduce the total number or size of recreation facilities proposed by removing from Bacon Island and Webb Tract all 22 facilities proposed for construction, and reducing the number or size of proposed facilities on Bouldin Island and Holland Tract by 70%. This would reduce the number of permanent docking spaces provided by the recreation facilities from 2,508 to 330 slips, significantly reducing the likelihood of pollution resulting from spills, exhaust, and waste discharges.

Impact WQ-12: Reduction in Agricultural Pollutants

Under Alternative 2 there would be more than a 14,000-acre reduction in harvested agricultural acres (see Tables 4.8-2 and 4.8-9). Fertilizers and pesticides currently used on this land can contaminate agricultural drainwater that returns to Delta channels. Implementation of the Project would have the beneficial effect of reducing these contaminants. This impact would be less than significant.

Mitigation
No mitigation is required.

Alternative 1

The potential impacts for Alternative 1 are the same as for Alternative 2. The amount of water diverted onto and released from the two Reservoir Islands could be slightly less under Alternative 1 from the amount under Alternative 2. However, the difference would be too small to alter the level of significance of each of the impacts.

Alternative 3

Alternative 3 would include storage of water on all four Project islands, with secondary uses for wildlife habitat and recreation. The portion of Bouldin Island north of SR 12 would be managed as a wildlife habitat area (the NBHA) and would not be used for water storage. Under Alternative 3, more water could be moved on and off the islands, potentially making the attainment of water quality objectives more difficult.

Impact WQ-1: Salinity Increase at Chipps Island

Restrictions on Project operations are likely to maintain adequately low levels of salinity in the Delta. As part of Project operations, minimum Delta outflow would be about 11,400 cfs, and X2 (the location of 2,640 µS/cm) would be at Chipps Island or downstream. In addition, one of the restrictions of the WQMP is that the Project should not cause salinity to exceed 90% of an adopted salinity standard. Because of Project operational restrictions, this impact is less than significant.

Mitigation

No mitigation is required.

Impact WQ-2: Salinity Increase at Emmaton

As described above for Impact WQ-2 for Alternatives 1 and 2, there are essentially no salinity intrusion effects at Emmaton for outflow greater than 10,000 cfs. Because Project operations would maintain a minimum Delta outflow of about 11,400 cfs, the effect of Alternative 3 on salinity at Emmaton would be small, and this impact is less than significant.

Mitigation

No mitigation is required.

Impact WQ-3: Salinity Increase at Jersey Point

As described above for Impact WQ-3 for Alternatives 1 and 2, there are essentially no salinity intrusion effects at Jersey Point for outflow greater than 10,000 cfs. Because Project operations would maintain a minimum Delta outflow of about 11,400 cfs, the effect of Alternative 3 on salinity at Jersey Point would be small, and this impact is less than significant.

Mitigation

No mitigation is required.

Impact WQ-4: Salinity Increase at Exports

The Rock Slough intake was used as the evaluation point for the effect of salinity on exports because this intake would have a larger impact from Project operations than the other drinking water intakes. As described above for Impact WQ-3 for Alternatives 1 and 2, there are essentially no salinity intrusion effects at the Rock Slough intake for outflow greater than 10,000 cfs. Because Project operations would maintain a minimum Delta outflow of about 11,400 cfs, the effect of Alternative 3 on salinity at Jersey Point would be small, and this impact is less than significant.

Mitigation

No mitigation is required.

Impact WQ-5: Beneficial Salinity Reductions at Exports

Alternative 3 would be able to create beneficial salinity reductions as is described above for Impact WQ-5 for Alternatives 1 and 2. However, because there is potential to store and release more water under Alternative 3, the potential decrease in salinity in the fall is greater for Alternative 3 than it is for Alternatives 1 and 2.

As for Alternatives 1 and 2, the levee improvements needed to implement Alternative 3 would reduce the risk of levee failure and subsequent seawater intrusion.

While not in the Project description, the Project could provide an emergency response during a Delta flood event. If the Project islands were filled at the time, the stored water could be released to provide about 350 taf of flushing water (more than for Alternatives 1 and 2) to move the salinity intrusion water downstream. This emergency response could be a benefit. This impact is less than significant.

Mitigation

No mitigation is required.

Impact WQ-6: Elevated DOC Concentrations in Delta Exports

Discharges from the Project islands may have relatively high DOC concentrations that may significantly increase DOC concentrations in Delta exports. As for Alternatives 1 and 2, DOC impacts associated with Alternative 3 would be less than significant because reservoir releases would be subject to the restrictions of the WQMP. However, because the volume of water to be released under Alternative 3 is potentially greater than for Alternatives 1 and 2, it could be more difficult to quickly release all of the water for export use. This impact is less than significant.

Mitigation

No mitigation is required.

Impact WQ-7: Increased Methylmercury Loading in the Delta

As indicated in Table 4.2-7, mercury loading under Alternative 3 may or may not be greater than under Alternatives 1 and 2 depending on the actual mercury flux rates from reservoirs versus wetlands. In any case, because both wetlands and open water impoundments of the Delta appear typically to produce more methylmercury than agricultural practices on peat soils, Alternative 3 may have a significant impact on methylmercury loading in the central Delta. Therefore, this impact is considered significant.

Implementing Mitigation Measures WQ-MM-1 and WQ-MM-2 (described above) could reduce Impact WQ-7 to a less-than-significant level.

Mitigation Measure WQ-MM-1: Follow Guidelines from Proposed Delta TMDL for Methylmercury

This mitigation measure is described above.

Mitigation Measure WQ-MM-2: Incorporate Mercury Methylation Control Measures in Wetland Design
This mitigation measure is described above.

Impact WQ-8: Changes in Other Water Quality Variables in Delta Channel Receiving Waters

Discharges of stored water from the Project Reservoir Islands may adversely affect channel water quality near the discharge locations. The FOC for fish protection identified discharge limits for temperature and DO. Implementing the FOC as part of the USFWS, NMFS, and DFG BOs would ensure that these impacts would be less than significant.

Mitigation
No mitigation is required.

Contaminants

The 2001 FEIR and 2001 FEIS identified sites of potential soil contamination resulting from historical agricultural operations or waste disposal practices on the Project islands. Mitigation was identified and required. The impact and mitigation remain the same.

Impact WQ-9: Potential Contamination of Stored Water by Contaminant Residues

Water storage on the Reservoir Islands could mobilize soil contaminants from historical pollution sites. If the contaminant concentrations are high, mobilization of the dissolved fraction of the contaminants could cause a significant impact on Delta channel water quality from discharged water. The potential for this to occur is greater for Alternative 3 than for Alternatives 1 and 2 because more land would be inundated. This impact is considered significant.

Implementing Mitigation Measure WQ-MM-3 (described above) could reduce Impact WQ-9 to a less-than-significant level.

Mitigation Measure WQ-MM-3: Conduct Assessments of Potential Contamination Sites and Remediate as Necessary
This mitigation measure is described above.

Impact WQ-10: Water Pollution Caused by Construction Activities

Construction activities could introduce contaminants into adjacent water bodies. More construction work would be needed for Alternative 3 than for Alternatives 1 and 2, but the nature of potential water pollution from construction activities is the same for all alternatives.

The environmental commitment to use BMPs (see above) would reduce the likelihood that construction-related water quality effects would occur, or would reduce any effect that does occur. With adherence to the BMPs, construction-related impacts on water quality would be less than significant.

Mitigation
No mitigation is required.

Impact WQ-11: Increase in Pollutant Loading in Delta Channels Associated with Recreational Boating

The recreational boat use associated with the Project could result in periodic pollution problems in Delta waters. This pollution could result from spills, exhaust, and waste discharges. This impact is considered less than significant. In addition, implementation of mitigation measures WQ-MM-4 and REC-MM-1 (described above) would further reduce the impact of Project-related recreational boating on water quality.

Mitigation Measure WQ-MM-4: Clearly Post Waste Discharge Requirements, Provide Waste Collection Facilities, and Educate Recreationists Regarding Illegal Discharges of Waste
This mitigation measure is described above.

Mitigation Measure REC-MM-1: Reduce the Size or Number of Recreation Facilities
This mitigation measure is described above.

Impact WQ-12: Reduction in Agricultural Pollutants

Under Alternative 3, there would be an even greater reduction in agricultural acres than under Alternatives 1 and 2. As a result, there would be a slightly greater benefit associated with a reduction in agriculture-related contaminants draining into Delta channels. This impact would be less than significant.

Mitigation
No mitigation is required.

No-Project Alternative

The existing water quality for the Delta includes a range of seasonal and year-to-year variations in water quality as predicted with Delta inflows and D-1641 objectives. Delta salinity and export water quality without the Project (i.e., continued agricultural uses on the four Project islands) would be similar to those observed in recent years (since 1995 when WQCP objectives were implemented). There would be no measurable changes in water quality compared to existing conditions. Existing water quality conditions are described both above (for DOC and mercury) and in the 2001 FEIS.

Under the No-Project Alternative, the Project islands would continue to affect water quality in the Delta by discharging agricultural drainage water. Agricultural drainage in the Delta contains high levels of nutrients, suspended sediments, DOC, and EC (salinity), as well as traces of agricultural chemicals (e.g., pesticides). EC, DOC, and methylmercury are the main water quality constituents in agricultural drainwater that have been measured and are a concern for water quality in the Delta.

EC. As described in the 2001 FEIS, measurements of drainage EC from many of the Delta island agricultural drains show a strong seasonal pattern, with the highest EC values in drainage water during winter. EC values generally ranged from low values characteristic of Delta channel water (137 to 568 µS/cm) to much higher values (1,280 to 2,870 µS/cm). This range in drainage EC values is expected because of the variation in Delta precipitation and irrigation, leaching, and drainage practices. Higher EC values indicate that the salt has become concentrated in the agricultural soils through ET.

The salt in irrigation water becomes concentrated on Delta islands as a result of evaporation. The islands do not provide any additional salts beyond what originates from irrigation water. (Because only a small portion of the total amount of water stored on the reservoir islands would evaporate, the EC of water discharged from the reservoir islands would be only slightly elevated above the relatively low-EC of the water diverted onto the islands).

DOC. Delta islands are a source of DOC (i.e., total DOC leaving the islands is greater than DOC applied to the islands). Appendix G, "Water Quality Assessment Methods," of the 2000 RDEIR/EIS presents detailed information on agricultural drainage water quality for Bacon Island, Webb Tract, Bouldin Island, Holland Tract, and Twitchell Island. Based on these estimates and on model calibration results, an average of 12 g-C/m^2/yr was used in the 2001 FEIR and 2001 FEIS for the DOC loading estimate for existing agricultural drains in the Delta.

Methylmercury. Methylmercury is produced and exported from Delta agricultural lands. Methylmercury loads from Delta agricultural lands with high organic content recently have been estimated at between 0.3 and 4.5 ng/m^2/day (Heim et al. 2009: 33; Wood et al. 2010a: 108).

Table 4.2-3. Monthly Cumulative Distributions for IDSM Simulated EC at Chipps Island for 1922–2003

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
A. Simulated EC at Chipps Island with Baseline Delta Conditions												
Min	537	150	150	150	150	150	150	150	150	152	305	298
10%	3,746	1,991	150	150	150	150	150	150	162	913	4,090	4,415
20%	6,860	5,539	248	150	150	150	151	168	533	1,785	4,642	6,702
30%	9,292	6,900	1,206	151	150	151	166	220	1,054	2,153	4,991	8,175
40%	9,784	9,071	4,291	306	151	159	252	472	1,590	2,692	5,244	8,424
50%	10,311	9,629	6,832	1,355	166	170	379	910	2,054	3,302	5,562	8,867
60%	10,702	10,174	8,123	2,644	361	373	644	1,453	2,803	3,654	6,466	9,129
70%	11,014	10,571	8,853	5,137	991	543	945	2,245	3,642	5,196	7,114	9,615
80%	11,219	10,798	9,534	7,207	1,867	1,229	1,598	2,721	4,206	5,476	7,633	10,272
90%	11,943	11,521	9,955	7,993	3,882	2,611	3,037	4,029	5,532	7,225	9,215	10,698
Max	12,365	12,452	11,182	10,130	8,477	6,728	6,083	7,299	8,962	9,478	10,047	11,624
Avg	9,131	8,264	5,502	3,035	1,202	792	994	1,617	2,629	3,740	5,992	8,180
B. Simulated EC at Chipps Island with Project Operations												
Min	537	150	150	150	150	150	150	150	150	152	305	298
10%	3,746	1,542	150	150	150	150	150	150	162	913	4,090	4,415
20%	6,860	4,285	322	150	150	150	151	168	533	1,785	4,642	6,702
30%	8,596	5,583	1,475	152	150	151	166	220	1,054	2,153	4,991	8,140
40%	9,059	7,102	4,234	449	151	160	252	472	1,590	2,692	5,244	8,298
50%	9,998	8,883	5,514	1,656	169	180	380	910	2,054	3,302	5,562	8,725
60%	10,621	9,916	7,084	2,588	416	387	649	1,453	2,805	3,655	6,466	9,125
70%	11,005	10,468	8,278	4,970	1,239	579	987	2,254	3,642	5,197	7,114	9,615
80%	11,211	10,737	9,205	6,875	1,867	1,228	1,615	2,749	4,215	5,479	7,633	10,272
90%	11,943	11,521	9,955	7,844	3,754	2,580	3,037	4,030	5,534	7,226	9,215	10,698
Max	12,365	12,452	11,182	10,130	8,477	6,728	6,083	7,299	8,962	9,478	10,047	11,623
Avg	8,933	7,666	5,192	3,019	1,225	805	1,002	1,619	2,630	3,740	5,992	8,152
C. Simulated Changes in EC at Chipps Island with Project Operations												
Min	-1,568	-2,556	-2,290	-923	-235	-41	-10	-4	-2	-1	0	-677
10%	-704	-1,882	-1,651	-285	-4	0	0	0	0	0	0	0
20%	-619	-1,531	-613	-15	0	0	0	0	0	0	0	0
30%	-73	-738	-62	0	0	0	0	0	0	0	0	0
40%	0	-369	0	0	0	0	0	0	0	0	0	0
50%	0	-91	0	0	0	0	0	0	0	0	0	0
60%	0	0	0	0	0	0	0	0	0	0	0	0
70%	0	0	0	0	0	0	0	0	0	0	0	0
80%	0	0	0	1	4	10	1	0	0	0	0	0
90%	0	0	39	224	74	66	20	6	2	1	0	0
Max	0	0	582	822	542	189	169	41	12	4	1	1
Avg	-198	-598	-310	-17	23	13	8	2	1	0	0	-28

Table 4.2-4. Monthly Cumulative Distributions for IDSM-Simulated EC at Emmaton

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
A. Simulated EC at Emmaton with Baseline Delta Conditions												
Min	159	150	150	150	150	150	150	150	150	150	152	152
10%	486	266	150	150	150	150	150	150	150	179	538	591
20%	1,061	791	151	150	150	150	150	150	159	245	629	1,027
30%	1,644	1,070	200	150	150	150	150	151	187	282	690	1,363
40%	1,774	1,586	571	152	150	150	151	157	228	343	736	1,423
50%	1,919	1,733	1,055	208	150	150	154	178	271	422	796	1,534
60%	2,029	1,881	1,350	338	154	154	164	216	356	472	977	1,601
70%	2,119	1,992	1,531	717	183	160	180	291	470	727	1,116	1,729
80%	2,178	2,057	1,708	1,137	253	199	228	346	557	779	1,234	1,908
90%	2,395	2,268	1,821	1,319	506	333	387	529	790	1,141	1,624	2,028
Max	2,525	2,552	2,168	1,869	1,437	1,032	898	1,158	1,558	1,693	1,846	2,298
Avg	1,693	1,503	970	534	258	201	214	282	406	554	923	1,432
B. Simulated EC at Emmaton with Project Operations												
Min	159	150	150	150	150	150	150	150	150	150	152	152
10%	486	227	150	150	150	150	150	150	150	179	538	591
20%	1,061	570	153	150	150	150	150	150	159	245	629	1,027
30%	1,466	800	218	150	150	150	150	151	187	282	690	1,354
40%	1,583	1,114	562	157	150	150	151	157	228	343	736	1,393
50%	1,832	1,538	787	233	150	150	154	178	271	422	796	1,498
60%	2,006	1,810	1,110	332	155	154	164	216	357	472	977	1,600
70%	2,116	1,963	1,388	687	200	161	183	292	470	727	1,116	1,729
80%	2,176	2,039	1,621	1,064	253	199	230	350	558	780	1,234	1,908
90%	2,395	2,268	1,821	1,284	487	329	387	529	790	1,141	1,624	2,028
Max	2,525	2,552	2,168	1,869	1,437	1,032	898	1,158	1,558	1,693	1,846	2,298
Avg	1,640	1,373	899	523	258	201	214	282	406	554	923	1,425
C. Simulated Changes in EC at Emmaton with Project Operations												
Min	-415	-630	-568	-214	-43	-5	-2	-1	0	0	0	-170
10%	-183	-384	-315	-43	0	0	0	0	0	0	0	0
20%	-165	-308	-126	-2	0	0	0	0	0	0	0	0
30%	-19	-178	-12	0	0	0	0	0	0	0	0	0
40%	0	-51	0	0	0	0	0	0	0	0	0	0
50%	0	-8	0	0	0	0	0	0	0	0	0	0
60%	0	0	0	0	0	0	0	0	0	0	0	0
70%	0	0	0	0	0	0	0	0	0	0	0	0
80%	0	0	0	0	0	0	0	0	0	0	0	0
90%	0	0	1	11	2	2	1	1	0	0	0	0
Max	0	0	42	104	34	10	11	5	2	1	0	0
Avg	-52	-130	-71	-10	0	0	0	0	0	0	0	-7

Table 4.2-5. Monthly Cumulative Distributions for IDSM-Simulated EC at Jersey Point

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
A. Simulated EC at Jersey Point with Baseline Delta Conditions												
Min	158	150	150	150	150	150	150	150	150	150	152	152
10%	419	243	150	150	150	150	150	150	150	173	461	503
20%	879	663	151	150	150	150	150	150	157	226	533	851
30%	1,345	886	190	150	150	150	150	150	180	255	582	1,120
40%	1,449	1,299	487	152	150	150	151	156	212	304	619	1,169
50%	1,565	1,416	874	197	150	150	153	172	247	368	667	1,257
60%	1,653	1,535	1,110	300	153	153	161	203	315	408	811	1,311
70%	1,725	1,623	1,255	603	176	158	174	263	406	612	923	1,413
80%	1,773	1,675	1,396	940	232	189	213	307	476	653	1,017	1,556
90%	1,946	1,844	1,487	1,085	435	296	339	453	662	943	1,329	1,652
Max	2,050	2,072	1,764	1,525	1,179	856	748	956	1,277	1,384	1,507	1,869
Avg	1,384	1,233	806	457	236	191	201	256	354	473	768	1,176
B. Simulated EC at Jersey Point with Project Operations												
Min	158	150	150	150	150	150	150	150	150	150	152	152
10%	419	211	150	150	150	150	150	150	150	173	461	503
20%	879	486	152	150	150	150	150	150	157	226	533	851
30%	1,203	670	204	150	150	150	150	150	180	255	582	1,113
40%	1,297	921	479	155	150	150	151	156	212	304	619	1,144
50%	1,496	1,261	659	217	150	150	153	172	247	368	667	1,229
60%	1,635	1,478	918	296	154	153	161	203	315	408	811	1,310
70%	1,723	1,600	1,140	580	190	159	176	264	406	612	923	1,413
80%	1,771	1,661	1,327	881	232	189	214	310	477	654	1,017	1,556
90%	1,946	1,844	1,487	1,057	420	293	339	453	662	943	1,329	1,652
Max	2,050	2,072	1,764	1,525	1,179	856	748	956	1,277	1,384	1,507	1,869
Avg	1,342	1,129	749	449	237	191	202	256	354	473	768	1,170
C. Simulated Changes in EC at Jersey Point with Project Operations												
Min	-332	-504	-454	-171	-34	-4	-1	-1	0	0	0	-136
10%	-146	-307	-252	-34	0	0	0	0	0	0	0	0
20%	-132	-247	-100	-2	0	0	0	0	0	0	0	0
30%	-15	-142	-9	0	0	0	0	0	0	0	0	0
40%	0	-41	0	0	0	0	0	0	0	0	0	0
50%	0	-6	0	0	0	0	0	0	0	0	0	0
60%	0	0	0	0	0	0	0	0	0	0	0	0
70%	0	0	0	0	0	0	0	0	0	0	0	0
80%	0	0	0	0	0	0	0	0	0	0	0	0
90%	0	0	1	9	2	2	1	1	0	0	0	0
Max	0	0	34	83	28	8	9	4	1	1	0	0
Avg	-42	-104	-57	-8	0	0	0	0	0	0	0	-6

Table 4.2-6. Monthly Cumulative Distributions for IDSM-Simulated Chloride Concentration (mg/l) at Rock Slough Intake

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
A. Simulated EC at Jersey Point with Baseline Delta Conditions												
Min	17	17	17	17	17	17	17	17	17	17	17	17
10%	30	19	17	17	17	17	17	17	17	17	33	37
20%	77	52	17	17	17	17	17	17	17	19	40	74
30%	143	78	17	17	17	17	17	17	17	20	44	109
40%	161	136	36	17	17	17	17	17	18	22	48	116
50%	180	155	76	17	17	17	17	17	19	26	53	130
60%	196	175	108	22	17	17	17	18	23	29	69	138
70%	209	190	129	46	17	17	17	20	29	47	83	155
80%	217	200	152	85	19	17	18	23	35	51	95	179
90%	251	231	167	104	31	22	25	33	52	85	141	196
Max	271	275	216	173	118	74	61	87	133	150	170	236
Avg	160	139	83	43	22	19	19	23	30	40	68	125
B. Simulated EC at Jersey Point with Project Operations												
Min	17	17	17	17	17	17	17	17	17	17	17	17
10%	30	18	17	17	17	17	17	17	17	17	33	37
20%	77	35	17	17	17	17	17	17	17	19	40	74
30%	122	53	18	17	17	17	17	17	17	20	44	108
40%	136	82	35	17	17	17	17	17	18	22	48	113
50%	168	130	52	18	17	17	17	17	19	26	53	125
60%	192	165	82	22	17	17	17	18	23	29	69	138
70%	208	186	112	44	17	17	17	20	29	47	83	155
80%	217	197	141	77	19	17	18	23	35	51	95	179
90%	251	231	167	101	30	22	25	33	52	85	141	196
Max	271	275	216	173	118	74	61	87	133	150	170	236
Avg	154	125	76	42	22	19	19	23	30	40	68	124
C. Simulated Changes in EC at Jersey Point with Project Operations												
Min	-54	-75	-68	-23	-3	0	0	0	0	0	0	-21
10%	-23	-44	-28	-3	0	0	0	0	0	0	0	0
20%	-20	-29	-10	0	0	0	0	0	0	0	0	0
30%	-3	-20	-1	0	0	0	0	0	0	0	0	0
40%	0	-4	0	0	0	0	0	0	0	0	0	0
50%	0	0	0	0	0	0	0	0	0	0	0	0
60%	0	0	0	0	0	0	0	0	0	0	0	0
70%	0	0	0	0	0	0	0	0	0	0	0	0
80%	0	0	0	0	0	0	0	0	0	0	0	0
90%	0	0	0	0	0	0	0	0	0	0	0	0
Max	0	0	1	6	2	0	0	0	0	0	0	0
Avg	-7	-14	-7	-1	0	0	0	0	0	0	0	-1

Table 4.2-7. Estimates of Methylmercury Load from Project Islands for the No-Project Alternative and for Alternatives 1 through 3

	Agricultural/Other Land		Open Water		Wetlands		Estimated Total Load (g/yr)	
	Low Flux	High Flux	Low Flux	High Flux	Low Flux	High Flux	Low Flux	High Flux
Source	Heim et al. 2009	Wood et al. 2010a	Sassone et al. 2008	Wood et al. 2010a	Sassone et al. 2008	Wood et al. 2010a		
Net Flux ($ng/m^2/day$)	0.3–3.3[a]	4.45	7.7[c]	10	7.7[c]	25.07[d]		
No-Project Acres	19,074[b]	19,074[b]	237	237	1,870	1,870		
Alternative 1 and 2 Acres	7,611[b]	7,611[b]	9,273	9,273	4,297	4,297		
Alternative 3 Acres	0	0	21,181	21,181	0	0		
No-Project Load (g/yr)	37.5	125.4	2.7	3.5	21.3	69.3	61.5	198.1
Alternative 1 and 2 Load (g/yr)	25.4	50.0	105.5	137.0	48.9	159.1	179.8	346.1
Alternative 3 Load (g/yr)	0	0.0	240.9	312.9	0.0	0.0	240.9	312.9

[a] Range of values assigned to the different Project islands. Value used in the calculation was a weighted average for the 4 islands (No-Project) or a weighted average for the 2 habitat islands (Alternatives 1 and 2).

[b] Acres calculated as total island area minus open water and wetland acres.

[c] Value for Twitchell Island East Pond, a flow-through wetland that is continuously inundated.

[d] Weighted average for year based on early Twitchell Island West Pond results.

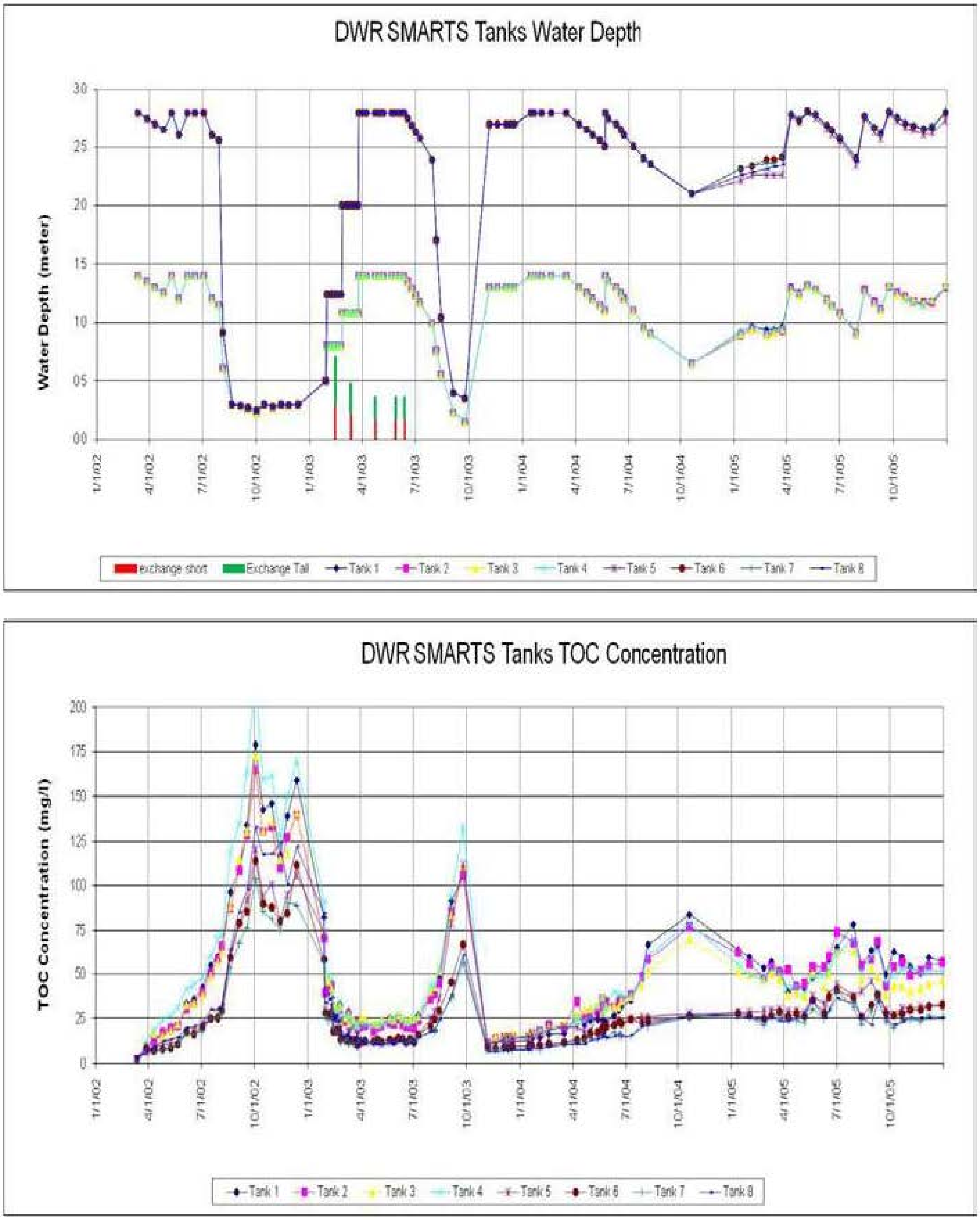


Figure 4.2-1. Measurements of SMARTS Tank Water Depth (m) and TOC (mg/l) for 2002–2005

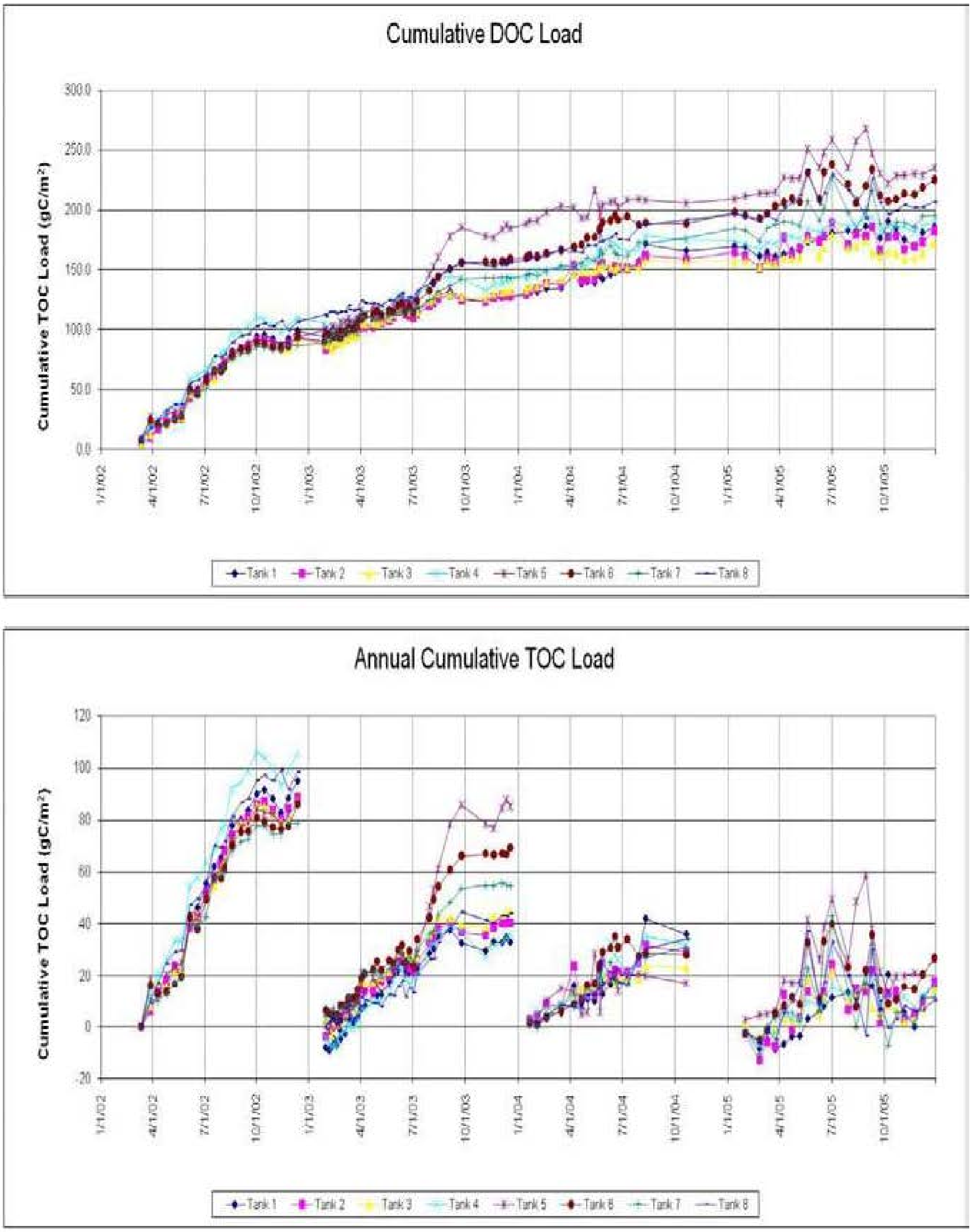


Figure 4.2-2. Calculated Cumulative and Annual TOC Loads (g/m^2) for SMARTS Tanks for 2002–2005

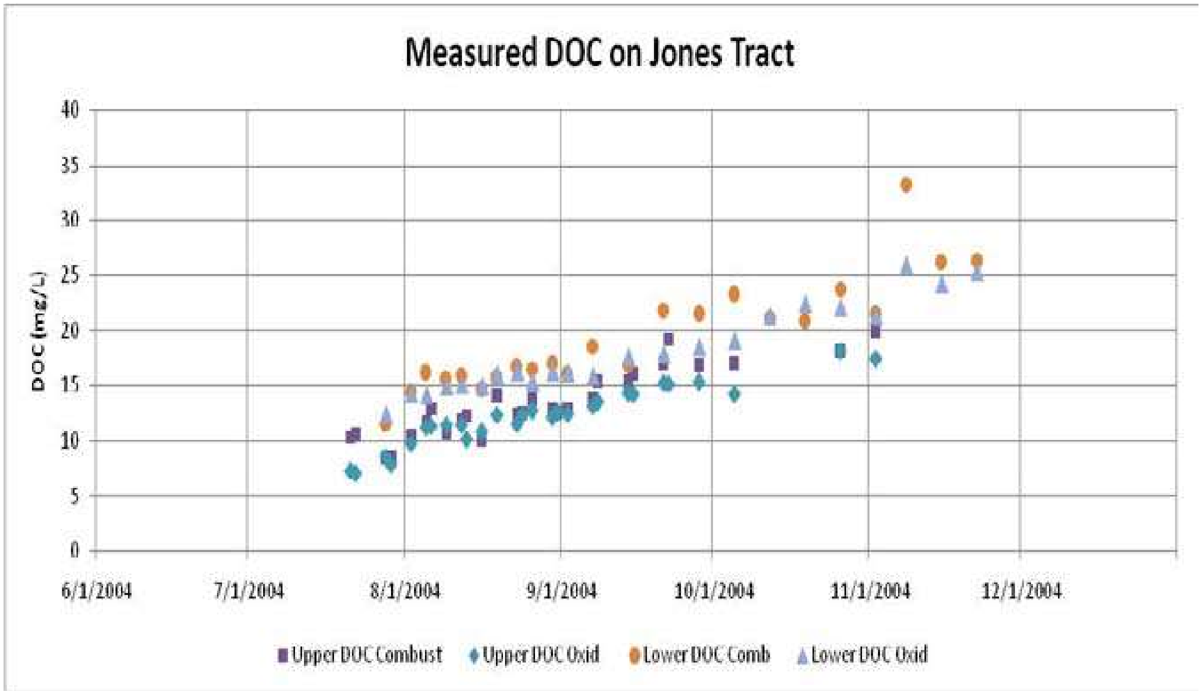


Figure 4.2-3a. Measured DOC from Upper and Lower Jones Tract Pump-off Discharges for 2004

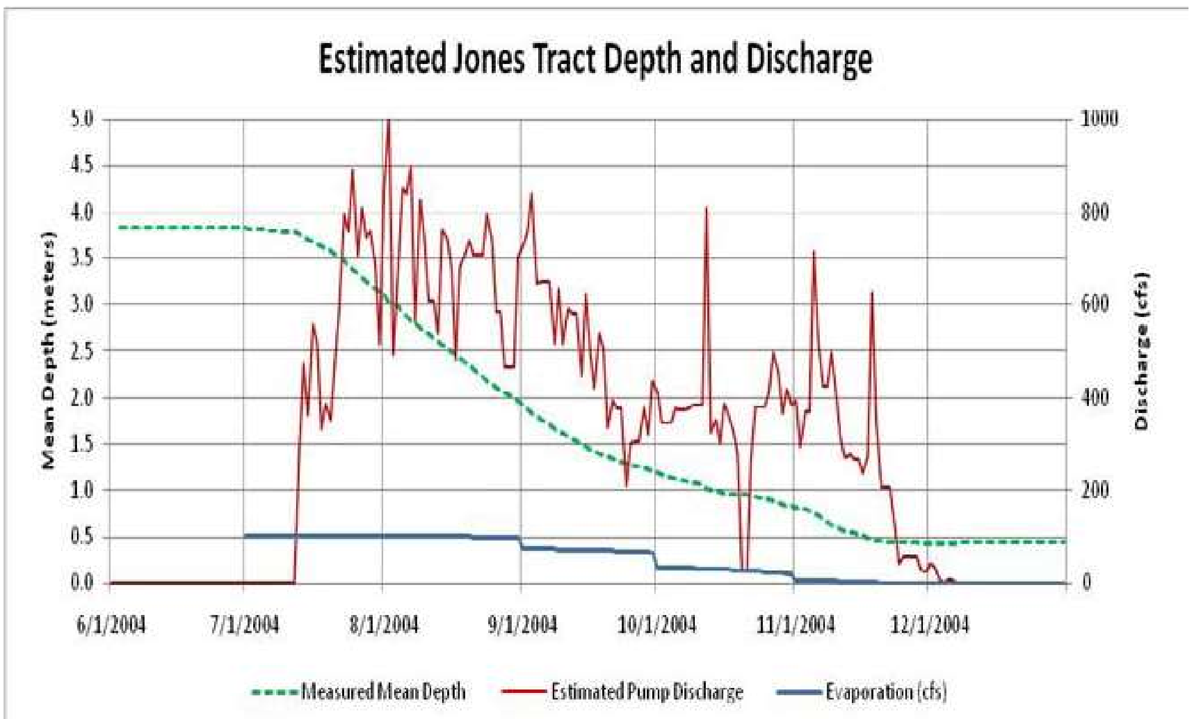


Figure 4.2-3b. Calculated Jones Tract Mean Depth (m) and Daily Discharge (cfs) for June–December 2004

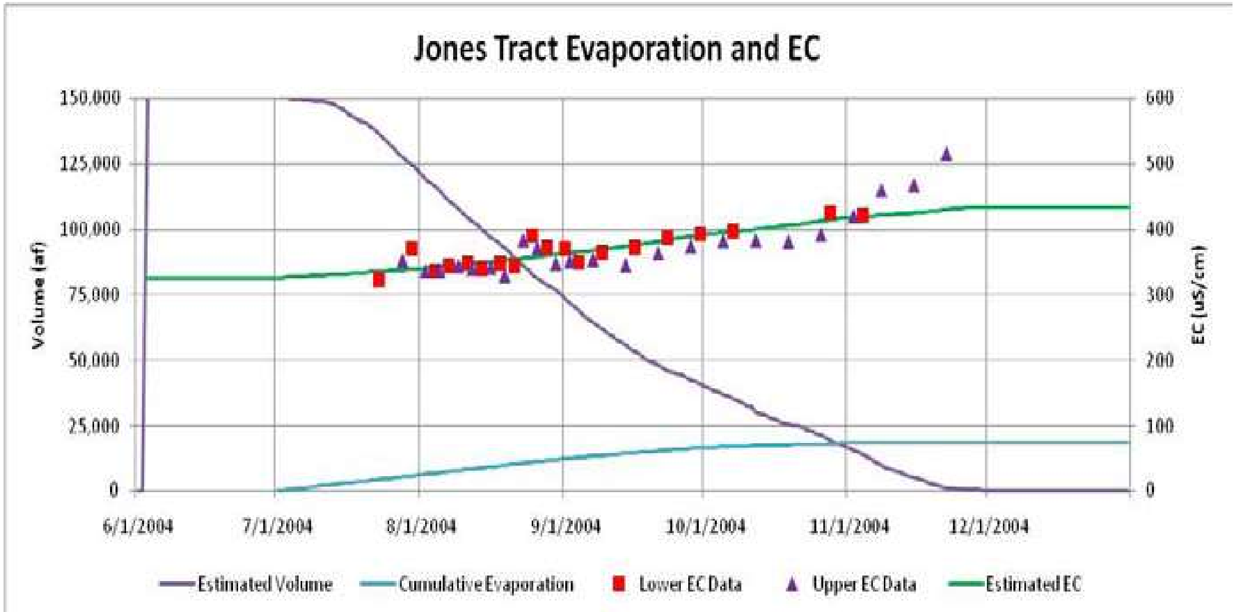


Figure 4.2-4a. Measured Jones Tract EC and Estimated Evaporation and EC for July–November 2004

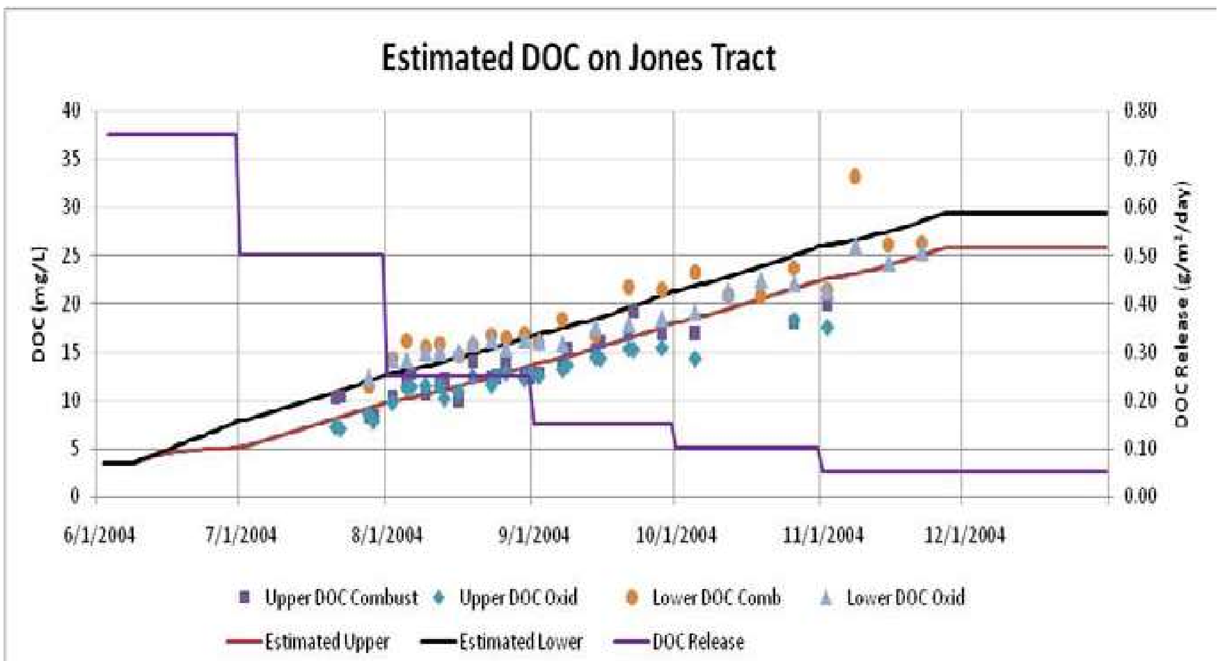


Figure 4.2-4b. Estimated Monthly DOC Release Rates and Estimated DOC Concentrations for Upper and Lower Jones Tract for June–November 2004

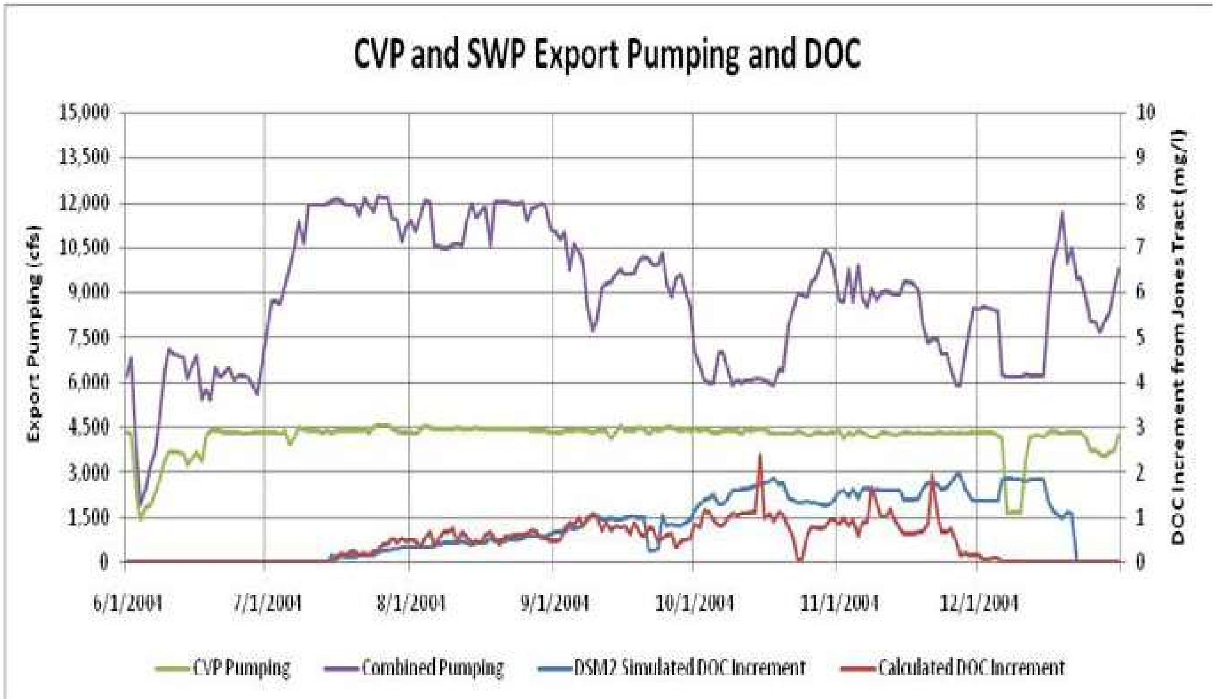


Figure 4.2-5a. CVP and SWP Export Pumping and Estimated DOC Increments from Jones Tract Discharge for June–December 2004

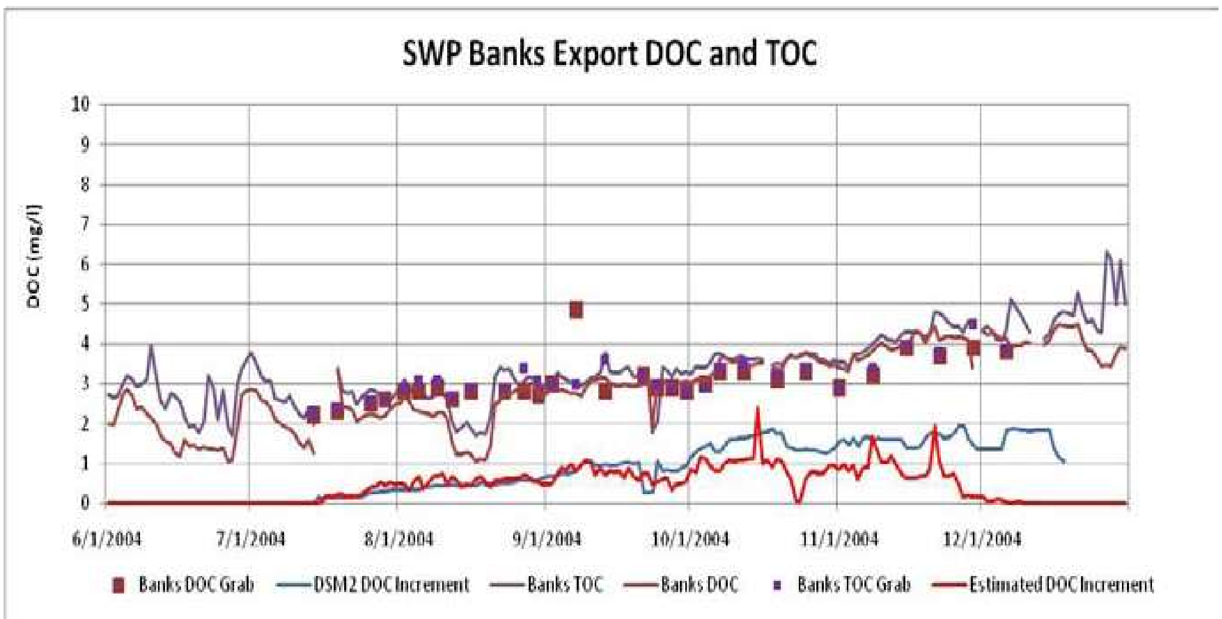


Figure 4.2-5b. Measured DOC and TOC at SWP Banks Export Pumping Plant with Estimated DOC Increments from Jones Tract Discharge for June–December 2004

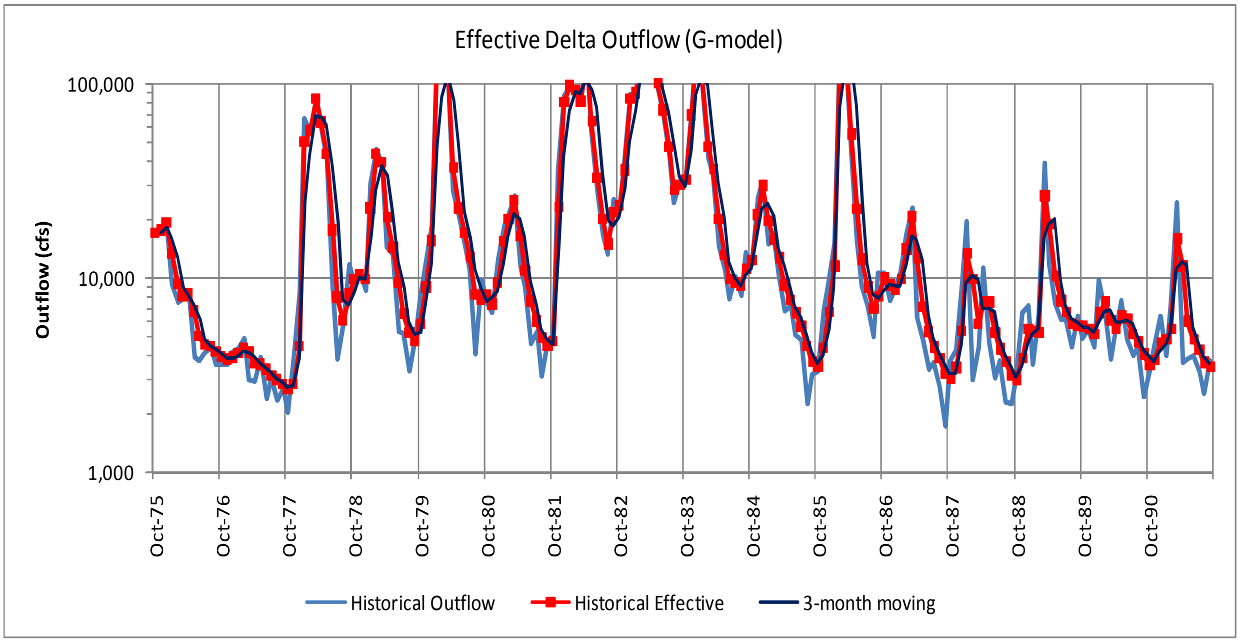


Figure 4.2-6a. Historical Monthly Delta Outflow and Effective Delta Outflow (Using the CCWD G-Model Relationships for Water Year 1976–1991

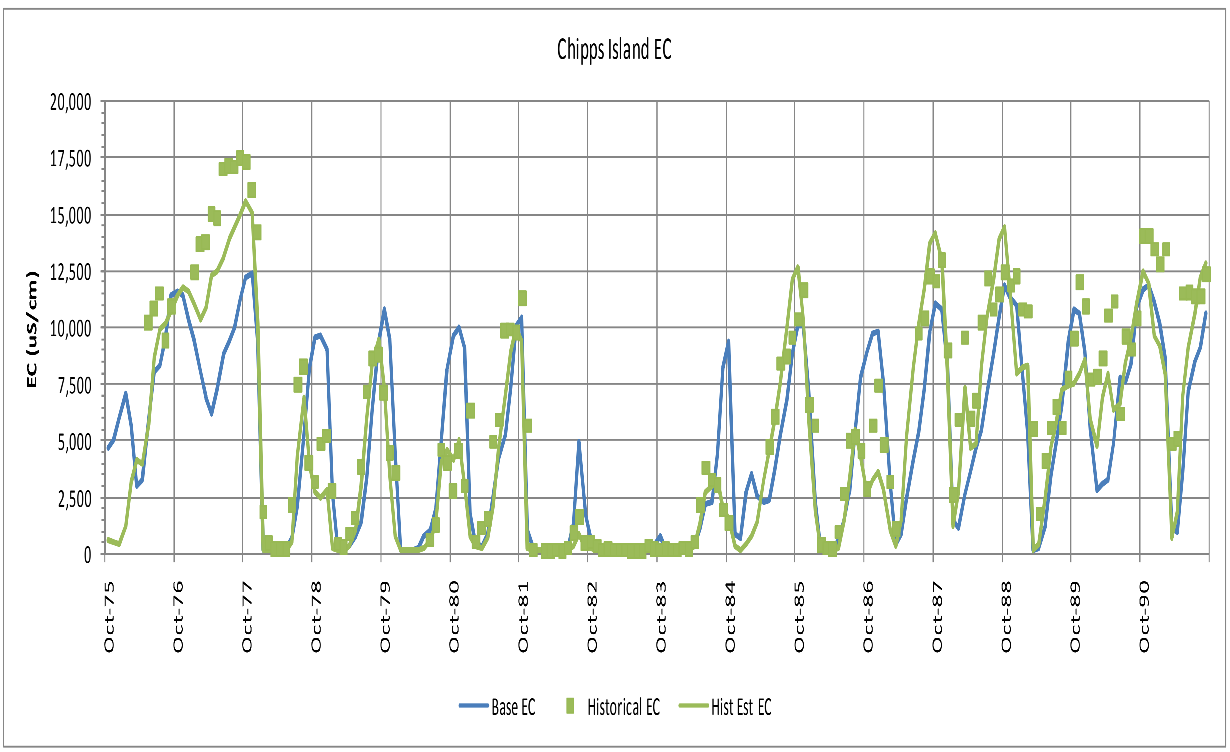


Figure 4.2-6b. Historical and Calculated EC at Chipps Island (Using Negative Exponential Relationship with Effective Outflow) for Water Years 1976–1991

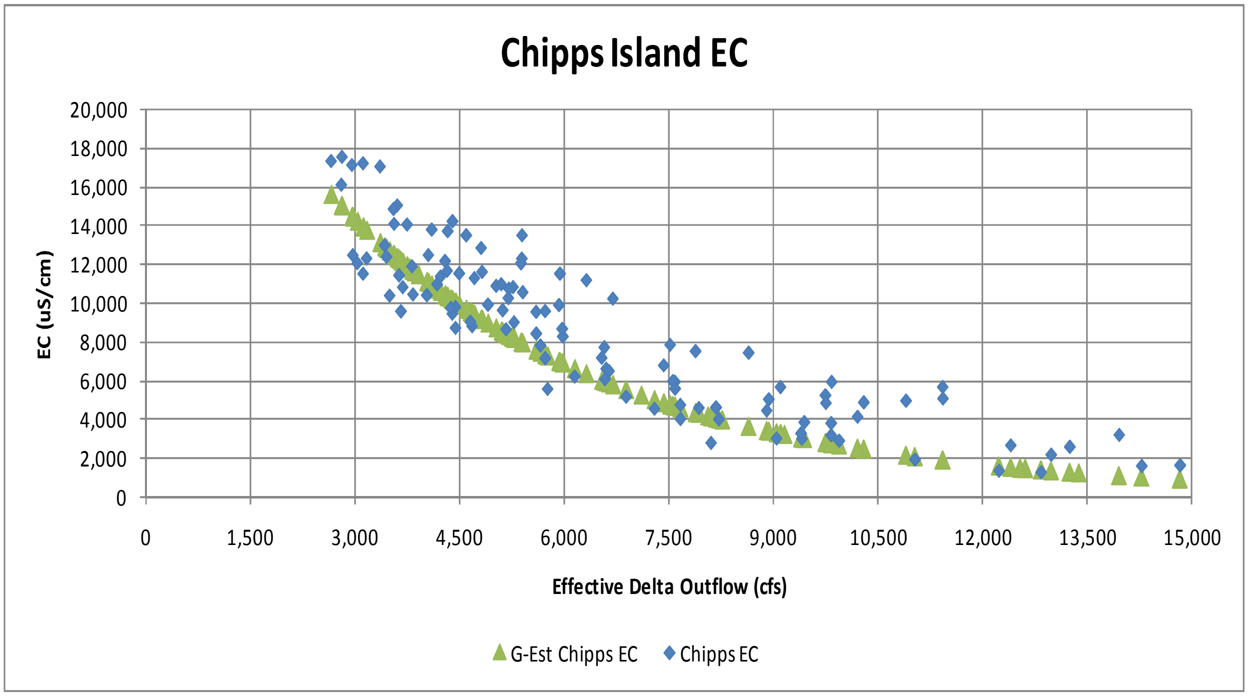


Figure 4.2-7a. Negative Exponential Relationship for Effective Delta Outflow and Salinity (EC)—Historical EC and Estimated EC at Chipps Island (75 km) for 1976–1991

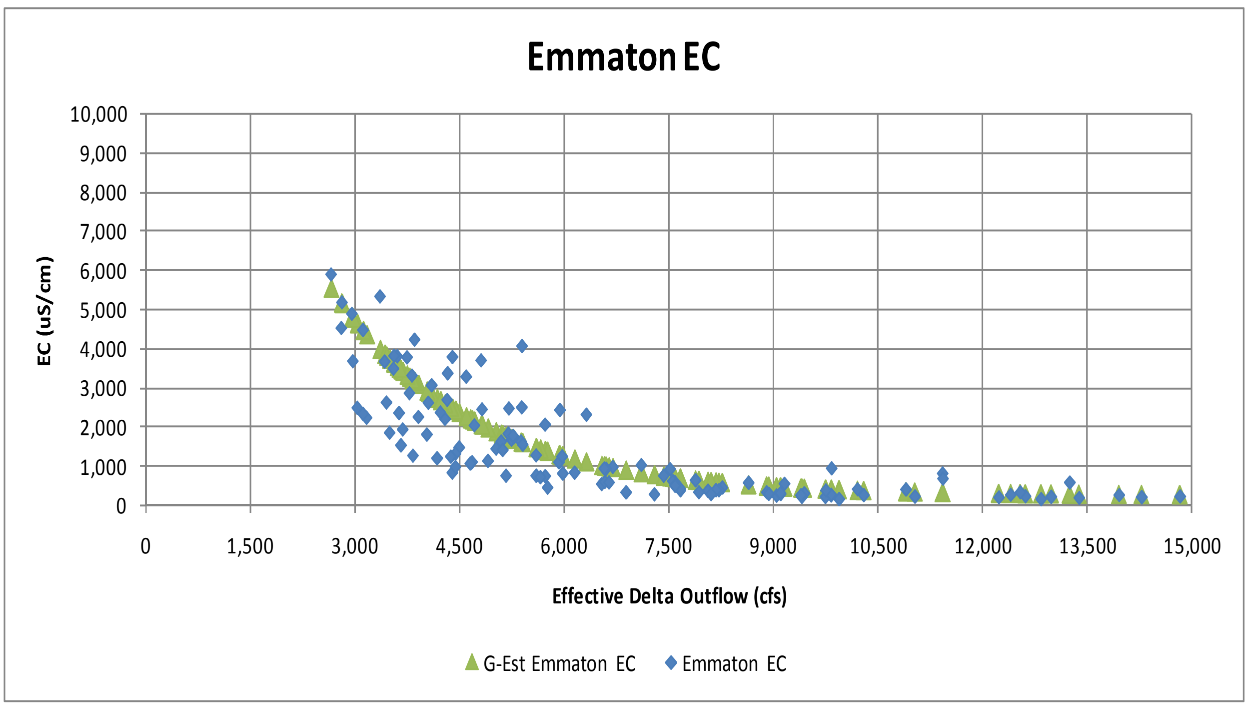


Figure 4.2-7b. Negative Exponential Relationship for Effective Delta Outflow and Salinity (EC)—Historical EC and Estimated EC at Emmaton (km 92) for 1976–1991

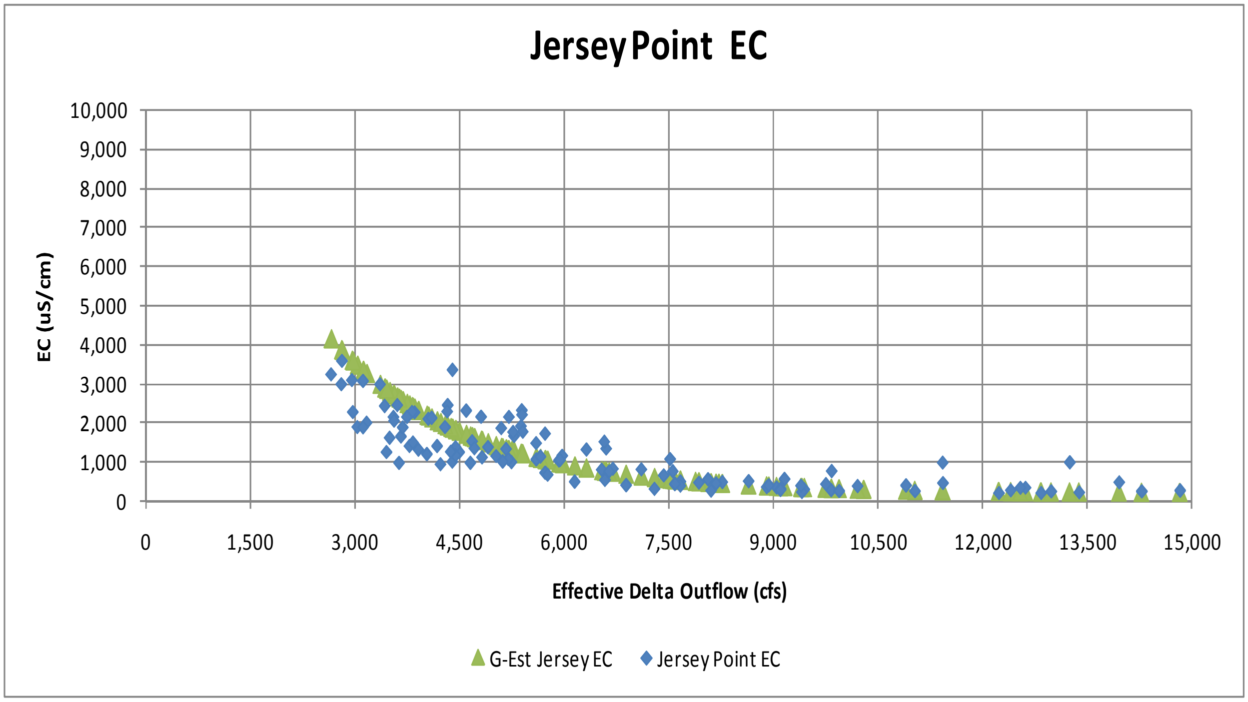


Figure 4.2-7c. Negative Exponential Relationship for Effective Delta Outflow and Salinity (EC)—Historical EC and Estimated EC at Jersey Point (km 52) for 1976–1991

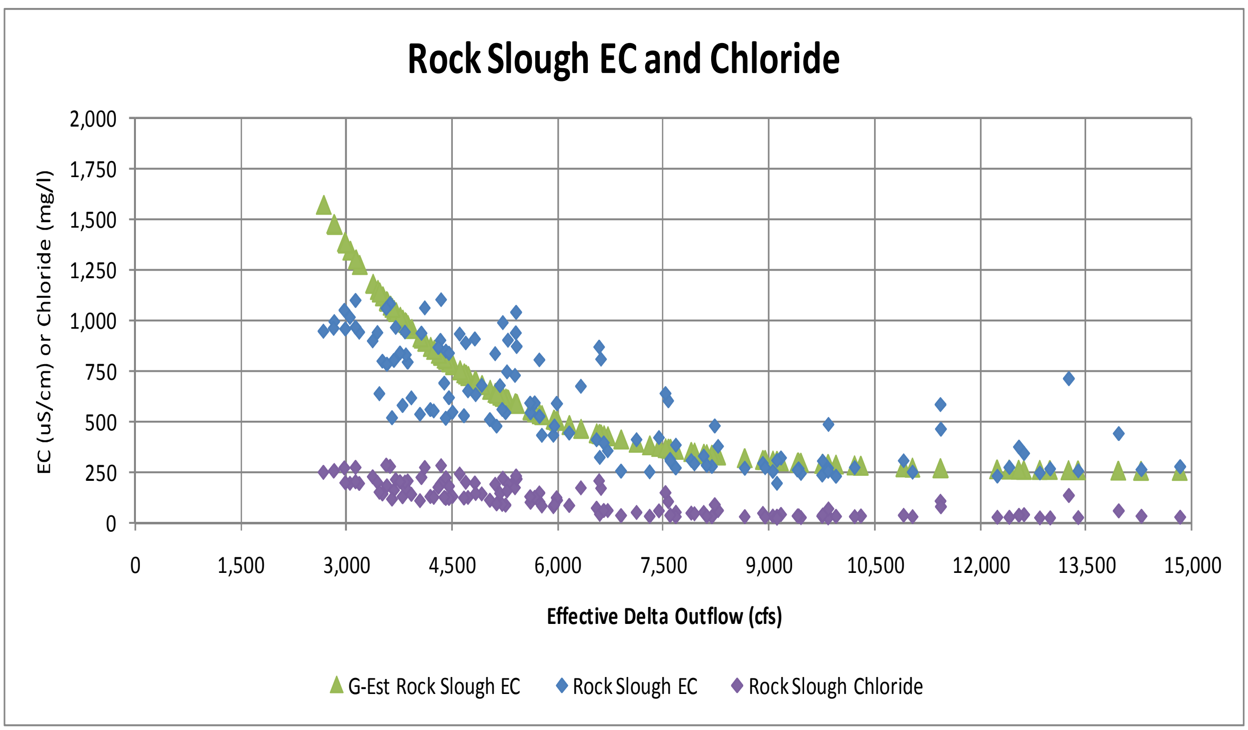


Figure 4.2-7d. Negative Exponential Relationship for Effective Delta Outflow and Salinity (EC)—Historical EC and Chloride at Rock Slough with Estimated EC for 1976–1991

Section 4.3
Flood Control and Levee Stability

Note: The term "Project levee" is generally used to refer to federal project levees that are under the jurisdiction of the U.S. Army Corps of Engineers. In order to avoid confusion regarding the ownership and jurisdiction of the Bacon Island, Webb Tract, Bouldin Island, and Holland Tract levees, these levees are referred to as "DW Project levees" in this section.

Introduction

This section describes recent changes to the existing environmental conditions and regulatory setting of the Project area, summarizes the unchanged affected environment, and describes changed environmental effects related to flood control and levee stability for the Project. This section contains a review and update of the 2000 RDEIR/EIS utilities, public services, and highways impact assessment, incorporated by reference in the 2001 FEIR. The utilities, public services, and highways impacts of the Project were analyzed most recently in the 2001 FEIS, which also served as a basis for this analysis.

The 2001 FEIR and 2001 FEIS concluded that the Project alternatives would affect flood control and levee stability for the Reservoir and Habitat Islands. Since that time, there have been minor changes in the affected environment and regulatory setting. However, there have been no changes in the Project that result in new significant environmental effects or a substantial increase in the severity of previously identified significant effects on flood control or levee stability.

The 2001 FEIR and 2001 FEIS "Levee Stability and Seepage" analysis has been updated here to reflect current environmental conditions on and around the Project islands. Information on the DW Project islands' levee design as determined by recommendations put forth in the Hultgren-Tillis Preliminary Design Report (Hultgren-Tillis 2003) recommendations for seepage mitigation, and considerations for projected sea-level rise are incorporated into this update. These changes are minor and do not affect the results of the analysis reported in the 2001 FEIR and 2001 FEIS.

Identification of the Project's specific places of use does not affect flood control and levee stability in any way that alters the conclusions of the 2001 FEIR and 2001 FEIS. The Project will not have any direct effects on flood control and levee stability in the places of use; the effects on flood control and levee stability, if any, associated with the provision of Project water to the place of use are addressed in Chapter 5, "Cumulative Impacts," and Chapter 6, "Growth-Inducing Impacts."

Summary of Impacts

Table 4.3-1 provides a summary and comparison of the impacts and mitigation measures for flood control and levee stability from the 2001 FEIR, 2001 FEIS, and this Place of Use EIR.

Table 4.3-1. Comparison between Delta Wetlands Project 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures for Flood Control and Levee Stability

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR Impacts and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
ALTERNATIVES 1 AND 2	
Impact D-1: Change in Long-Term Levee Stability on Reservoir Islands (LTS-M) **Mitigation Measure RD-1:** Adopt Final Levee Design That Achieves Recommended Factor of Safety and Reduces Risk of Catastrophic Levee Failure	**Impact FC-1:** Improvement in Long-Term Levee Stability on Reservoir Islands (LTS) **Mitigation:** No mitigation is required. The proposed levee design has changed; however, this impact has not changed. No mitigation is required as final levee designs are subject to engineering review before construction. Reservoir Island levees will be designed to exceed PL84-99 standards and provide necessary revetment on both the slough side and reservoir side to protect against erosive forces from waves, wind, and overtopping.
Impact D-2: Potential for Seepage from Reservoir Islands to Adjacent Islands (LTS-M) **Mitigation Measure RD-2:** Modify Seepage Monitoring Program and Seepage Performance Standards	**Impact FC-2:** Potential for Seepage from Reservoir Islands to Adjacent Islands (LTS) **Mitigation:** No mitigation is required. This impact has not changed. However, the changes recommended in Mitigation Measure RD-2 in the 2001 FEIR and 2001 FEIS have since been incorporated into the Seepage Monitoring Program (described in Chapter 2 of this document under Project Environmental Commitments), making mitigation for this effect no longer necessary. Final levee designs are subject to engineering review before construction. Reservoir Island levees will be designed to include a core trench and interceptor well system to provide a levee seepage barrier.
Impact D-3: Potential for Wind and Wave Erosion on Reservoir Islands (LTS) **Mitigation:** No mitigation is required.	**Impact FC-3:** Potential for Wind and Wave Erosion on Reservoir Islands (LTS) **Mitigation:** No mitigation is required. This impact has not changed. Final levee designs are subject to engineering review before construction. Reservoir Island levees will be designed to exceed PL84-99 standards and provide necessary revetment on both the slough side and reservoir side to protect against erosive forces from waves, wind, and overtopping.

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR Impacts and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
Impact D-4: Potential for Erosion of Levee Toe Berms at Pump Stations and Siphon Stations on Reservoir Islands (LTS) **Mitigation:** No mitigation is required.	**Impact FC-4:** Potential for Erosion of Levee Toe Berms at Pump Stations and Siphon Stations on Reservoir Islands (LTS) **Mitigation:** No mitigation is required. This impact has not changed. Final levee designs are subject to engineering review before construction.
Impact D-5: Change in Potential for Levee Failure on Project Islands during Seismic Activity (LTS-M) **Mitigation Measure RD-1:** Adopt Final Levee Design That Achieves Recommended Factor of Safety and Reduces Risk of Catastrophic Levee Failure	**Impact FC-5:** Change in Potential for Levee Failure on Project Islands during Seismic Activity (LTS) **Mitigation:** No mitigation is required. The proposed levee design has changed. No mitigation is required as final levee designs are subject to engineering review before construction. Reservoir and Habitat Island levees will be designed to meet or exceed PL84-99 standards and provide improved protection against seismic acceleration.
Impact D-6: Increase in Long-Term Levee Stability on Habitat Islands (B) **Mitigation:** No mitigation is required.	**Impact FC-6:** Increase in Long-Term Levee Stability on Habitat Islands (B and LTS) **Mitigation:** No mitigation is required. This impact has not changed. Final levee designs are subject to engineering review before construction. Habitat Island levees will be designed to meet PL84-99 standards and provide necessary revetment on the slough side to protect against erosive forces from waves, wind, and overtopping.
ALTERNATIVE 3: *Differences in Alternative 3 impacts correspond with differences in Alternative 1 and 2 impacts and are described above.*	
Impact D-7: Change in Long-Term Levee Stability on Reservoir Islands (LTS-M) **Mitigation Measure RD-1:** Adopt Final Levee Design that Achieves Recommended Factor of Safety and Reduces the Risk of Catastrophic Levee Failure	**Impact FC-1:** Change in Long-Term Levee Stability on Reservoir Islands (LTS) **Mitigation:** No mitigation is required.
Impact D-8: Potential for Seepage from Reservoir Islands to Adjacent Islands (LTS-M) **Mitigation Measure RD-2:** Modify Seepage Monitoring Program and Seepage Performance Standards	**Impact FC-2:** Potential for Seepage from Reservoir Islands to Adjacent Islands (LTS) **Mitigation:** No mitigation is required.
Impact D-9: Potential for Wind and Wave Erosion on Reservoir Islands (LTS) **Mitigation:** No mitigation is required.	**Impact FC-3:** Potential for Wind and Wave Erosion on Reservoir Islands (LTS) **Mitigation:** No mitigation is required.
Impact D-10: Potential for Erosion of Levee Toe Berms at Pump Stations and Siphon Stations on Reservoir Islands (LTS) **Mitigation:** No mitigation is required.	**Impact FC-4:** Potential for Erosion of Levee Toe Berms at Pump Stations and Siphon Stations on Reservoir Islands (LTS) **Mitigation:** No mitigation is required.
Impact D-11: Change in Potential for Levee Failure on DW Project Islands during Seismic (LTS-M) **Mitigation Measure RD-1:** Adopt Final Levee Design that Achieves Recommended Factor of Safety and Reduces the Risk of Catastrophic Levee Failure	**Impact FC-5:** Change in Potential for Levee Failure on Project Islands during Seismic Events (LTS) **Mitigation:** No mitigation is required.

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR Impacts and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
Note: SU = Significant and unavoidable; LTS = Less than significant; LTS-M = Less than significant with mitigation; B = Beneficial.	

Summary of Changes, New Circumstances, and New Information

Changes in the affected environment, regulatory setting, and environmental effects of the Project related to flood control and levee stability are described in the Existing Conditions section below. A summary of findings based on that consideration follows. While there are new circumstances and new information affecting flood control and levee stability, these changes are minor and will not result in new significant effects or increase the severity of effects.

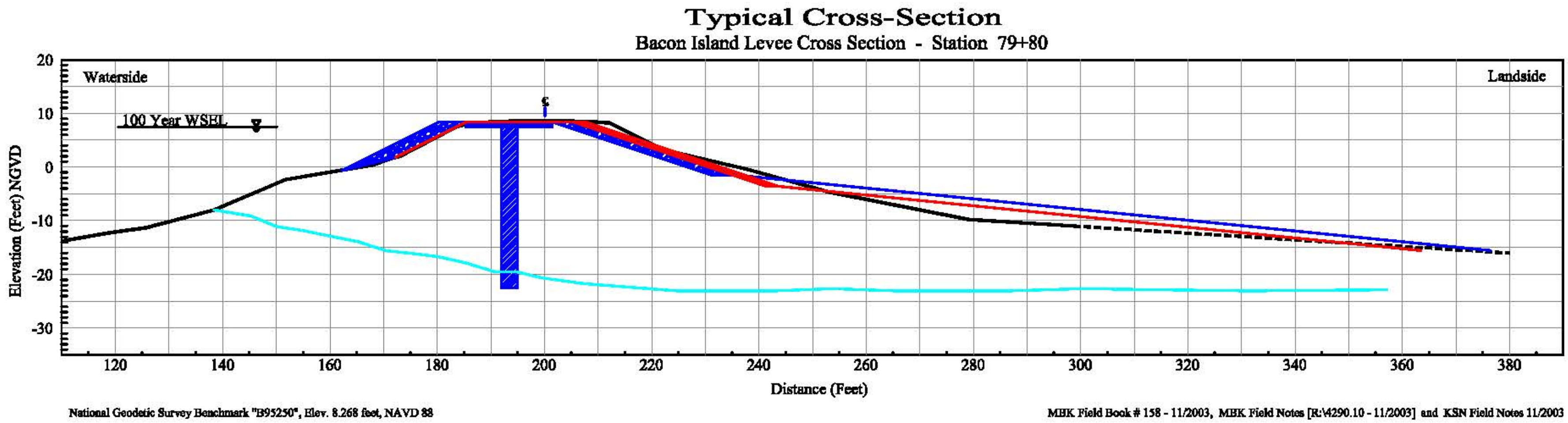
Substantial Changes in the Project

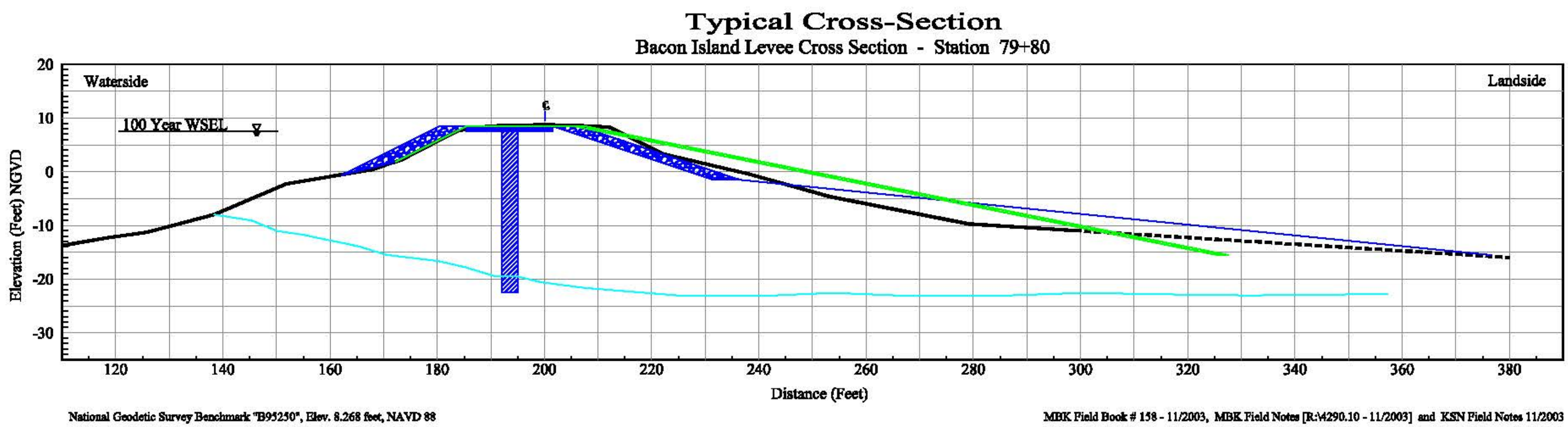
Since the 2001 FEIR and 2001 FEIS were completed, the levee design has been improved. Principally, the levee cross section has been increased, and new levee standards adopted to ensure consistency with the CALFED program. Additionally, the Seepage Monitoring Program has been updated to incorporate the changes recommended under Mitigation Measure RD-2 in the 2001 FEIR and 2001 FEIS. These changes are described below and in Chapter 2 and do not result in any changes in the severity of previously identified effects on flood control and levee stability.

Proposed Levee Design

The 2001 FEIR and 2001 FEIS included two distinct levee designs, one for the Reservoir Islands and one for the Habitat Islands. The Reservoir Islands were to be designed to PL84-99 geometry standards, while the Habitat Islands were to be designed to the DWR Bulletin 192-82 standards. Since the 2001 FEIR and 2001 FEIS, CALFED and DWR have adopted PL84-99 as the preferred design standard for Delta levees.

All four Project islands under all proposed implementation alternatives would be designed to meet or exceed PL84-99 levee geometry standards at the time of construction. (See Figure 4.3-1, “Proposed Reservoir Island Levee Design for Alternatives 1, 2, and 3”). Proposed levee elevations for Habitat and Reservoir Islands are based on the current hydraulic model used by local reclamation district engineers. Sea level rise is incorporated into on-going maintenance to provide adequate flood control. Maintenance activities will add material as necessary in response to actual sea-level rise rates over time. Future sea level rise





LEGEND

- BASE DESIGN
- 2009 DESIGN
- 2001 "BROKEN-SLOPE" DESIGN
- APPROXIMATE BASE OF EXISTING FILL
- 2001 "CONSTANT-SLOPE" DESIGN
- CORE TRENCH
- AGGREGATE BASE
- RIP-RAP

2009 Design Assumptions

1. Final levee crest elevation is 1.5' above 100-year flood elevation.
2. The waterside levee slope will be 2:1
3. The landside levee slope will be 3:1 on the upper end and 10:1 on the lower end. The 3:1 and 10:1 slopes intersect at 10 to 15 feet below the levee crest. Typical assumes 10 feet below levee crest.
4. The core trench will be 3' wide, excavated to 3' below the base of existing fill, and will be backfilled with low-permeability material.
5. Final crown width will be 26'. Assumes 16' for the levee crest plus 5' of riprap on either side.
6. 100-year flood elevation based on the USACE's 1992 report: "Sacramento-San Joaquin Delta, California, Special Study: Hydrology"

Figure 4.3-1
Proposed Reservoir Island Levee Design for Alternatives 1, 2, and 3

predictions are not included in water surface calculations used in development of the proposed levee design.

Reservoir Islands

The proposed Reservoir Island levee design includes a revetment-protected slough side slope (2:1) and in oversteepened areas a waterside notch to create a bench and flatter slope. The crest would be widened to 45 feet and be surfaced with an all-weather access road. The design also includes placement of fill and revetment on a 3:1 upper landside slope and a 10:1 lower toe berm slope that extends interior until it intersects the island surface to create a landside buttress. The 45-foot constructed crest width provides room for additional fill in anticipation of post-construction settling. The wider initial levee top width will allow future maintenance activities to place material to increase heights to accommodate anticipated settling and sea-level rise, while still providing minimum top widths and acceptable side slopes after the material placement. This design also includes the addition of a core trench to reduce through-levee seepage potential, increasing stability and safety. This proposed design is also similar to the geometric recommendations put forth in the 2009a Hultgren-Tillis report that investigated the levee stability of a “seismically repairable” levee, using Webb Tract for the analysis (Hultgren-Tillis Engineers 2009a). The seismically repairable geometry included similar crest width and side slopes and was found to perform well during large seismic events, allowing quick repairs and increased stability. Figure 4.3-1 also shows the previously proposed Reservoir Island levee designs, as described in the 2001 FEIR and 2001 FEIS, for comparison. Final levee design will be subject to engineering review.

Habitat Islands

Since the adoption of PL84-99 as the preferred standard for Delta levees, the habitat levee design based on the Bulletin 192-82 standard was reevaluated. The change resulting from the adoption of the PL84-99 standard was a slight decrease in overall height from the 2001 FEIR and 2001 FEIS design. In accordance with PL84-99 levee geometry standards, the new height provides 1.5 feet of freeboard above the 100-year water surface elevation and not the 300-year water surface elevation. In the Project area this change allows for approximately a 0.5-foot reduction in overall levee height from the proposed levee height in the 2001 FEIR and 2001 FEIS.

Depth of Impounded Water

The 2001 FEIR and 2001 FEIS analyzed the proposed impoundment of water to depths up to 6 feet (National Geodetic Vertical Datum of 1929 [NGVD 29]), which is a static datum and stable point of reference for this Project. The proposed operations of all Alternatives now will limit the maximum impoundment depth to depths not exceeding 4 feet (NGVD 29) on any of the Project islands.

NGVD 29 is the datum specified in the California Division of Safety of Dams (DSOD) regulations and is commonly used throughout the Delta. Each reservoir island currently has accurate benchmarks with elevation reported on the NGVD 29 datum. If needed in the future, this datum can be converted to another datum, but that will not change the allowable elevation of water in the reservoirs.

New Circumstances

Since the 2001 FEIR and 2001 FEIS was completed, there have been many additional studies in the Delta and events that call into question the long-term sustainability of flood control and levee stability in the Delta. Specifically, the Delta Risk Management Strategy (DRMS) (URS 2008) evaluated the potential for catastrophic levee failure, including failure of the levee on Jones Tract, and determined that "business as usual" practices are not sustainable in the Delta. Phase 1 of the DRMS project was completed in early 2009. Phase 2 of the DRMS project currently is evaluating long-term risk reduction options for the Delta and Suisun Marsh levees, but no discrete set of actions has yet been made available. Separately, the ISI considered potential for operational and maintenance changes to Project islands and several miles of levees throughout the Delta. The ISI results were summarized in the 2006 Supplemental Report (California Department of Water Resources 2006) which concluded that seepage models applied to estimate seepage rates at Webb Tract and Bacon Island were reasonable. It went further to identify riprap as the recommended slope protection against wind and wave action. The risk analysis concluded that annual failure probability and the expected dollar risk during the 50-year Project life are about 6 to 10 times greater under the existing conditions than for the proposed Project. Overall the proposed Project was considered to be technically feasible to safely design, construct, and operate.

Additionally, since the 2001 FEIR and 2001 FEIS was completed, CALFED and DWR adopted PL84-99 as the target levee standard for all Delta levees to achieve. This new circumstance slightly alters the guidance for levee construction design standards on the Habitat Islands.

While there are new circumstances affecting flood control and levee stability, these changes do not require major revisions to the previous analysis because there are no new significant impacts or increase in the severity of impacts.

New Information

There is no new information of substantial importance that would result in an increase in severity of effects on flood control and levee stability. The key sources of new information reviewed or used to prepare this section include:

- Integrated Storage Investigations, In-Delta Storage Program Draft Report on Engineering Investigations, CALFED Bay-Delta Program, May 2002 (CALFED Bay-Delta Program 2002a);
- Integrated Storage Investigations, In-Delta Storage Program Draft Summary Report, CALFED Bay-Delta Program, May 2002 (CALFED Bay-Delta Program 2002b);
- In-Delta Storage Program Final Draft Report on Risk Analysis, URS December 2001;
- In-Delta Storage Program Draft Report on Embankment Design Analysis, URS June 2003 (URS Corporation 2003a);
- In-Delta Storage Program Draft Report on Flooding Analysis, URS June 2003 (URS Corporation 2003b);
- In-Delta Storage Program Draft Report on Risk Analysis, URS June 2003 (URS Corporation 2003c);
- Preliminary Design Report, Reservoir Island Levees, Delta Wetlands Project, Sacramento–San Joaquin River Delta, Hultgren-Tillis Engineers, March 11, 2003;
- Geotechnical Evaluation, Sea Level Rise, Webb Tract Levees, Sacramento-San Joaquin Delta, Hultgren-Tillis Engineers, December 10, 2009(Hultgren-Tillis Engineers 2009a);
- Geotechnical Evaluation, Seismically Repairable Levee, Webb Tract, Sacramento–San Joaquin Delta, Hultgren-Tillis Engineers, December 30, 2009 (Hultgren-Tillis Engineers 2009b);
- In-Delta Storage Program Draft Report on Risk Analysis, URS May 31, 2005; and,
- 2006 Supplemental Report to the 2004 Draft State Feasibility Study In-Delta Storage Project, DWR May 2006.

Existing Conditions

This section discusses changes in the existing conditions or regulatory setting since the 2001 FEIR and 2001 FEIS.

Regulatory Setting

The regulatory setting has experienced little change since the completion of the 2001 FEIR and 2001 FEIS. The regulatory setting described in the 2001 FEIR and 2001 FEIS is included by reference. Updates or clarifications to regulations are summarized below.

Federal

U.S. Army Corps of Engineers

EC 1165-2-211

In July 2009, the Corps issued EC 1165-2-211, a water resource policy mandating that every Corps coastal activity influenced by tidal waters include potential relative sea-level change in the starting water surface elevation, where appropriate. To comply, projects must determine how sensitive plans and designs are to rates of future local mean sea-level change, how this sensitivity affects calculated risk, and what design or operations and maintenance measures should be implemented to minimize adverse consequences while maximizing beneficial effects.

The Project is not a Corps activity subject to EC 1165-2-211; however, the Project will include maintenance operations that will require placement of levee materials as necessary to maintain freeboard in response to actual sea-level rise rates.

ETL 1110-2-571

Post Hurricane Katrina investigations brought scrutiny to levee management practices throughout the United States, particularly within communities that rely upon levees to protect against flood waters and tidal surges. In response, in April 2009, the Corps issued ETL 1110-2-571, a levee management policy concerning landscape planting and vegetation management. This policy does not permit landscape planting to be incorporated into the design of flood damage reduction projects, where the safety of the structure may be compromised, or effective surveillance, monitoring, inspection, maintenance, and flood-fighting of the facility are adversely impacted. DW Project levees are not subject to Corps jurisdiction because they are not Corps levees or a flood damage reduction project; however, the surface treatments and landscaping plans generally will be consistent with the Corps's ETL guidance.

Levees meeting eligibility requirements for the PL84-99 program must comply with ETL 1110-2-571 or a vegetation variance adopted by the local Corps District and approved by headquarters. However, at this time, the Project applicant does not intend to participate in the PL84-99 program and therefore is not required to meet the ETL vegetation standards.

State

California Division of Safety of Dams

The DSOD has oversight and approval authority for structures that are considered dams under the Water Code. Some levees are "dams" as defined by California Water Code section 6002, and as such, are required to meet DSOD's standards and design review requirements. Dams under DSOD jurisdiction are artificial barriers that are at least 25 feet high or have an impounding capacity of at least 50 acre feet.

However, Water Code section 6004(c) specifically excludes structures in the Sacramento-San Joaquin Delta "…if the maximum possible water storage elevation of the impounded water does not exceed four feet above mean sea level, as established by the United States Geological Survey 1929 Datum." Since the Project design has incorporated operational controls to limit the depth of storage below DSOD jurisdictional levels, DSOD oversight is not applicable for the alternatives analyzed below. Rising sea level is not considered in the current DSOD regulations.

Central Valley Flood Protection Board Encroachment Permit

The Central Valley Flood Protection Board (CVFPB) Encroachment Permit (formerly The Reclamation Board) requires an encroachment permit for any non-federal activity along or near federal flood damage reduction project levees and floodways or in CVFPB-designated floodways to ensure that proposed local actions or projects do not impair the integrity of existing flood damage reduction systems to withstand flood conditions. The permits are conditioned upon receipt of permission from the Corps for alteration of the federal project works pursuant to Section 408. The Project will not require a CVFPB Encroachment Permit, as the DW Project levees are not federal flood damage reduction project levees.

Local

Bacon and Bouldin Islands are located in San Joaquin County, and Webb and Holland Tracts are located in Contra Costa County. The local regulations established by San Joaquin and Contra Costa Counties that pertain to the islands that fall within their respective boundaries are described below.

Contra Costa County General Plan Safety Element

This element requires, in part, that flood protection levees protecting areas of intensive urban and suburban development meet the standards of the U.S. Army Corps of Engineers while protecting the beneficial uses of the Delta and its water. Geologic and engineering investigations are a prerequisite to construction of public and private facilities in affected areas. The safety element includes goals to ensure public safety by directing development away from flood-prone areas and to mitigate risk related to flood hazards and subsidence.

DW's Project levees do not provide flood protection for areas of intensive urban and suburban development, they will undergo extensive engineering review including seismic analyses similar to those completed for Webb Tract (Hultgren-Tillis 2009), through operation they will help to slow oxidation processes that are linked to subsidence, and accordingly the Safety Element does not apply to the Project.

San Joaquin County General Plan Safety Element

The San Joaquin County General Plan flood hazard section includes discussion of ordinance requirements for development in the 100-year flood zone. The Proposed Project does not include development that is restricted by ordinance.

San Joaquin County Department of Engineering is responsible for the review and design of storm drainage requirements in the unincorporated county area, while city engineering departments review projects within their separate jurisdictions. Coordination between the various agencies and governmental departments concerned with flood control and storm drainage systems occurs during project reviews.

The proposed Project final design and construction documents are subject to engineering review and will be required to meet the guidance of the general plan safety element for portions of the Project within San Joaquin County.

Affected Environment

Flood control and levee stability conditions are, for the most part, as they were presented in the 2001 FEIR and 2001 FEIS and are hereby incorporated by reference and summarized below. The only change to the Project that affects flood control and levee stability is the proposed design of the improved levees associated with implementation of the Project, the proposed depth of impounded water, and the alteration of the Seepage Monitoring Program and Seepage Performance Standards.

The Project applicant proposes to improve the levees surrounding the Project islands. Under existing conditions, levee conditions vary greatly. A typical present levee condition is a 20-foot-wide crest at an approximate elevation of +8.5 feet above mean sea level with an exterior (water-side) slope of 2:1 (horizontal to vertical) and an interior (land-side) slope of 4:1.

Under the Proposed Project in the 2001 FEIR and 2001 FEIS, a typical improved levee would have an exterior slope of 2:1, a crest about 26 feet wide (including the thickness of erosion protection) at an elevation providing 1.5 feet of freeboard above the 100-year flood elevation, and a 3:1 initial interior slope transitioning to 10:1 approximately 10 to 15 feet below the crest elevation, creating a wide landside toe. The new slopes would meet or exceed PL84-99 standards. This design is similar to what is now proposed; however, the new proposed design for Reservoir Island Levees includes a greater crest width of 45 feet. This creates a larger and more stable levee than that proposed in 2001.

Levee-improvement materials would be obtained primarily from sand deposits on the Project islands. Each borrow area generally would be located more than 400 feet inward from the toe of a levee so that the borrow excavation would not cause structural impacts on the levee and would be at least 2,000 feet inward from the final toe of an improved levee where a greater setback is necessary to control seepage.

The interior slopes of these perimeter levees would be protected from erosion by conventional rock revetment similar to that used on existing exterior slopes. In areas where final design studies indicate that wave splash and run-up potentially could erode the levee crest if it is unprotected, the levee crest would be hardened or the erosion-protection facing would be extended up as a splash berm.

The Project applicant would implement a seepage monitoring program to provide early detection of seepage problems caused by Project operations. A network of wells (i.e., piezometers) located immediately across the channels from the reservoir islands would be used to monitor seepage; background wells at distant locations would establish water-level changes that typically occur without Project operations. The Project applicant has proposed seepage performance standards for the Project that would be used to determine the amount of interceptor-well pumping needed to ensure that seepage is reduced to acceptable levels.

Environmental Commitments

Since publication of the 2000 RDEIR/EIS, the following environmental commitments related to flood control and levee stability have been added to the Project description. These environmental commitments are described in detail in Chapter 2.

Prior Agreement with East Bay Municipal Utility District

The Settlement Agreement between the East Bay Municipal Utility District (EBMUD) and the Project applicant, signed on September 13, 2000, stipulates that a Reservoir Island design review board will serve as an oversight committee for the Reservoir Islands while construction is ongoing. A Reservoir Island monitoring and action board will serve as a technical review committee for operations of the Reservoir Islands and for enforcing the implementation of the Project Seepage Control Plan.

Improved Reservoir Island Levee Design

Based on the recommendations by Hultgren-Tillis Engineers contained in the 2003 document, "Preliminary Design Report: Reservoir Island Levees, Delta Wetlands Project," the proposed Reservoir Island levee design has been improved to provide increased stability and reduced through-levee seepage potential, as described above under "Proposed Levee Design." This improved levee design is considered an environmental commitment.

Seepage Monitoring and Control System

The Seepage Monitoring Program, which was developed to avoid seepage issues and to provide early detection of seepage problems caused by the Project, has been updated to incorporate the changes recommended under Mitigation Measure RD-2 in the 2001 FEIR and 2001 FEIS. The Project applicant has now committed to this program as an environmental commitment. The changes to the Seepage Monitoring Program are as follows:

- Locate the background monitoring wells at least 1,000 feet from the nearest seepage monitoring wells.
- Use more than one background monitoring well for each row of seepage monitoring wells.
- Use at least 1 year of data to establish reference water levels in all the background monitoring wells and in at least half of the seepage monitoring wells.
- Reevaluate seepage performance standards 2, 5, and 10 years after reservoir operations begin and then every 10 years.

The Seepage Monitoring Program is described in further detail in Chapter 2 of this document under Project Environmental Commitments.

Environmental Effects

Methods and Significance Criteria

The analytical approach, impact mechanisms, and significance criteria remain as presented in the 2001 FEIR and 2001 FEIS and are hereby incorporated by reference.

The flood control and levee stability impact analysis considered several criteria for determining the significance of impacts related to this resource. The analysis took into account both relevant criteria contained in Appendix G of the State CEQA Guidelines (Association of Environmental Professionals 2009) and Project-specific criteria developed by the lead agency to address potential impacts unique to the Project's location and elements.

An alternative is considered to have a significant impact on flood control and levee stability if it would:

- substantially decrease levee stability on the Project islands during Project construction;
- substantially induce additional seepage on adjacent islands when compared to No-Project conditions;
- substantially decrease regional supplies of levee material;
- substantially decrease long-term levee stability on the Project islands below long-term stability under existing conditions; or
- substantially increase risk of cumulative levee failure and flooding in the Project vicinity.

Impacts and Mitigation Measures

The impacts on flood control and levee stability resulting from implementation of the Project were described in detail in the 2001 FEIR and 2001 FEIS and are summarized briefly in Table 4.3-1. Where there have been no changes to the impact analysis, the 2001 FEIR and 2001 FEIS is incorporated by reference. Changes in the levee design for habitat and Reservoir Islands—necessitate updating the impact analysis. These changes result in no new significant environmental effects or a substantial increase in the severity of previously identified significant effects on flood control and levee stability.

Proposed Project (Alternative 2)

With the exception of reduced water storage depths and improved Reservoir Island levee design as described above, the Proposed Project (Alternative 2) remains largely as it was presented in the 2001 FEIR and 2001 FEIS.

Alternative 2 involves storage of water on Bacon Island and Webb Tract (Reservoir Islands) and management of Bouldin Island and Holland Tract (Habitat Islands) primarily for wetlands and wildlife habitat. The Reservoir Islands would be managed primarily for water storage, with wildlife habitat and recreation constituting secondary uses.

Impact FC-1: Improvement in Long-Term Levee Stability on Reservoir Islands

The proposed levee design includes improved side slopes, erosion countermeasures (revetment), seepage reduction measures, and overall mass to improve stability over existing conditions and provide adequate flood control characteristics. Both reservoir and habitat levees would be reconstructed (i.e., improved) to geometries that meet or exceed PL84-99 standards. Both Reservoir and Habitat Islands would be maintained to address settlement and sea-level rise.

However, implementation of the improved levee design would reduce this impact to a less-than-significant level.

Mitigation
No mitigation is required.

Impact FC-2: Potential for Seepage from Reservoir Islands to Adjacent Islands

Implementation of Alternative 2 could increase the potential for seepage beneath the Reservoir Island levees to adjacent islands during Project operation by increasing the hydraulic head between Reservoir Islands and adjacent islands during periods of storage. This impact is considered significant. However, implementation of the Seepage Monitoring and Control System to determine seepage flow rates, collect excess seepage, and maintain acceptable seepage rates and quantities over the life of the Project, as described in Chapter 2 of this document under Project Environmental Commitments, would reduce this impact to a less-than-significant level.

Mitigation
No mitigation is required.

Impact FC-3: Potential for Wind and Wave Erosion on Reservoir Islands

The proposed levee design considered wind and wave erosion. Levee heights are recommended to accommodate expected wave heights, and revetment designs are determined to dissipate wave energy and counteract erosive forces. This impact is less than significant.

Mitigation
No mitigation is required.

Impact FC-4: Potential for Erosion of Levee Toe Berms at Pump Stations and Siphon Stations on Reservoir Islands

The potential for erosion of levee toe berms at pump stations and siphon stations on Reservoir Islands was presented in the 2001 FEIR and 2001 FEIS as Impact D-4. The 2001 FEIR and 2001 FEIS concluded that this impact is less than significant. The current Reservoir Island levee design would further reduce erosion potential through placement of revetment and erosion countermeasures that are typical for Delta islands and easily maintainable over the life of the Project. This impact remains less than significant.

Mitigation
No mitigation is required.

Impact FC-5: Change in Potential for Levee Failure on Project Islands during Seismic Activity

The proposed design for all DW Project levees would meet or exceed PL84-99 levee geometry criteria creating a wide and more stable levee mass that exceeds the existing levee geometry on any of the Project islands. The proposed design would undergo necessary engineering review required by County planning agencies and the environmental commitments described above; thus, it would provide a more stable levee than would exist without the implementation of the Project. The Project therefore would reduce the potential for levee failure on Project islands during seismic activity as described in the 2009 Hultgren-Tillis report. This impact is considered less than significant.

Mitigation
No mitigation is required.

Impact FC-6: Increase in Long-Term Levee Stability on Habitat Islands

The proposed Habitat Island levee design includes side slopes, erosion countermeasures (revetment), seepage reduction measures, and overall mass to improve stability over existing conditions and provide adequate flood control characteristics. This design would create a larger levee than currently exists and would provide for long term stability through its size, shallow slopes, and improved erosion countermeasures. Habitat Island levees would be constructed to meet PL84-99 geometry and maintained to address settlement and sea-level rise. This impact is considered beneficial and less than significant.

Mitigation
No mitigation is required.

Alternative 1

With the exception of reduced water storage depths and improved Reservoir Island levee design as described above, Alternative 1 remains largely as it was presented in the 2001 FEIR and 2001 FEIS.

Alternative 1 involves storage of water on Bacon Island and Webb Tract (Reservoir Islands) and management of Bouldin Island and Holland Tract (Habitat Islands) primarily for wetlands and wildlife habitat. The Reservoir Islands would be managed primarily for water storage, with wildlife habitat and recreation constituting secondary uses.

Impacts on flood control and levee stability and mitigation measures of Alternative 1 are the same as those of Alternative 2, as described above. Alternative 1 varies in description from Alternative 2 only by the operational period.

Alternative 3

With the exception of reduced water storage depths and improved Reservoir Island levee design as described above, Alternative 3 remains largely as it was presented in the 2001 FEIR and 2001 FEIS and the associated impacts and mitigation measures are summarized below.

Alternative 3 involves storage of water on Bacon Island, Webb Tract, Bouldin Island, and Holland Tract, with secondary uses for wildlife habitat and recreation. The portion of Bouldin Island north of SR 12 would be managed as a wildlife habitat area and would not be used for water storage. Impacts on flood control and levee stability and mitigation measures of Alternative 3 are the same as those of Alternative 1.

Impact FC-1: Change in Long-Term Levee Stability on Reservoir Islands

This impact is described above under Alternative 2. This impact is considered less than significant.

Mitigation

No mitigation is required.

Impact FC-2: Potential for Seepage from Reservoir Islands to Adjacent Islands

This impact is described above under Impact Alternative 2. This impact is considered significant. However, implementation of the Seepage Monitoring and Control System to determine seepage flow rates, collect excess seepage, and maintain acceptable seepage rates and quantities over the life of the Project, as described in Chapter 2 of this document under Project Environmental Commitments, would reduce this impact to a less-than-significant level.

Mitigation

No mitigation is required.

Impact FC-3: Potential for Wind and Wave Erosion on Reservoir Islands

This impact is described above under Alternative 2. This impact is considered less than significant.

Mitigation

No mitigation is required.

Impact FC-4: Potential for Erosion of Levee Toe Berms at Pump Stations and Siphon Stations on Reservoir Islands

This impact is described above under Alternative 2. This impact is considered less than significant.

Mitigation

No mitigation is required.

Impact FC-5: Change in Potential for Levee Failure on Project Islands during Seismic Activity

This impact is described above under Alternative 2. This impact is considered less than significant.

Mitigation

No mitigation is required.

No-Project Alternative

The No-Project Alternative remains as it was presented in the 2001 FEIR and 2001 FEIS and is hereby incorporated by reference and briefly summarized below.

Decrease in Long-Term Levee Stability, Increase in Potential for Seepage onto Project Islands, and Increase in Potential for Levee Failure during Seismic Activity

Under the No-Project Alternative, the DW Project levees would continue to be maintained as agriculture levees. Levee geometries (width, side slope, and height) would remain at current levels, with fill placed to repair storm-related damage and material placed to maintain appropriate heights to offset levee settlement and sea-level rise. Hultgren-Tillis' 2009a report, *Geotechnical Evaluation: Sea Level Rise, Webb Tract Levees*, confirms that the existing safety and reliability of the DW Project levees can be maintained with rising sea level by raising the levee crest and providing a broader toe berm (Hultgren-Tillis Engineers 2009b). Maintenance practices would continue at their current levels as the local reclamation districts strive to achieve the adopted PL84-99 standard as the preferred Delta island levee geometry with limited resources.

In anticipation of a potential project, agricultural activities have been reduced over time. The No-Project Alternative would see a return to historical intense agricultural activity on each of the islands. High levels of agricultural land use would return the area to higher levels of subsidence through oxidation of peat soils. This subsidence would increase the hydrostatic pressure on the island levees, increasing the risk of wet weather and dry weather levee seepage problems typical of all Delta islands.

Implementing the No-Project Alternative would provide less flood control benefit and decreased levee stability through greater potential subsidence and greater potential hydrostatic pressure.

Section 4.4
Utilities, Public Services, and Highways

Introduction

This section describes recent changes to the existing environmental conditions and regulatory setting of the Project area, summarizes the unchanged affected environment, and describes changed environmental effects related to utilities, public services, and highways for the Project. This section contains a review and update of the 2000 RDEIR/EIS utilities, public services, and highways impact assessment, incorporated by reference in the 2001 FEIR. The utilities, public services, and highways impacts of the Project were analyzed most recently in the 2001 FEIS, which also served as a basis for this analysis.

The 2001 FEIR and 2001 FEIS concluded that the Project alternatives would affect utilities, public services, highways, and ferry service operations. Since 2001, there have been changes in the Project and the affected environmental setting that either do not alter the conclusions in the 2001 FEIR and 2001 FEIS or result in a decrease in the significance of some of the previously identified impacts on utilities, and the elimination of associated mitigation measures.

Identification of the Project's specific places of use as part of the affected Project environment does not affect utilities, public services, highways and ferry service in any way that alters the conclusions of the 2001 FEIR and 2001 FEIS. The Project would not have any direct effects on utilities, public services, highways, and ferry service in the places of use; the effects on utilities, public services, highways, and ferry service, if any, associated with the provision of Project water to the places of use are addressed in Chapter 5, "Cumulative Impacts," and Chapter 6, "Growth-Inducing Impacts."

Summary of Impacts

Table 4.4-1 provides a summary and comparison of the impacts and mitigation measures from the 2001 FEIR, 2001 FEIS, and this Place of Use EIR for utilities, public services, and highways.

Table 4.4-1. Comparison between Delta Wetlands Project 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures for Utilities and Highways

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
ALTERNATIVES 1 AND 2	
Impact E-1: Increase in the Structural Integrity of County Roads (B) **Mitigation:** No mitigation is required.	**Impact UT-1:** Increase in the Structural Integrity of County Roads (B and LTS) **Mitigation:** No mitigation is required. No change.
Impact E-2: Reduction in Ferry Traffic from Jersey Island to Webb Tract (LTS) **Mitigation:** No mitigation is required.	**Impact UT-2:** Reduction in Ferry Traffic from Jersey Island to Webb Tract (LTS) **Mitigation:** No mitigation is required. No change.
Impact E-3: Increase in the Risk to Gas Lines Crossing Exterior Levees on Bacon Island Resulting from Levee Improvements (LTS-M) **Mitigation Measure RE-1:** Monitor Locations Where Gas Pipelines Cross Bacon Island Levees during and after Levee Construction; and **Mitigation Measure RE-2:** Implement Corrective Measures to Reduce Risk of Pipeline Failure during Levee Construction	**Impact UT-3:** Increase in the Risk to Gas Lines Crossing Exterior Levees on Bacon Island Resulting from Levee Improvements (LTS) No mitigation required, but the following will monitor Project measures: **Mitigation Measure UT-MM-1:** Monitor Locations Where Gas Pipelines Cross Bacon Island Levees during and after Levee Construction As part of the 2006 Delta Wetlands Properties and PG&E settlement agreement (Delta Wetlands 2006), it is stipulated that: • If future levee embankment construction for the Project creates stress on the Line 57B pipeline that is significantly greater than the stress on the pipeline caused by the current levee, the Project Proponent (DW) will pay for the design and construction of an engineering solution to reinforce, replace, or relocate the Line 57B eastern levee crossing on Bacon Island before water is diverted for storage onto Bacon Island; the Line 57B pipeline at the western levee embankment will be replaced and that the cost of the design, permitting, materials and construction of the new replacement pipeline will be shared by PG&E and the Project; and • The Project will compensate PG&E for any loss or damage to Line 57C caused by the conversion of Bacon Island into a water storage reservoir. Implementation of these measures would prevent damage to the gas pipeline from increased bending or shear loads at levee crossings during levee construction and settlement. Therefore, this impact is considered less than significant. However, Mitigation

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
	Measure UT-MM-1 would monitor the effectiveness of the corrective measures implemented as part of the settlement agreement. Mitigation Measure RE-2 is no longer applicable.
Impact E-4: Increase in PG&E Response Time to Repair a Gas Line Failure on Bacon Island (No significance conclusion) *This potential impact is economic in nature. Because economic effects are not considered environmental impacts under CEQA and NEPA, no significance conclusion is made and no mitigation is identified.*	**Impact UT-4:** Increase in PG&E Response Time to Repair a Gas Line Failure on Bacon Island (LTS) Since 2001, PG&E has installed Line 57C, which reduces the impact of the increased response time to a less-than-significant level, and no mitigation is required.
Impact RE-1: Increase in the Risk to Line 57A from Island Inundation (LTS-M) **Mitigation Measure RE-3:** Securely Anchor Line 57A before Bacon Island Flooding	PG&E has abandoned the portion of Line 57A across Bacon Island. The Project would remove the portion of Line 57A under Bacon Island Road prior to Reservoir Island construction. Therefore, this is no longer an impact and no mitigation is required.
Impact RE-2: Potential Interference with Pipeline Inspection Procedures (LTS-M) **Mitigation Measure RE-4:** Provide Adequate Facilities on Bacon Island for Annual Pipeline Inspection; and **Mitigation Measure RE-5:** Relocate Cathodic Protection Test Stations before Bacon Island Flooding	**Impact UT-5:** Potential Interference with Pipeline Inspection Procedures (LTS) **Mitigation:** No mitigation is required As part of the 2006 Delta Wetlands Properties and PG&E settlement agreement (Delta Wetlands 2006), it is stipulated that: • Before water is diverted to storage on Bacon Island, the Project applicant will provide mutually acceptable facilities on the island for PG&E's annual inspection of Lines 57B and 57C; • The Project will provide a ramp and turnaround facilities to launch a boat for regular inspections; provide a suitable staging area for materials and equipment necessary for gas pipeline repairs; and install an elevated access roadway adjacent to Lines 57B and 57C; • Before water is diverted to storage on Bacon Island, the Project will, at its expense, relocate Line 57B cathodic protection test stations on Bacon Island to a mutually acceptable location; and • PG&E will consult with the Project on the design, siting and construction of the test stations if they are to be located on the Project applicant's property, and the Project will provide PG&E access to the stations. These measures, and the addition of Line 57C, will ensure that the Project does not interfere with PG&E's annual pipeline operation, inspection, and maintenance procedures. Therefore, this impact is considered less than significant and no mitigation is required.

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
Impact E-5: Inundation of Electrical Distribution Utilities on the Reservoir Islands (LTS-M) **Mitigation Measure E-1:** Relocate Electrical Distribution Lines to the Perimeter Levee around Webb Tract	**Impact UT-6:** Inundation of Electrical Distribution Utilities on the Reservoir Islands (LTS-M) **Mitigation Measure UT-MM-2:** Relocate Electrical Distribution Lines to the Perimeter Levee around Webb Tract No change.
Impact E-6: Possible Need to Increase Capacity of the Existing Electrical Distribution Lines on the Project Islands (LTS) **Mitigation:** No mitigation is required.	**Impact UT-7:** Possible Need to Increase Capacity of the Existing Electrical Distribution Lines on the Project Islands (LTS) **Mitigation:** No mitigation is required. No change.
Impact E-7: Possible Need to Expand the Existing Electrical Distribution Lines on Webb Tract, Bouldin Island, and Holland Tract to Serve a Proposed Siphon Station and Recreation Facilities (LTS-M) **Mitigation Measure E-2:** Extend Electrical Distribution Lines to Serve New Siphon and Pump Stations and Recreation Facilities	**Impact UT-8:** Possible Need to Expand the Existing Electrical Distribution Lines on Webb Tract, Bouldin Island, and Holland Tract to Serve a Proposed Siphon Station and Recreation Facilities (LTS-M) **Mitigation Measure UT-MM-3:** Extend Electrical Distribution Lines to Serve New Siphon and Pump Stations and Recreation Facilities No change.
Impact E-8: Increase in Demand for Police Services on the Project Islands (LTS-M) **Mitigation Measure E-3:** Provide Adequate Lighting in and around Buildings, Walkways, Parking Areas, and Boat Berths **Mitigation Measure E-4:** Provide Private Security Services for Recreation Facilities and Boat Docks	**Impact UT-9:** Increase in Demand for Police Services on the Project Islands (LTS-M) **Mitigation Measure UT-MM-4:** Provide Adequate Lighting in and around Buildings, Walkways, Parking Areas, and Boat Berths **Mitigation Measure UT-MM-5:** Provide Private Security Services for Recreation Facilities and Boat Docks **Mitigation Measure REC-MM-1:** Reduce the Size or Number of Recreation Facilities
Impact E-9: Increase in Demand for Fire Protection Services on the Project Islands (LTS-M) **Mitigation Measure E-5:** Incorporate Fire Protection Features into Recreation Facility Design **Mitigation Measure E-6:** Provide Fire Protection Services to Webb Tract and Bacon Island.	**Impact UT-10:** Increase in Demand for Fire Protection Services on the Project Islands (LTS-M) **Mitigation Measure UT-MM-6:** Incorporate Fire Protection Features into Recreation Facility Design **Mitigation Measure UT-MM-7:** Provide Fire Protection Services to Webb Tract and Bacon Island No change.

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
Impact E-10: Increase in Demand for Water Supply Services (LTS) Measures that would minimize the effects of this impact have been incorporated into the Project description. However, implementing the following would monitor the effectiveness of those measures: **Mitigation Measure E-7:** Obtain Appropriate Local and State Permits for Recreation Facility Services and Utilities	**Impact UT-11:** Increase in Demand for Water Supply Services (LTS) No mitigation required, but the following will monitor Project measures: **Mitigation Measure UT-MM-8:** Obtain Appropriate Local and State Permits for Recreation Facility Services and Utilities No change.
Impact E-11: Increase in Demand for Sewage Disposal Services (LTS) Measures that would minimize the effects of this impact have been incorporated into the Project description. However, implementing the following would monitor the effectiveness of those measures: **Mitigation Measure E-7:** Obtain Appropriate Local and State Permits for Recreation Facility Services and Utilities	**Impact UT-12:** Increase in Demand for Sewage Disposal Services (LTS) No mitigation required, but the following will monitor Project measures: **Mitigation Measure UT-MM-8:** Obtain Appropriate Local and State Permits for Recreation Facility Services and Utilities No change.
Impact E-12: Increase in Demand for Solid Waste Removal (LTS) Measures that would minimize the effects of this impact have been incorporated into the Project description. However, implementing the following would monitor the effectiveness of those measures: **Mitigation Measure E-7:** Obtain Appropriate Local and State Permits for Recreation Facility Services and Utilities	**Impact UT-13:** Increase in Demand for Solid Waste Removal (LTS) No mitigation required, but the following will monitor Project measures: **Mitigation Measure UT-MM-8:** Obtain Appropriate Local and State Permits for Recreation Facility Services and Utilities No change.
ALTERNATIVE 3	
Impact E-13: Increase in the Structural Integrity of County Roads (B) **Mitigation:** No mitigation is required.	**Impact UT-1:** Increase in the Structural Integrity of County Roads (B and LTS) **Mitigation:** No mitigation is required No change.
Impact E-14: Increase in the Risk of Structural Failure of SR12 (LTS) Measures that would minimize the effects of this impact have been incorporated into the Project description. However, implementing the following would monitor the effectiveness of those measures: **Mitigation Measure E-8:** Coordinate Design and Construction of Wilkerson Dam with Caltrans and DSOD	**Impact UT-14:** Increase in the Risk of Structural Failure of SR 12 (LTS) No mitigation required, but the following will monitor Project measures: **Mitigation Measure UT-MM-9:** Coordinate Design and Construction of Wilkerson Dam with Caltrans No change.
Impact E-15: Increase in the Fog Hazard on SR12 (SU) **Mitigation:** No mitigation is available.	**Impact UT-15:** Increase in the Fog Hazard on SR 12 (SU) **Mitigation:** No mitigation is available No change.

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
Impact E-16: Reduction in Ferry Traffic from Jersey Island to Webb Tract (LTS) **Mitigation:** No mitigation is required.	**Impact UT-2:** Reduction in Ferry Traffic from Jersey Island to Webb Tract (LTS) **Mitigation:** No mitigation is required No change.
Impact E-17: Increase in the Risk to Gas Lines Crossing Exterior Levees on Bacon Island Resulting from Levee Improvements (LTS-M) *This impact is the same as Impact E-3* Mitigation Measures RE-1 and RE-2 would reduce this impact to a less-than-significant level. **Mitigation Measure RE-1:** Monitor Locations Where Gas Pipelines Cross Bacon Island Levees during and after Levee Construction; and **Mitigation Measure RE-2:** Implement Corrective Measures to Reduce Risk of Pipeline Failure during Levee Construction	**Impact UT-3:** Increase in the Risk to Gas Lines Crossing Exterior Levees on Bacon Island Resulting from Levee Improvements (LTS) No mitigation required, but the following will monitor Project measures: **Mitigation Measure UT-MM-1:** Monitor Locations Where Gas Pipelines Cross Bacon Island Levees during and after Levee Construction Implementation of these corrective measures in the 2006 Delta Wetlands Properties and PG&E settlement agreement (discussed above for Impact E-3) would prevent damage to the gas pipeline from increased bending or shear loads at levee crossings during levee construction and settlement. Therefore, this impact is considered less than significant. However, Mitigation Measure RE-1 would monitor the effectiveness of the corrective measures implemented as part of the settlement agreement. Mitigation Measure RE-2 is no longer applicable.
Impact E-18: Increase in PG&E Response Time to Repair a Gas Line Failure on Bacon Island (No significance conclusion) *This impact is the same as Impact E-4.* *This potential impact is economic in nature. Because economic effects are not considered environmental impacts under CEQA and NEPA, no significance conclusion is made and no mitigation is identified.*	**Impact UT-4:** Increase in PG&E Response Time to Repair a Gas Line Failure on Bacon Island (LTS) Since 2001, PG&E installed Line 57C, which reduces the impact of the increased response time to a less-than-significant level and no mitigation is required.
Impact RE-3: Increase in the Risk of Line 57A from Island Inundation (LTS-M) **Mitigation Measure RE-3:** Securely Anchor Line 57A before Bacon Island Flooding	PG&E has abandoned the portion of Line 57A across Bacon Island. Therefore, this is no longer an impact and no mitigation is required.

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
Impact RE-4: Potential Interference with Pipeline Inspection Procedures (LTS-M) **Mitigation Measure RE-4:** Provide Adequate Facilities on Bacon Island for Annual Pipeline Inspection **Mitigation Measure RE-5:** Relocate Cathodic Protection Test Stations before Bacon Island Flooding	**Impact UT-5:** Potential Interference with Pipeline Inspection Procedures (LTS) **Mitigation:** No mitigation is required As part of the 2006 DW Properties and PG&E settlement agreement (Delta Wetlands 2006), it is stipulated that: • Before water is diverted to storage on Bacon Island, the Project will provide mutually acceptable facilities on the island for PG&E's annual inspection of Lines 57B and 57C; • The Project will provide a ramp and turnaround facilities to launch a boat for regular inspections; provide a suitable staging area for materials and equipment necessary for gas pipeline repairs; and install an elevated access roadway adjacent to Lines 57B and 57C; • Before water is diverted to storage on Bacon Island, PG&E will, at its expense, relocate Line 57B cathodic protection test stations on Bacon Island to a mutually acceptable location; and • PG&E will consult with the Project on the design, siting and construction of the test stations if they are to be located on the Project applicant's property, and the Project will provide PG&E access to the stations. These measures and the addition of Line 57C will ensure that the Project does not interfere with PG&E's annual pipeline operation, inspection, and maintenance procedures. Therefore, this impact is considered less than significant, and no mitigation is required.
Impact E-19: Inundation of Electrical Distribution Utilities on the Reservoir Islands (LTS-M) **Mitigation Measure E-9:** Relocate Electrical Distribution Lines to the Perimeter Levees around Webb and Holland Tracts and Bouldin Island	**Impact UT-6:** Inundation of Electrical Distribution Utilities on the Reservoir Islands (LTS-M) **Mitigation Measure UT-MM-10:** Relocate Electrical Distribution Lines to the Perimeter Levees around Webb and Holland Tracts and Bouldin Island No change.
Impact E-20: Possible Need to Increase Capacity of the Existing Electrical Distribution Lines on the Reservoir Islands (LTS) **Mitigation:** No mitigation is required.	**Impact UT-7:** Possible Need to Increase Capacity of the Existing Electrical Distribution Lines on the Reservoir Islands (LTS) **Mitigation:** No mitigation is required No change.

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
Impact E-21: Possible Need to Expand the Existing Electrical Distribution Lines on Webb Tract, Bouldin Island, and Holland Tract to Serve Proposed Siphon and Pump Stations and Recreation Facilities (LTS-M) **Mitigation Measure E-2:** Extend Electrical Distribution Lines to Serve New Siphon and Pump Stations and Recreation Facilities	**Impact UT-8:** Possible Need to Expand the Existing Electrical Distribution Lines on Webb Tract, Bouldin Island, and Holland Tract to Serve Proposed Siphon and Pump Stations and Recreation Facilities (LTS-M) **Mitigation Measure UT-MM-3:** Extend Electrical Distribution Lines to Serve New Siphon and Pump Stations and Recreation Facilities No change.
Impact E-22: Increase in Demand for Police Services on Project Islands (LTS-M) **Mitigation Measure E-3:** Provide Adequate Lighting in and around Buildings, Walkways, Parking Areas, and Boat Berths **Mitigation Measure E-4:** Provide Private Security Services for Recreation Facilities and Boat Docks	**Impact UT-9:** Increase in Demand for Police Services on the Project Islands (LTS-M) **Mitigation Measure UT-MM-4:** Provide Adequate Lighting in and around Buildings, Walkways, Parking Areas, and Boat Berths **Mitigation Measure UT-MM-5:** Provide Private Security Services for Recreation Facilities and Boat Docks **Mitigation Measure REC-MM-1:** Reduce the Size or Number of Recreation Facilities
Impact E-23: Increase in Demand for Fire Protection Services on the Project Islands (LTS-M) **Mitigation Measure E-5:** Incorporate Fire Protection Features into Recreation Facility Design **Mitigation Measure E-6:** Provide Fire Protection Services to Webb Tract and Bacon Island	**Impact UT-10:** Increase in Demand for Fire Protection Services on the Project Islands (LTS-M) **Mitigation Measure UT-MM-6:** Incorporate Fire Protection Features into Recreation Facility Design **Mitigation Measure UT-MM-7:** Provide Fire Protection Services to Webb Tract and Bacon Island No change.
Impact E-24: Increase in Demand for Water Supply Services (LTS) Measures that would minimize the effects of this impact have been incorporated into the Project description. However, implementing the following would monitor the effectiveness of those measures: **Mitigation Measure E-7:** Obtain Appropriate Local and State Permits for Recreation Facility Services and Utilities	**Impact UT-11:** Increase in Demand for Water Supply Services (LTS) No mitigation required, but the following will monitor Project measures: **Mitigation Measure UT-MM-8:** Obtain Appropriate Local and State Permits for Recreation Facility Services and Utilities No change.
Impact E-25: Increase in Demand for Sewage Disposal Services (LTS) Measures that would minimize the effects of this impact have been incorporated into the Project description. However, implementing the following would monitor the effectiveness of those measures: **Mitigation Measure E-7:** Obtain Appropriate Local and State Permits for Recreation Facility Services and Utilities	**Impact UT-12:** Increase in Demand for Sewage Disposal Services (LTS) No mitigation required, but the following will monitor Project measures: **Mitigation Measure UT-MM-8:** Obtain Appropriate Local and State Permits for Recreation Facility Services and Utilities No change.

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
Impact E-26: Increase in Demand for Solid Waste Removal (LTS) Measures that would minimize the effects of this impact have been incorporated into the Project description. However, implementing the following would monitor the effectiveness of those measures: **Mitigation Measure E-7:** Obtain Appropriate Local and State Permits for Recreation Facility Services and Utilities	**Impact UT-13:** Increase in Demand for Solid Waste Removal (LTS) No mitigation required, but the following will monitor Project measures: **Mitigation Measure UT-MM-8:** Obtain Appropriate Local and State Permits for Recreation Facility Services and Utilities No change.

Note: SU = Significant and unavoidable; LTS = Less than significant; LTS-M = Less than significant with mitigation; B = Beneficial.

Summary of Changes, New Circumstances, and New Information

Changes in the environmental setting, regulatory setting, or environmental effects of the Project related to utilities, public services, and highways are described in the Existing Conditions section below. A summary of findings based on that consideration follows.

Substantial Changes in the Project

Since the 2001 FEIR and 2001 FEIS were completed, the Project applicant and PG&E entered into an agreement in 2006 (Delta Wetlands Properties 2006), amended in 2007, that resolved PG&E's protest to the Project water right applications. The agreement between the Project applicant and PG&E provides for:

1. The removal of abandoned Line 57A on Bacon Island before water is diverted for storage onto Bacon Island.
2. Grant of an easement for new Line 57C to PG&E.
3. Reinforcement of the Line 57B levee crossings on Bacon Island before water is diverted for storage onto Bacon Island.
4. Relocation of the Line 57B cathodic protection station on Bacon Island, and provision of facilities for PG&E's annual inspection of pipelines 57B and 57C before water is diverted for storage onto Bacon Island.
5. Relocation of electrical transmission lines on Bacon Island before water is diverted for storage onto Bacon Island.

This agreement is discussed under Environmental Commitments, below, and in Chapter 2, "Project Description and Alternatives."

New Circumstances

Since the 2001 FEIR and 2001 FEIS were issued, PG&E has added a natural gas transmission pipeline, Line 57C, to the existing utility infrastructure on Bacon Island. Line 57C was installed in 2007 to improve the reliability of the Line 57 system connecting McDonald Island to major PG&E transmission facilities. The majority of the deactivated Line 57A across Bacon Island has been removed, and the line is now considered abandoned. The remainder of Line 57A under Bacon Island Road will be removed prior to water storage on Bacon Island in accordance with the agreement between PG&E and the Project applicant.

New Information

There is no new information of substantial importance that would result in a substantial increase in severity of effects on utilities, public services, or highways.

Existing Conditions

This section discusses changes in the existing conditions or regulatory setting since the 2001 FEIR and 2001 FEIS.

Regulatory Setting

Federal, state, and local regulations were not summarized in the 2001 FEIR and 2001 FEIS. Although no federal laws or policies related to utilities, public services, highways, and county roads apply to the proposed Project, applicable state and local regulations and policies are summarized in the following section. These changes in the regulatory environment do not alter the 2001 FEIR and 2001 FEIS impact analysis conclusions or mitigation measures.

State

State Building Energy Efficiency Standards

The energy consumption of new buildings in California is regulated by State Building Energy Efficiency Standards, Title 24. These are contained in the California Code of Regulations (CCR), Title 24, Part 2, Chapter 2-53. Enforcement of the regulations is addressed in the CCR, Title 20, Chapter 2, Subchapter 4, Article 1. Title 24 applies to all new construction of both residential and nonresidential buildings and regulates energy consumed for heating, cooling, ventilation, water heating, and lighting. Title 24 is the minimum requirement for energy efficiency. Not all cost-effective efficiency equipment is necessarily installed in projects.

Local

Bacon and Bouldin Islands are located in San Joaquin County and Webb and Holland Tracts are located in Contra Costa County. The local regulations established by San Joaquin and Contra Costa Counties that pertain to the islands that fall within their respective boundaries are described below.

Contra Costa County General Plan 2005–2020

The Contra Costa County General Plan 2005–2020 (CCGP), updated in 2005, establishes goals and policies that address the provision of public facilities and services, as well as roadway facilities, in Contra Costa County.

Police and Fire Protection

Policies regarding routine police service and fire protection are presented in the Public Facilities/Services Element of the CCGP (Contra Costa County 2005: 7-24 to 7-30). Included are policies regarding the configuration of sheriff patrol beats to ensure minimum response times and efficient uses of resources; maximum and total response time goals for police and fire protection services; and upgrading fire facilities and equipment.

Domestic Water Supply

Goals and policies addressing water services are presented in the Public Facilities/Service Element, Water Services section of the CCGP (Contra Costa County 2005: 7-10 to 7-11). These policies include assurance of meeting regulatory standards for water delivery, water storage, and emergency water supplies to residents. The County encourages water conservation and water reclamation.

Stormwater Drainage

Drainage policies for stormwater and flood water conveyance are addressed in the CCGP's Public Facilities/Services Element, in the Drainage and Flood Control section. These policies provide for the protection of the public health from flooding hazards and a surface water drainage system for projected growth (Contra Costa County 2005: 7-20 to 7-21).

Wastewater

Goals and policies for wastewater management are detailed in the CCGP's Public Facilities/Services Element, within the Sewer Service section (Contra Costa County 2005: 7-14 to 7-16).

Solid Waste Management

Solid waste management policies and implementation measures are outlined in the CCGP's Public Facilities/Services Element, Solid Waste Management section (Contra Costa County 2005: 7-33 to 7-35). These policies are intended to ensure the adequate, safe, and cost-effective removal of solid waste from residences and businesses. Solid waste resource recovery (including recycling, composting, and waste to energy) is encouraged by the County.

Roadways

The Transportation and Circulation Element of the CCGP establishes goals, policies, and implementation measures intended to maintain an efficient traffic circulation network. Such goals and policies include right-of-way requirements, emergency response efficiency, and roadway development (Contra Costa County 2005: 5-13 to 5-18). The CCGP also outlines level of service (LOS) standards (discussed further in Section 4.10, Traffic and Navigation, of this EIR) and routes of regional significance. Contra Costa County has not designated local truck routes or adopted specific policies regarding management of construction activities.

San Joaquin County General Plan 2010

Police and Fire Protection

Policies regarding routine police service and fire protection are presented in the Public Health and Safety chapter of the San Joaquin County General Plan (SJCGP) (San Joaquin County 1992: Volume 1, V-8 to V-9). These policies are intended to ensure that fire and police protection services and facilities are provided for the public's health and safety, and that fire and law enforcement hazards are prevented through physical planning.

Domestic Water Supply

The Community Development chapter, Water Supply section of the San Joaquin County general plan contains policies intended to maintain a safe and adequate public water supply within the county (San Joaquin County 1992: Volume 1, IV-105 to IV-108).

Stormwater Drainage

The Community Development chapter, Infrastructure Services—Stormwater Drainage section of the general plan establishes goals and policies for the collection and conveyance of stormwater within the county (San Joaquin County 1992: Volume 1, IV-109 to IV-110). On-site drainage is a minimum requirement for stormwater drainage for discretionary applications in rural and agricultural areas in the county.

Wastewater

The Community Development chapter, Infrastructure Services—Wastewater Treatment section of the general plan establishes goals and policies for the collection and treatment of wastewater in the county (San Joaquin County 1992: Volume 1, IV-102 to IV-104). Septic tanks are the minimum requirement for wastewater treatment facilities in rural and agricultural areas for discretionary applications within the county.

Solid Waste Management

Solid waste management and disposal is governed by the San Joaquin County Waste Management Plan. This plan defines programs for recycling, resource recovery, and disposal. All development in the county must be consistent with the County's Waste Management Plan. The County promotes solid waste source reduction, composting, and recycling.

Roadways

The Community Development chapter, Transportation section of the general plan establishes goals and policies for the design and management of the County's transportation system (San Joaquin County 1992; Volume 1, IV-128 to IV-159). The general plan also outlines LOS standards (discussed further in Section 4.10, Traffic and Navigation, of this EIR), routes of regional significance, and planned major arterial improvement projects.

Affected Environment

The description of utilities, public services, and highways has been updated to reflect changes in the utility infrastructure, police and fire protection services, and Jersey-Bradford-Webb ferry passenger numbers and ferry service. These changes have been incorporated into the environmental setting summary below. There have been no substantial changes to the roads or SR 12; they remain as described in the 2001 FEIR and 2001 FEIS and are incorporated by reference. More information on the existing use of roads is given in Section 4.10, Traffic and Navigation.

Similarly, there have been no substantial changes to public services such as water supply, sewage disposal, or solid waste collection/disposal. These services for the Project islands remain as described in the 2001 FEIR and 2001 FEIS and are hereby incorporated by reference.

Highways, County Roads, and Ferry Service

As stated above, there have been no changes to the highways and county roads in the Project vicinity since the 2001 FEIR and 2001 FEIS. The discussion for Bacon Island, Bouldin Island and Holland Tract from the 2001 FEIR and 2001 FEIS are incorporated here by reference.

Webb Tract

The Delta Ferry Authority continues to provide ferry service to Webb Tract and Bradford Island from Jersey Island. The Victory II Ferry is a 100-ton car ferry capable of transporting up to 12 vehicles. Hours of operation are from 8:00 a.m. to 5:00 p.m., Monday through Friday, excluding Thanksgiving and Christmas, and half-days on weekends. A total of 5,146 passengers used the Delta Ferry Authority ferry system in Contra Costa County in fiscal year 2005–2006 (California Office of the Controller 2007). Based on this figure, year-round average daily use is estimated at 20 passengers. The ferry system is funded through the Delta Ferry Authority. The Delta Ferry Authority is composed of Reclamation District No. 2026 (Webb Tract) and Reclamation District No. 2059 (Bradford Island). Each reclamation district provides monthly funding for ferry operation and maintenance, and Contra Costa County supplements these local funds annually to support the ferry service.

Gas Facilities and Transmission Pipelines

Bacon Island

PG&E presently owns two high-pressure gas transmission pipelines that cross Bacon Island, Lines 57B and 57C (Figure 4.4-1). PG&E has abandoned

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ICF Jones & Stokes
an ICF International Company

Figure 4.4-1
Gas Transmission Lines on Bacon Island

Line 57A within Bacon Island. As part of PG&E's Line 57C Reliability Project, Line 57C, an approximately 6.4-mile high-pressure gas transmission pipeline, was constructed in 2007. Line 57C provides redundant pipeline capacity to ensure gas transmission between Brentwood and the McDonald Island Storage Field in the event of a failure of Line 57B in this region.

Line 57A

The majority of the deactivated Line 57A across Bacon Island has been removed, and the line is now considered abandoned. The remainder of Line 57A will be removed prior to water storage on Bacon Island in accordance with the agreement between PG&E and the Project applicant.

Line 57B

Line 57B, constructed in 1974, serves as an input and output conduit for gas stored in the McDonald Island Storage Field. Line 57B connects PG&E's interstate and intrastate gas transmission and distribution system to the utility's underground natural gas storage facility under McDonald Island. The McDonald Island Storage Field has been used primarily to supply gas to the Bay Area and Sacramento/Stockton market centers when other resources, such as gas production fields in Canada and the southwestern United States, are inadequate to meet instantaneous (i.e., peak) demands. The McDonald Island storage facility has supplied gas for up to one-third of PG&E's customers during peak demand periods (Jones & Stokes 2001).

Line 57B is 22 inches in diameter and is buried at a minimum of 3.5 feet below the ground surface as it crosses Bacon Island. Line 57B is designed to operate under temporarily flooded conditions or in saturated soils and, as constructed, is engineered and built to withstand more than the external pressure that would be applied by the load, or weight, of water under full reservoir conditions. Normal operation or integrity of the pipeline would not be impaired by the pressure of overlying water in a full reservoir. Line 57B is concrete-coated and rated for pressures up to 2,160 pounds per square inch (psi). It can convey approximately 1.25 billion cubic feet per day (Bcf/day).

Line 57C

Line 57C was installed in 2007 to expand and improve the reliability of the Line 57 system connecting McDonald Island to the major PG&E transmission facilities.

Line 57C originates at the McDonald Island Storage Field and crosses four islands—McDonald Island, Lower Jones Tract, Bacon Island, and Palm Tract—and four major waterways—Old River, Middle River, Latham Slough and Empire Cut. Line 57C ties in with PG&E's existing Line 57 system on Palm Tract.

On Bacon Island, Line 57C is buried approximately 6 feet below farm fields, directionally drilled under the levees at a depth of approximately 100 feet and under the center canal at a depth of approximately 30 feet (Forkel pers. comm.). Line 57C is 24 inches in diameter and concrete-coated. Line 57C is rated for pressures up to 2,160 psi.

Webb Tract

There is one active natural gas well on Webb Tract (Forkel pers. comm.). There is one gas transmission pipeline from the island. There also are several previously plugged and abandoned gas extraction wells on Webb Tract (Jones & Stokes 2001).

Bouldin Island

One natural gas well exists on Bouldin Island, and it is not presently active (Forkel pers. comm.). There are no gas transmission pipelines on the island.

Holland Tract

No natural gas wells or transmission pipelines exist on Holland Tract.

Electrical Transmission and Distribution Lines

No changes in electrical distribution lines have been made since the 2001 FEIR and 2001 FEIS. Briefly, PG&E operates 12-kilovolt (kV) electrical distribution lines on all four Project islands to serve residences and farm operations. These lines typically run on wooden utility poles.

Additionally, two major electrical transmission lines cross Hotchkiss Tract and Veale Tract to the west and southwest of Holland Tract: PG&E's 500-kV Table Mountain-to-Tesla line and Western Area Power Administration's 230-kV Intertie line.

Police and Fire Protection Services

Bacon Island and Bouldin Island

Police protection for Bacon Island and Bouldin Island is provided by the San Joaquin County Sheriff's Department. The department's headquarters are in French Camp, California. The San Joaquin County Sheriff's department marine patrol division provides water patrol services to approximately 600 square miles of waterways in the Delta area. The marine patrol unit is staffed by six deputy sheriffs and one supervisor; reserve officers are also used during major events and holidays. The marine patrol division substation, located at Steven's Anchorage in Stockton, responds to emergencies on the water for Bouldin Island and Bacon Island. Sheriff's land units respond to emergencies on the islands. Through a mutual aid agreement with San Joaquin County, the Sacramento County Sheriff's Department, the Contra Costa County Sheriff's Department, and the U.S. Coast Guard also provide emergency services to Bacon and Bouldin

Islands if needed. The San Joaquin County Sheriff's Department is responsible for law enforcement and investigation in the area regarding, but not limited to, drownings, boat accidents, drunkenness, theft, vandalism, property crimes, trespassing, disturbances, and enforcement of boat speed limits (Malcolm pers. comm.).

Fire protection for Bouldin Island is provided by the Woodbridge Fire District. The Woodbridge Fire District's service area encompasses approximately 192 square miles. Station 74, located in Lodi, provides fire protection and emergency services to Bouldin Island. Station 74 is staffed by three personnel and equipped with one engine and one fire boat. Volunteer firefighters are also available to respond to fire emergencies as needed. The fire boat is berthed and launched at Tower Park Marina, on Little Potato Slough. Response time from Station 74 to Bouldin Island is approximately 5–8 minutes (Kirkle pers. comm.).

Bacon Island is not in a fire protection district. Fire protection services are the responsibility of the landowners.

Webb Tract and Holland Tract

The Contra Costa County Sheriff's Department provides law enforcement services for Webb and Holland Tracts. The department's headquarters are in Martinez. The Contra Costa County Sheriff's Department Delta marine patrol division provides emergency service to Webb and Holland Tracts through its substation in Oakley. The marine patrol is staffed by two deputy officers year-round; an additional deputy officer is available during the peak summer season (Memorial Day through Labor Day). Contra Costa County has a statewide mutual aid agreement with the San Joaquin County Sheriff's Department and the U.S. Coast Guard to respond to emergency situations in the Delta.

The East Contra Costa Fire Protection District provides fire protection for Holland Tract. The district is staffed by approximately 48 full-time firefighters and 24 reserve firefighters. The district service area encompasses approximately 260 square miles. Station 94, located in Knightsen, is the closest station to Holland Tract. Response time from Station 94 to Holland Tract is less than 7 minutes. The district has a Class III/VIIII Fire Department Insurance Service Office Rating and operates under a statewide mutual aid agreement with other fire agencies in and around San Joaquin County (Helmick pers. comm.).

Webb Tract is not in a fire protection district. Fire protection is the responsibility of the landowners.

Environmental Commitments

Since publication of the 2000 RDEIR/EIS, the following environmental commitments related to flood control and levee stability have been added to the

Project description. These environmental commitments are described in detail in Chapter 2.

As previously described, since the 2001 FEIR and 2001 FEIS were completed, the Project applicant and PG&E entered into an agreement that resolved PG&E's protest to the Project water right applications. This agreement has resulted in environmental commitments specific to utilities and these include those following.

- If levee embankment construction for the Project creates stress on the Line 57B pipeline that is significantly greater than the stress on the pipeline caused by the current levee, the Project will pay for the design and construction of a mutually acceptable engineering solution to reinforce, replace, or relocate the Line 57B eastern levee crossing on Bacon Island before water is diverted for storage onto Bacon Island.
- Line 57B, at the western Bacon Island levee embankment adjacent to Old River, will be replaced with a new pipeline installed by horizontal directional drillng (HDD) between Bacon Island and Palm Tract, unless the Project and PG&E mutually agree in writing to another approach. The design and length will be similar to the Line 57C HDD crossing, including setbacks to prevent pipe exposure in the event of a levee failure. Prior to construction of the new pipeline, the Project and PG&E will enter into a 50/50 cost sharing agreement for the design, permitting, material procurement, and construction of a new Line 57B HDD crossing beneath Old River, Bacon Island, and Palm Tract levees. The Project's construction activities that require the isolation and blowdown of Line 57B will occur only at a time when activities will not disrupt PG&E gas operations, typically between April 15 and November 15.
- The Project will pay to relocate the Line 57B cathodic protection station on Bacon Island, and will provide facilities for PG&E's annual inspection of pipelines 57B and 57C before water is diverted for storage onto Bacon Island.
- The Project will compensate PG&E for any loss or damage to Line 57C caused by the conversion of Bacon Island into a water storage reservoir.

In addition to the above commitments stipulated in the settlement agreement, as part of the Project's environmental commitments, during levee strengthening, Project engineers will install equipment to monitor levee settlement and subsidence rates. After levee completion, the Project will conduct weekly inspections to check for potential problems at the gas pipeline crossings, including concerns about levee stability, settlement, and subsidence. If the weekly inspection indicates that settlement, erosion, or slumping at the gas pipelines has occurred, the Project will notify PG&E and will implement corrective measures to mitigate any decrease in levee stability near the gas lines.

Environmental Effects

Methods

The analytical approach, impact mechanisms, and significance criteria remain as presented in the 2001 FEIR and 2001 FEIS and are hereby incorporated by reference. To summarize, potential effects of the Project alternatives on emergency services and public utilities were evaluated based on how Project operation would affect the ability of the service agencies and existing facilities to adequately serve the Project islands. Effects of the Project alternatives on gas and electrical lines and facilities on the Project islands were determined through discussions with the affected utility agency and estimation of alterations to the existing infrastructure and any changes in existing operation of the facilities that would be needed during Project operation.

Effects of the Project alternatives on highways and county roads were evaluated based on how operation of the Project could affect the integrity of the roadway levees through wave erosion and differential settlement; these effects are based on the assessment of levee stability described in Section 4.3, Flood Control and Levee Stability. Potential changes in operation of the ferry system to Webb Tract were evaluated through discussions with the Delta Ferry Authority and estimation of changes in passenger travel during Project operation.

Significance Criteria

The utilities, public services, and highway impact analysis considered several criteria for determining the significance of impacts related to this resource. The analysis took into account both relevant criteria contained in Appendix G of the State CEQA Guidelines (Association of Environmental Professionals 2009) and Project-specific criteria developed by the lead agency to address potential impacts unique to the Project's location and elements.

In the 2001 FEIR and 2001 FEIS analysis, an alternative was considered to have a significant impact on utilities, public services, or highways if it would:

- increase risk of structural failure of existing railways and roadways, gas facilities and pipelines, electrical transmission or distribution lines, and water distribution facilities;
- result in a need for new systems, or substantial alterations to or increased maintenance of power or natural gas facilities, communication systems, water infrastructure, sewer lines, septic tanks, or solid waste services;
- result in a substantial disruption to existing natural gas service;
- increase risk of structural failure of gas facilities and pipelines;
- result in a need for substantial alterations to, or increased maintenance of, natural gas facilities;

- result in increased demand for existing emergency services beyond their current capacity; or
- increase traffic hazards to motor vehicles, bicyclists, or pedestrians by degrading the existing infrastructure.

Impacts and Mitigation Measures

Impacts on utilities, public services, and highways resulting from implementing the Project were described in detail in the 2001 FEIR and 2001 FEIS and are summarized briefly in Table 4.4-1. Where there have been no changes to the impact analysis or conclusions, the 2001 FEIR and 2001 FEIS is incorporated by reference, and the impact conclusions and mitigation measures are summarized briefly in the following section.

Certain changes in the affected environment, such as the agreement between the Project applicant and PG&E and changes in PG&E's gas utility infrastructure on Bacon Island, necessitate updating the impact analysis. None of these changes has resulted in new significant environmental effects or a substantial increase in the severity of previously identified significant effects on utilities, public services, or highways. However, as indicated in Table 4.4-1, certain impacts related to PG&E's gas lines, which previously were identified as significant, are now considered less than significant. Similarly, previously identified impacts on PG&E's Line 57A are no longer considered impacts because PG&E has abandoned Line 57A on Bacon Island, and most of the pipeline has been removed. These changes to impacts and associated changes in mitigation are discussed in the following sections as they apply to each alternative.

Proposed Project (Alternative 2)

Alternative 2 involves storage of water on Bacon Island and Webb Tract (Reservoir Islands), with wildlife habitat and recreation constituting secondary uses. Bouldin Island and Holland Tract (Habitat Islands) would be managed primarily as wildlife habitat.

Highways, County Roads and Ferry Service

Impacts on highways, county roads, and ferry service resulting from implementation of the Project were described in detail in the 2001 FEIR and 2001 FEIS. Where there have been no changes to the impact analysis, the 2001 FEIR and 2001 FEIS is incorporated by reference, and the impact conclusions and mitigation measures are summarized briefly in the following section.

Impact UT-1: Increase in the Structural Integrity of County Roads
Implementation of Alternative 2 would result in levees surrounding Reservoir Islands being raised and widened. Erosion-resistant facing would be placed on

the interior slopes of the levees. These levee improvement activities would increase the structural integrity of Bacon Island Road on the eastern perimeter levee of Bacon Island.

Because subsidence rates on Habitat Islands would decrease under Alternative 2, the stability of levees surrounding Bouldin Island and Holland Tract would increase. The Project would undertake levee rehabilitation on the Habitat Islands as needed consistent with the state standards as described in Department of Water Resources Bulletin 192-82 (California Department of Water Resources 1982), which would strengthen the levees. Holland Tract Road would benefit from the increased levee stability and the probable reduction of road maintenance activities. This impact is considered beneficial and less than significant.

Mitigation
No mitigation is required.

Impact UT-2: Reduction in Ferry Traffic from Jersey Island to Webb Tract

Implementation of Alternative 2 would result in cessation of farming operations on Webb Tract, and ferry traffic from Jersey Island to Webb tract would decline. Although Alternative 2 could generate approximately 15 passengers per hunting day (3 hunting days per week during the October–January season) for recreation access to Webb Tract, there still would be an overall decline of ferry use from the existing average of 20 passengers per day. The current ferry schedule (5 days per week) would not change during Project operation. The ferry would provide transportation for Project workers year round. A projected net decline in ferry use during Project operation would not result in a need for a new system or adversely affect operation and maintenance of the existing system. Reductions in traffic on the ferry, especially heavy grain truck traffic during harvest, could result in reduced operations and maintenance costs. Therefore, this impact is considered less than significant.

Mitigation
No mitigation is required.

Gas Facilities and Transmission Pipelines

The 2001 FEIR and 2001 FEIS discussion of Project effects on gas facilities and transmission pipelines across Bacon Island has been superseded by the updated information presented in this Place of Use EIR. As previously stated, consistent with the settlement agreement between PG&E and the Project applicant (Delta Wetlands Properties 2006), Line 57A has been removed/abandoned and therefore will not be considered in the impact analysis. In addition, Line 57C was completed after the 2001 FEIR and 2001 FEIS were issued and is therefore included in the following impact analysis. The impact and mitigation conclusions below have been revised to reflect pertinent information contained in the settlement agreement, as well changes in PG&E’s gas utility infrastructure.

Water storage on Webb Tract would not preclude future natural gas exploration. During the final design of the Project, consultations with the Department of Conservation, Division of Oil and Gas, and existing mineral rights holders would determine whether active wells located on Webb Tract would need to be raised or relocated (Forkel pers. comm.). Any new wells constructed on Webb Tract would be designed to accommodate seasonal flooding (Forkel pers. comm.).

Flooding of the PG&E easement on Bacon Island under proposed Project operations would not increase the risk of structural failure of the operating gas pipelines or cause a physical change in PG&E's ability to supply gas to Bay Area or Sacramento/Stockton market centers. Flooding the island probably would change the manner in which PG&E monitors its pipelines and repairs leaks to the pipeline. These impacts are discussed below.

Impact UT-3: Increase in the Risk to Gas Lines Crossing Exterior Levees on Bacon Island Resulting from Levee Improvements

Implementation of Alternative 2 could cause settlement issues or increased loads on the pipelines at the levee crossings and may require corrective measures during levee construction and settlement. The proposed levee buttressing could locally increase the rates of levee settlement or subsidence where the gas pipelines penetrate the Bacon Island exterior levees. Levee settlement or subsidence could increase the shear or bending loads on the pipelines, depending on the location of the pipeline with respect to the compressible levee foundation materials. The need for corrective measures and associated costs may increase during levee construction and settlement compared to existing pipeline maintenance requirements.

As outlined in the Environmental Commitments for the Project, the Project will pay for the design and construction of a mutually acceptable engineering solution to reinforce, replace, or relocate the Line 57B eastern levee crossing on Bacon Island prior to water diversion for storage on the island. Similarly, the Project will replace the Line 57B pipeline at the western levee embankment and the cost of the design, permitting, materials, and construction of the new replacement pipeline will be shared by PG&E and the Project. Any reinforced, replaced, or relocated pipelines would be engineered to withstand increased soil settlement pressures. Implementation of these Environmental Commitments would prevent damage to the gas pipeline from increased bending or shear loads at levee crossings during levee construction and settlement. As such, this impact is considered less than significant. However, Mitigation Measure UT-MM-1 would monitor the effectiveness of the corrective measures implemented as part of the settlement agreement.

Mitigation Measure UT-MM-1: Monitor Locations Where Gas Pipelines Cross Bacon Island Levees during and after Levee Construction

During levee strengthening, the Project applicant engineers will install equipment to monitor levee settlement and subsidence rates. After levee completion, the Project applicant will conduct weekly inspections to check for potential problems at the gas pipeline crossings, including concerns about levee stability, settlement, and subsidence If the weekly inspection indicates that settlement, erosion, or slumping at the gas pipelines has occurred, the Project applicant will notify

PG&E and will implement corrective measures to mitigate any decrease in levee stability near the gas lines.

Impact UT-4: Increase in PG&E Response Time to Repair a Gas Line Failure on Bacon Island

Implementation of Alternative 2 would delay and complicate repairs of PG&E pipeline facilities. Inundation of the island under Project operations could interrupt service for a longer period than would occur under existing conditions; a severe leak or pipeline rupture would take longer to repair under flooded reservoir conditions than under the existing dry conditions. However, the risk of a pipeline leak or rupture on Bacon Island is very low, and such a leak or rupture would be equally likely under dry or wet conditions. This conclusion is based on the following considerations:

- Pipeline ruptures or leaks on Bacon Island under the proposed Project would be caused by internal or external corrosion, levee settlement, or subsidence loads. In recent years, no pipeline ruptures in the Delta have been caused by these modes (U.S. Department of Transportation 2008). PG&E more often must respond to leaks caused by farm equipment; emergency repairs in the Delta caused by ground-disturbing equipment generally occur once or twice a year (Jones & Stokes 2001).
- Annual inspections to detect small leaks, monitor corrosion protection, identify potential levee subsidence or settlement problems, and prevent future pipeline ruptures or substantial pipeline leaks in those areas by prescribing immediate repair work still will be conducted in accordance with federal and state regulations.
- Based on modeling of water storage operations for the proposed Project (see Chapter 3), it is estimated that Bacon Island would be at full storage in approximately 60% of the months simulated. Therefore, opportunities for repair and replacement of damaged pipeline segments under dry conditions would occur about 40% of the time.

Furthermore, it is unlikely that both Lines 57B and 57C would be damaged and need repair simultaneously. Line 57C was designed and constructed to provide redundancy in PG&E's Line 57 gas transmission system. Prior to the installation of Line 57C, Line 57B was the sole pipeline transporting gas between the McDonald Island underground storage field and PG&E's transmission system. Line 57C travels a different route from the McDonald Island storage field, thereby enhancing the reliability of gas supplies from that source.

If repairs are needed during flooded conditions on Bacon Island, the Project could extend the time required by PG&E to make necessary repairs. PG&E's emergency repair procedures under existing conditions and under Project conditions are described in detail in the 2001 FEIR and 2001 FEIS. However, the system redundancy from installation of Line 57C would reduce the impact of the increased response time to a less-than-significant level.

Mitigation

No mitigation is required.

Impact UT-5: Potential Interference with Pipeline Inspection Procedures

As part of its pipeline operation, inspection, and maintenance procedures required by federal and state regulations (49 CFR 192 and California Public Utilities Commission [CPUC] General Order 112), PG&E conducts annual aerial and walking inspections along the pipeline route to check for small leaks, evidence of internal or external corrosion, or easement encroachment (e.g., new drainage ditches). Valves are also regularly monitored for pressure fluctuations that could be caused by leaks (Jones & Stokes 2001).

As part of the 2006 settlement agreement between the Project applicant and PG&E, before water is diverted to storage on Bacon Island, the Project will provide mutually acceptable facilities on the island for PG&E's annual inspection of Lines 57B and 57C (Delta Wetlands Properties 2006). These facilities will be identified and located during the planning and design phase for the Bacon Island reservoir. In addition, as part of the settlement agreement the Project will provide a ramp and turnaround facilities to launch a boat for regular inspections; provide a suitable staging area for materials and equipment necessary for gas pipeline repairs; and install an elevated access roadway adjacent to Lines 57B and 57C (Delta Wetlands Properties 2006). These measures will ensure that PG&E has access to the lines for annual inspections under wet as well as dry conditions.

PG&E also monitors the pipelines using internal inspection and cathodic protection testing. No valves are located on Bacon Island, and internal inspection ("pigging") could occur regardless of dry or wet conditions. Flooding the island would inundate cathodic protection test stations, rendering them unusable. The cathodic protection test stations would need to be relocated before flooding of Bacon Island. As stipulated in the 2006 settlement agreement, before water is diverted to storage on Bacon Island, PG&E will, at its expense, relocate the Line 57B cathodic protection test stations on Bacon Island to a mutually acceptable location (Delta Wetlands Properties 2006). In addition, if the test stations are to be located on Delta Wetlands' property, PG&E will consult with the Project applicant on the design, siting and construction of the test stations, and the Project applicant will provide PG&E access to the stations (Delta Wetlands Properties 2006).

This impact is considered less than significant.

Mitigation
No mitigation is required.

Electrical Distribution Lines

Impacts on electrical distribution utilities resulting from implementation of the Project were described in detail in the 2001 FEIR and 2001 FEIS. Where there have been no changes to the impact analysis, the 2001 FEIR and 2001 FEIS is incorporated by reference, and the impact conclusions and mitigation measures are briefly summarized in the following section.

The Project has removed construction of recreation facilities from its CWA permit applications, and Corps will not include the construction of such facilities in permits issued for the Project at this time. Nevertheless, the analysis of impacts on electrical distribution utilities presented below assumes that the recreation facilities would be constructed and operated. This information provides readers with a complete record of the environmental analysis; it may be used in any subsequent environmental assessment of the recreation facilities.

Impact UT-6: Inundation of Electrical Distribution Utilities on the Reservoir Islands

Implementation of Alternative 2 would inundate existing PG&E overhead distribution lines on Webb Tract during water storage operations. Maintenance of electrical service between Bradford Island and Mandeville Island would require raising or relocating the distribution lines. This impact is considered significant.

Implementing Mitigation Measure UT-MM-2 would reduce this impact to a less-than-significant level.

Mitigation Measure UT-MM-2: Relocate Electrical Distribution Lines to the Perimeter Levee around Webb Tract

The Project, in coordination with PG&E, will permanently relocate the existing electrical distribution lines on Webb Tract to the improved perimeter levees during Project construction. The new or relocated distribution lines will be located along perimeter levees and will be installed overhead, similar to existing installations. Before temporarily or permanently modifying or relocating existing electrical lines, the Project will conduct special-status plant surveys (Mitigation Measure VEG-MM-1) in areas that could be affected by the proposed modifications. If threatened or endangered plant species are found, the Project will avoid disturbing those plants when making changes to existing electrical lines.

Impact UT-7: Possible Need to Increase Capacity of the Existing Electrical Distribution Lines on the Project Islands

Implementation of Alternative 2 may require PG&E to provide electrical service for discharge pump stations, siphon stations, and recreation facilities on the Project islands. If electrical service is required, PG&E would add capacity to the existing distribution lines. The proposed locations for some pump and siphon stations and recreation facilities are adjacent to or within existing electrical line easements. Increasing capacity of existing distribution lines would not require new distribution easements or structures on the islands. Therefore, this impact is considered less than significant.

It also may be necessary to relocate or upgrade electrical lines and substation facilities to serve new Project facilities; any relocation or upgrade of electrical substation facilities (50,000 volts and above) may require formal approval from the CPUC and the CPUC may need to conduct additional environmental impact analyses.

Mitigation

No mitigation is required.

Impact UT-8: Possible Need to Expand the Existing Electrical Distribution Lines on Webb Tract, Bouldin Island, and Holland Tract to Serve a Proposed Siphon Station and Recreation Facilities

Implementation of Alternative 2 may require PG&E to provide electrical service to a siphon station on the northeast end of Webb Tract and to recreation facilities along the perimeters of Webb Tract, Bouldin Island, and Holland Tract that would not easily be serviced by existing lines. Because service to these facilities would require an extension of existing service lines, this impact is considered significant. Implementing Mitigation Measure UT-MM-3 would reduce this impact to a less-than-significant level.

Mitigation Measure UT-MM-3: Extend Electrical Distribution Lines to Serve New Siphon and Pump Stations and Recreation Facilities

The Project, in coordination with PG&E, will extend existing electrical distribution lines on the Reservoir Islands where needed to serve new siphon and pump stations and recreation facilities. Before modifying existing electrical lines, the Project will conduct special-status plant surveys (Mitigation Measure VEG-MM-1) in areas that could be affected by the proposed modifications. If threatened or endangered plant species are found, the Project will avoid disturbing those plants when making changes to existing electrical lines.

Police and Fire Protection Services

Impacts on police and fire protection services resulting from implementation of the Project were described in detail in the 2001 FEIR and 2001 FEIS. Where there have been no changes to the impact analysis, the 2001 FEIR and 2001 FEIS is incorporated by reference, and the impact conclusions and mitigation measures are summarized briefly in the following section.

Impact UT-9: Increase in Demand for Police Services on the Project Islands

Implementation of Alternative 2 could result in an incremental increase in demand for police service during Project operation. Construction and operation of the proposed recreation facilities would result in the following conditions that would contribute to the need for emergency services:

- construction of new buildings;
- an increase in the number of people visiting the Project islands;
- an increase in boating use on waterways adjacent to the Project islands; and
- establishment of boat facilities, which commonly attract criminal activities (e.g., vandalism and theft).

This impact is considered significant. Implementing Mitigation Measures UT-MM-4 and UT-MM-5 would reduce this impact to a less-than-significant level. In addition, Mitigation Measure REC-MM-1: Reduce the Size or Number of Recreation Facilities (discussed in detail in Chapter 4.9, Recreation and Visual Resources) would also reduce this impact.

Mitigation Measure UT-MM-4: Provide Adequate Lighting in and around Buildings, Walkways, Parking Areas, and Boat Berths

The Project will provide illumination, in compliance with the recommendations of the Contra Costa County Sheriff's Department and the San Joaquin County Sheriff's Department, in and around recreation facilities, walkways, parking areas, and boat berths on all the Project islands. Also, the Project will consult with both sheriff departments for building design recommendations in order to avoid features that may promote criminal activity.

Mitigation Measure UT-MM-5: Provide Private Security Services for Recreation Facilities and Boat Docks

The Project will provide 24-hour on-site private security for the recreation facilities and boat docks on all four Project islands. The security service would assist the San Joaquin County Sheriff's Department and Contra Costa County Sheriff's Department in deterring criminal activity.

Mitigation Measure REC-MM-1: Reduce the Size or Number of Recreation Facilities

The Project will reduce the total number or size of recreation facilities proposed by removing from Bacon Island and Webb Tract all 22 facilities proposed for construction, and reducing the number or size of proposed facilities on Bouldin Island and Holland Tract by 70%. This will significantly reduce the number of people using the recreation facilities, resulting in a decrease in public services and crime concerns.

Impact UT-10: Increase in Demand for Fire Protection Services on the Project Islands

Implementation of Alternative 2 could increase demands on fire protection services during Project operation. Construction of the recreation facilities would increase the number of people recreating on the Project islands. Also, two of the Project islands (Webb Tract and Bacon Island) are not serviced by a fire protection district. This impact is considered significant. Implementing Mitigation Measures UT-MM-6 and UT-MM-7 would reduce this impact to a less-than-significant level.

Mitigation Measure UT-MM-6: Incorporate Fire Protection Features into Recreation Facility Design

The Project will require recreation facilities to incorporate the Uniform Building Codes and the Uniform Fire Codes into the design of the recreation facilities and boat docks.

Mitigation Measure UT-MM-7: Provide Fire Protection Services to Webb Tract and Bacon Island

The Project, in coordination with the county and the Local Agency Formation Commission (LAFCO), will incorporate Webb Tract and Bacon Island into an existing fire protection district, or will create new fire protection resources to serve these islands upon full development of the recreation facilities. In addition, Mitigation Measure REC-MM-1: Reduce the Size or Number of Recreation Facilities (discussed in detail in Chapter 4.9, Recreation and Visual Resources) would also reduce this impact.

Water Supply Facilities and Sewage Disposal Service

Impacts on water supply facilities and sewage disposal service resulting from implementation of the Project were described in detail in the 2001 FEIR and 2001 FEIS. Where there have been no changes to the impact analysis, the 2001 FEIR and 2001 FEIS is incorporated by reference, and the impact conclusions and mitigation measures are briefly summarized in the following section.

Impact UT-11: Increase in Demand for Water Supply Services

Implementation of Alternative 2 would increase the need for potable water on the Project islands. As part of the recreation facility design, the Project would increase bottled-water delivery service, drill new wells, and incorporate water purification techniques as necessary to increase water supply at the recreation facilities. New services would need to be consistent with County policies. Therefore, this impact is considered less than significant. Measures that would minimize the effects of this impact have been incorporated into the Project description. Mitigation Measure UT-MM-8 would monitor the effectiveness of those measures.

Mitigation Measure UT-MM-8: Obtain Appropriate Local and State Permits for Recreation Facility Services and Utilities

Before construction of the proposed recreation facilities, the Project will obtain all required permits and approvals from local and state agencies for the design and construction of utilities and services, including, but not limited to, water supply, sewage disposal, and solid waste disposal on the Project islands.

In order to obtain a sewage permit in San Joaquin County, the Project will submit an application along with a work plan for the recreation facilities to the San Joaquin County Environmental Health Department. The work plan will be reviewed by the Environmental Health Department to ensure compliance with all county requirements, and a permit will be issued or denied based on the findings of the review (Jones & Stokes 2001).

Contra Costa County Environmental Health Division issues sewage permits in Contra Costa County. As with San Joaquin County, the Project will be required to submit an application. In addition, the Project will be required to submit three sets of plans for the recreation facilities along with a site map depicting existing structures and resources on the islands, and a safety plan. Issuance of the permit will be based on compliance with all County requirements, review of the application, and site visit information obtained by the health inspector (Jones & Stokes 2001).

If, when specific design details are submitted to the appropriate regulating agencies, the agency determines that site-specific environmental impacts are not covered in enough detail by the NEPA and CEQA documentation already completed for the Project, additional environmental documentation may be required prior to approval of permits, entitlements, or alternative treatment methods.

Impact UT-12: Increase in Demand for Sewage Disposal Services

Implementation of Alternative 2 would result in an increased need for sewage disposal at the proposed recreation facilities. As part of the recreation facility design, the Project would install a new sewage disposal system at each facility consistent with San Joaquin County and Contra Costa County requirements for sewage disposal systems and design. Therefore, this impact is considered less than significant.

Measures that would minimize the effects of this impact have been incorporated into the Project description. Implementing Mitigation Measure UT-MM-8 (described above) would monitor the effectiveness of those measures.

Mitigation Measure UT-MM-8: Obtain Appropriate Local and State Permits for Recreation Facility Services and Utilities

Solid Waste

Under Alternative 2, use of the recreation facilities would increase demand for solid waste removal services on the Project islands. The Project would need to contract with a private waste collection and disposal service authorized to operate in Contra Costa County and San Joaquin County to serve the recreation facilities.

Impact UT-13: Increase in Demand for Solid Waste Removal

Some waste would likely be generated during construction activities. The small amount of waste that may require landfill disposal is not expected to substantially decrease the existing lifespan of the landfills near the Project area. Implementation of Alternative 2 would result in the need for solid waste removal at the recreation facilities. The Project would contract with a private waste collection and disposal service to respond to the need for removal of solid waste from the recreation facilities. The Project would investigate and implement, to the extent financially feasible, recycling opportunities for the recyclable waste generated at the recreation facilities. However, the amount of solid waste generated at the recreation facilities would not likely exceed capacity of the collection service or local landfills. Therefore, this impact is considered less than significant.

Measures that would minimize the effects of this impact have been incorporated into the Project description. However, implementing Mitigation Measure UT-MM-8 (described above) would monitor the effectiveness of those measures.

Mitigation Measure UT-MM-8: Obtain Appropriate Local and State Permits for Recreation Facility Services and Utilities

Infrastructure Facilities on Adjacent Islands

Infrastructure on adjacent islands includes transportation and water conveyance facilities, underground gas fields and storage areas, and gas and electrical lines.

Increased risk of levee failure and seepage to adjacent islands caused by proposed water storage on Bacon Island and Webb Tract could threaten the reliability of these facilities and increase maintenance and repair costs; however, the Project has made a commitment to improve levees around the Project islands, which would increase their reliability. The Project also would mitigate any seepage problems beyond existing seepage levels by installing an interceptor well system around the Project island levees. Project features would maintain potential impacts related to levee stability and seepage at existing levels or better, so implementation of Alternative 2 would not increase the risk to adjacent utilities. Adjacent utilities would not be affected by Alternative 2.

Alternative 1

Impacts and mitigation measures under Alternative 1 are the same as under Alternative 2.

Alternative 3

Alternative 3 involves storage of water on Bacon Island, Webb Tract, Bouldin Island, and Holland Tract with secondary uses for wildlife habitat and recreation. The portion of Bouldin Island north of SR 12 would be managed as a wildlife habitat area and would not be used for water storage. A detailed impact analysis of Alternative 3 was presented in the 2001 FEIR and 2001 FEIS, and is incorporated here by reference. The impact conclusions and mitigation are briefly summarized in the following section.

Highways, County Roads, and Ferry Service

Impact UT-1: Increase in the Structural Integrity of County Roads

Implementation of Alternative 3 would result in levees surrounding the reservoirs on the Project islands being raised and widened. Erosion-resistant facing would be placed on the interior slopes of the levees. These levee improvements would increase the structural integrity of Bacon Island Road on the eastern levee of Bacon Island and Holland Tract Road on the southern levee of Holland Tract. Therefore, this impact is considered beneficial and less than significant.

Mitigation

No mitigation is required.

Impact UT-14: Increase in the Risk of Structural Failure of SR 12

Implementation of Alternative 3 could potentially affect the structural integrity of SR 12 and expose SR 12 to flooding. If Alternative 3 is implemented, a dam, Wilkerson Dam, would be required south of SR 12 to retain water on the island and protect the existing highway. Because the design of Wilkerson Dam would minimize seepage, settlement, and erosion, adverse impacts on the structural integrity of SR 12 caused by levee failure and flooding would have a low probability of occurring (see 2001 FEIS, Appendix E1, "Design and Construction of Wilkerson Dam South of SR 12 on Bouldin Island).

Groundwater levels beneath SR 12 roadbed and in the seepage drainage ditches on both sides of the highway are controlled by farming practices. Water levels in the ditches can vary by as much as 6 feet over 1 year because of cyclical flooding and irrigation. Water from the existing drainage ditches would be pumped to stabilize groundwater levels in the ditches and beneath the SR 12 roadbed. To ensure that the Project does not cause a significant increase in water levels, the Project applicant will coordinate with the California Department of Transportation (Caltrans) to establish a seepage performance level for Wilkerson Dam. Groundwater levels along SR 12 would be regulated by pumps that maintain water levels in the drainage ditch along SR 12 being set to activate automatically if ditch water levels exceed the performance standard established by Caltrans and the Project applicant. Additionally, as part of Alternative 3, the Project applicant, in coordination with Caltrans, will review the regrading design for the North Bouldin Habitat Area (NBHA) to verify that the probability of adverse flooding impacts along the north side of SR 12 would be negligible. Therefore, this impact is considered less than significant.

Measures that would minimize the effects of this impact have been incorporated into the Project description. However, implementing Mitigation Measure UT-MM-9 would monitor the effectiveness of those measures.

Mitigation Measure UT-MM-9: Coordinate Design and Construction of Wilkerson Dam with Caltrans

Prior to Project construction, the Project will consult with and obtain all required permits and approvals from Caltrans for the design and construction of Wilkerson Dam.

Impact UT-15: Increase in the Fog Hazard on SR 12

Implementation of Alternative 3 could increase the amount of fog produced along SR 12 on Bouldin Island by increasing the water surface area adjacent to the roadway. Fog on the roadway would increase traffic hazards on SR 12. This impact is considered significant and unavoidable.

Mitigation

No mitigation is available to reduce this impact to a less-than-significant level.

Impact UT-2: Reduction in Ferry Traffic from Jersey Island to Webb Tract

This impact is described above under Alternative 2. This impact is considered less than significant.

Mitigation

No mitigation is required.

Gas Facilities and Transmission Pipelines

Impact UT-3: Increase in the Risk to Gas Lines Crossing Exterior Levees on Bacon Island Resulting from Levee Improvements

This impact is described under Alternative 2. This impact is considered less than significant, as discussed above. However, Mitigation Measure UT-MM-1 would monitor the effectiveness of the corrective measures implemented as part of the settlement agreement.

Mitigation

No mitigation is required.

Impact UT-4: Increase in PG&E Response Time to Repair a Gas Line Failure on Bacon Island

This impact is described above under Alternative 2. The potential impact on PG&E's operation is economic in nature. Because economic effects are not considered environmental impacts under CEQA and NEPA, no significance conclusion is made and no mitigation is identified.

Mitigation

No mitigation is identified.

Impact UT-5: Potential Interference with Pipeline Inspection Procedures

This impact is summarized above under Alternative 2. The impact on access for pipeline inspections and on monitoring facilities is considered less than significant, as discussed above.

Mitigation

No mitigation is required.

Electrical Distribution Lines

Impact UT-6: Inundation of Electrical Distribution Utilities on the Reservoir Islands

Implementation of Alternative 3 would cause inundation of existing PG&E overhead distribution lines on Webb Tract, Holland Tract, and Bouldin Island during water storage operations. To maintain existing service, the lines would need to be relocated. This impact is considered significant.

Implementing Mitigation Measure UT-MM-10 would reduce this impact to a less-than-significant level.

Mitigation Measure UT-MM-10: Relocate Electrical Distribution Lines to the Perimeter Levees around Webb and Holland Tracts and Bouldin Island

The Project applicant, in coordination with PG&E, will permanently relocate the electrical distribution lines on Webb and Holland Tracts and Bouldin Island to the improved perimeter levees during Project construction. The new or relocated distribution lines would be located along perimeter levees and would be installed overhead, similar to existing installations. Before temporarily or permanently modifying or relocating existing electrical lines, the Project will conduct special-status plant surveys (Mitigation Measure VEG-MM-1) in areas that could be affected by the proposed modifications. If threatened or endangered plant species are found, the Project will avoid disturbing those plants when making changes to existing electrical lines.

Impact UT-7: Possible Need to Increase Capacity of the Existing Electrical Distribution Lines on the Reservoir Islands

Alternative 3 may require PG&E to provide electrical service for discharge pump stations, siphon stations, and recreation facilities on the Project islands. PG&E would add capacity to the existing distribution lines, which would not require new easements or structures on the islands. Therefore, this impact is considered less than significant.

It also may be necessary to relocate or upgrade electrical lines and substation facilities to serve new Project facilities; any relocation or upgrade of electrical substation facilities (50,000 volts and above) may require formal approval from the CPUC. If, when specific design details are submitted, the CPUC determines that the NEPA and CEQA documentation already completed for the Project does not cover site-specific environmental impacts in enough detail, it may require additional environmental documentation before it provides approvals.

Mitigation

No mitigation is required.

Impact UT-8: Possible Need to Expand the Existing Electrical Distribution Lines on Webb Tract, Bouldin Island, and Holland Tract to Serve Proposed Siphon and Pump Stations and Recreation Facilities

Implementation of Alternative 3 may require PG&E to provide electrical service to siphon stations, a pump station, and recreation facilities that would not be serviced easily by existing lines. The following proposed pump station and siphon stations (as shown in Figures 2-1 through 2-4) would not be located adjacent to existing electrical line corridors: a siphon station in the northeastern corner of Webb Tract, a discharge pump station and a siphon station on the eastern side of Bouldin Island, and a siphon station near the northernmost point of Holland Tract. Recreation facilities also would be located along the perimeter levees in areas not serviced by electrical lines. Because electrical service to those facilities would require an extension of existing service lines, this impact is considered significant.

Implementing Mitigation Measure UT-MM-3 would reduce this impact to a less-than-significant level.

Mitigation Measure UT-MM-3: Extend Electrical Distribution Lines to Serve New Siphon and Pump Stations and Recreation Facilities

This mitigation measure is described above under Alternative 2.

Police and Fire Protection Services

The effects on emergency services that would result from constructing and operating recreation facilities are described above for Alternative 2 and briefly summarized here.

Impact UT-9: Increase in Demand for Police Services on the Project Islands

This impact is described above under Alternative 2. This impact is considered significant.

Implementing Mitigation Measures UT-MM-4 and UT-MM-5, both described above for Alternative 2, would reduce this impact to a less-than-significant level. In addition, Mitigation Measure REC-MM-1: Reduce the Size or Number of Recreation Facilities (discussed in detail in Chapter 4.9, Recreation and Visual Resources) would also reduce this impact.

Mitigation Measure UT-MM-4: Provide Adequate Lighting in and around Buildings, Walkways, Parking Areas, and Boat Berths

This mitigation measure is described above under Alternative 2.

Mitigation Measure UT-MM-5: Provide Private Security Services for Recreation Facilities and Boat Docks

This mitigation measure is described above under Alternative 2.

Mitigation Measure REC-MM-1: Reduce the Size or Number of Recreation Facilities

This mitigation measure is described above under Alternative 2.

Impact UT-10: Increase in Demand for Fire Protection Services on the Project Islands

This impact is described above under Alternative 2. This impact is considered significant. Implementing Mitigation Measures UT-MM-6 and UT-MM-7, both described above for Alternative 2, would reduce this impact to a less-than-significant level.

Mitigation Measure UT-MM-6: Incorporate Fire Protection Features into Recreation Facility Design

This mitigation measure is described above under Alternative 2.

Mitigation Measure UT-MM-7: Provide Fire Protection Services to Webb Tract and Bacon Island

This mitigation measure is described above under Alternative 2.

Water Supply Facilities and Sewage Disposal Service

The effects on water supply and sewage disposal services that would result from constructing and operating recreation facilities are as described above for Alternative 2 and briefly summarized here.

Impact UT-11: Increase in Demand for Water Supply Services

This impact is described above under Alternative 2. This impact is considered less than significant.

Measures that would minimize the effects of this impact have been incorporated into the Project description. However, implementing Mitigation Measure UT-MM-8, described above for Alternative 2, would monitor the effectiveness of those measures.

Mitigation Measure UT-MM-8: Obtain Appropriate Local and State Permits for Recreation Facility Services and Utilities

This mitigation measure is described above under Alternative 2.

Impact UT-12: Increase in Demand for Sewage Disposal Services

This impact is described above under Alternative 2. This impact is considered less than significant.

Measures that would minimize the effects of this impact have been incorporated into the Project description. However, implementing Mitigation Measure UT-MM-8 would monitor the effectiveness of those measures.

Mitigation Measure UT-MM-8: Obtain Appropriate Local and State Permits for Recreation Facility Services and Utilities

This mitigation measure is described above under Alternative 2.

Solid Waste

The effects on solid waste disposal services that would result from constructing and operating recreation facilities are as described above for Alternative 2 and are briefly summarized here.

Impact UT-13: Increase in Demand for Solid Waste Removal

This impact is described above under Alternative 2. This impact is considered less than significant.

Mitigation Measure UT-MM-8: Obtain Appropriate Local and State Permits for Recreation Facility Services and Utilities

Measures that would minimize the effects of this impact have been incorporated into the Project description. However, implementing Mitigation Measure UT-MM-8, described above for Alternative 2, would monitor the effectiveness of those measures.

Infrastructure Facilities on Adjacent Islands

Under Alternative 3, potential seepage from Project islands would be similar to that described for Alternative 2. As part of Alternative 3, the Project would install an interceptor well system in the exterior levees of the Project islands to control seepage onto adjacent islands, as described in Appendix D2, "Levee Design and Maintenance Measures," of the 2001 FEIS. Design features and proposed seepage control measures would keep potential adverse seepage problems at existing levels or better and there would be no change in the risk to facilities on adjacent islands. Adjacent utilities would not be affected by implementation of Alternative 3.

No-Project Alternative

Increase in the Risk of Road Failure and Maintenance and Repair Needs, Increase in Maintenance Requirements for Gas Lines on Bacon Island, and Increase in the Risk of Structural Failure and Increase in Maintenance Requirements for Existing Distribution Utilities

It is assumed that under the No-Project Alternative, agricultural conditions would intensify on the Project islands. As such, implementation of the No-Project Alternative would result in continued, if not increased subsidence of the island interiors. Subsidence would gradually increase levee instability, seepage, and threats to utility and highway facilities on the Project islands and the risk of a cumulative levee failure on adjacent islands. If the rate of subsidence were to increase with intensified farming under the No-Project Alternative, the rate at which these effects begin to occur on the Project islands also would increase. These effects are discussed in detail in the 2001 FEIR and 2001 FEIS (Jones & Stokes 2001) and hereby are incorporated by reference.

The Project applicant would not be required to implement mitigation measures if the No-Project Alternative were selected by the lead agency. However, mitigation measures were presented for impacts of the No-Project Alternative in the 2001 FEIR and 2001 FEIS to provide information to the reviewing agencies regarding the measures that would reduce impacts if the Project applicant implemented a project that required no federal or state agency approvals. Those mitigation measures are hereby incorporated by reference.

Section 4.5
Fishery Resources

Introduction

This section describes recent changes to the existing environmental conditions and regulatory setting of the Project area, summarizes the unchanged affected environment, and describes changed environmental effects related to fisheries and aquatic resources for the Project. This section contains a review and substantial update of the 2000 RDEIR/EIS fisheries and aquatic resources impact assessment, incorporated by reference in the 2001 FEIR. The fisheries and aquatic resources impacts of the Project were analyzed most recently in the 2001 FEIS, which also served as a basis for this analysis.

This section assesses impacts of Project operations and facilities on fish species that reside in the Delta, Suisun Bay, and San Francisco Bay for at least part of their lives. The effects of Project operations and facilities on habitat conditions common to multiple species and life stages are identified. Factors affecting the population abundance and distribution of individual species are evaluated in detail. Available information was used to identify relationships between species' abundance, survival, and distribution and their habitat.

The methods used in the 2001 FEIR and 2001 FEIS remain largely applicable. For this analysis, those methods are used to assess the likely impacts of the Project on fish resources under the current 2009 Delta conditions. The 1995 Bay-Delta WQCP objectives for fish and wildlife protection, assumed in the 1995 DEIR/EIS baseline, are still used to manage Delta waters. Therefore, the impacts addressed in this chapter continue to assume these objectives (such as X2 and E/I ratio) for the baseline conditions. Diversions to the Project Reservoir Islands are assumed to occur from December to March, a period with high outflow, to allow X2 and E/I objectives to be met. The analysis also incorporates new analyses that build on information provided in the recent USFWS and NMFS BOs.

More than 100 fish species are found in the Delta and Bay. The impact assessment is limited to a subset of species that support important sport and commercial fisheries; species that are unique to the Bay-Delta environment; species listed or being considered for listing under the federal ESA and the CESA; and species that, when considered as a group, encompass the range of potential responses to the effects of Project operations and facility construction. The species specifically addressed in this impact assessment and profiled below are Chinook salmon (*Oncorhynchus tshawytscha*), steelhead (*O. mykiss*), striped bass (*Morone saxatilis*), American shad (*Alosa sapidissima*), threadfin shad (*Dorosoma petenense*), delta smelt (*Hypomesus transpacificus*), longfin smelt (*Spirinchus thaleichthys*), Sacramento splittail (*Pogonichthys macrolepidotus*), and green sturgeon (*Acipenser medirostris*).

On-island fishery resources (i.e., fish within the existing water bodies on the Project islands) were not included in the fishery impact assessment. The existing on-island fishery resources are negligible relative to total fishery resources in the Delta. Existing fish populations on the Project islands are limited to perennial ponds and drainage ditches. The ponds support primarily introduced sunfish, catfish, and minnows. No fish species that are federally listed as Threatened or Endangered or candidates for listing, or state-listed as Threatened or Endangered or candidates for listing, are known to exist on the Project islands.

The discussion of fisheries in this chapter includes some terms that may not be familiar to all readers. The following are definitions of these terms as they are used in this Place of Use EIR:

- **Entrapment zone**. An area or zone of the Bay-Delta estuary where riverine current meets upstream-flowing estuarine currents and variations in flow interact with particle settling to trap particles. This results in a region of the estuary characterized by higher levels of particulates, higher abundance of several types of organisms, and a turbidity maximum. The entrapment zone generally corresponds to a surface salinity range of 2–10 milliSiemens per centimeter (mS/cm) specific conductance (Kimmerer 1992).
- **X2**. The location in the Bay-Delta estuary relative to the Golden Gate Bridge (measured in kilometers) of the 2-parts per thousand (ppt) isohaline 1 meter off the bottom (San Francisco Estuary Project 1993). An isohaline is a line connecting all points of equal salinity. This represents the upstream end of the entrapment zone and the transition from fresh water to the estuarine salt gradient. X2 is a function of Delta outflow volume; as outflow increases, X2 is reduced (the 2-ppt isohaline moves downstream).
- **Fall midwater trawl index (FMWT)**. This annual index is the sum of the weighted catch of four monthly samples (September–December) from numerous locations in the Delta and Suisun Bay. The index is assumed to be a measure of abundance when considered in relation to the catch for all other years of the sampling record (1967–2008). In the Bay-Delta estuary, the index has been developed for striped bass, American shad, delta smelt, Sacramento splittail, longfin smelt, and other species.
- **Entrainment**. The process in which fish are drawn into water diversion facilities along with water drawn from a channel or other water body by siphons and/or pumps. Entrainment loss includes all fish not salvaged (i.e., eggs, larvae, juveniles, and adults that pass through the fish screens, are impinged on the fish screens, or are eaten by predators).
- **Salvage**. Removal of fish from screens on diversion structures and the subsequent return of the fish to the water body. Fish eggs and larvae (e.g., delta smelt, striped bass, longfin smelt) are small, pass through the screens, and are not included in salvage numbers. The CVP and SWP fish collection

facilities use louvers rather than wire screens to separate fish from the water being pumped for export.

Fish resources in the places of use are expected to remain unchanged because the project will not directly affect fish in those areas. Additional discussion of effects associated with the places of use occur in Chapter 5, “Cumulative Impacts,” and Chapter 6, “Growth-Inducing Impacts.”

Summary of Impacts

The No-Project Alternative includes continued loss of fish through unscreened intakes on the Project islands and elsewhere in the Delta and entrainment loss of fish during export of Delta water by the SWP and CVP pumping facilities.

The Project has the potential to affect fishery resources during construction and operations. Short-term construction-related impacts (e.g., increase in turbidity) will be minimized by incorporation of best management practices. Long-term loss of spawning and rearing habitat due to construction of Project facilities are significant and unavoidable because of the critical status of many of the affected species; these losses are mitigated by providing a conservation easement of tidal habitat at Chipps Island that is three times larger than the area lost due to construction.

Operations-related water quality impacts on fish during discharge of Project reservoir water include potential increases in organic materials, toxics, and temperature, as well as decreases in DO. Changes in organic materials (primarily dissolved organic carbon) would not be significant to fish (See Section 4.2, Water Quality). Temperature and DO changes are not expected to be significant because temperature and DO of reservoir water will be monitored as an environmental commitment and discharges will not be made if to do so would cause receiving Delta water to exceed established thresholds. Increases in boat operations at the new dock facilities would increase the potential for accidental spills of fuels and other materials, as well as increased erosion caused by boat wakes. These impacts are not significant because of two environmental commitments: implementation of an accidental spill prevention program and a boat-wake reduction measure.

Among all Project impacts, operations-related flow impacts are probably the most likely to affect fish. For species residing in or passing through the Delta, direct entrainment of larvae and small fish onto the Project’s Reservoir Islands is likely to occur despite the Project’s intakes being screened, although the loss of fish of screenable size should be minimal (i.e., 5% that of an unscreened intake). Entrainment onto the Project islands would occur during diversions made from December to March and would affect species present in the central Delta at the time. Sensitive species present at that time include delta smelt, longfin smelt, various salmonids, and green sturgeon. Monitoring of water diverted onto the Reservoir Islands that is included as part of the Project’s environmental commitments would allow diversions to be reduced/curtailed if delta smelt are found in the diverted water.

Increased entrainment of fish at the SWP and CVP pumping facilities during export of discharged Project water would occur from July to November and would therefore avoid most sensitive species, although losses of Sacramento splittail and green sturgeon would be likely to occur. Entrainment losses of zooplankton may decrease the amount of prey available for species such as delta smelt. Changes in Old and Middle River flows due to Project diversions could also increase delta smelt entrainment at the SWP and CVP pumping facilities in December to March by drawing fish towards to the south Delta.

Project diversions to the Reservoir Islands may create altered hydrodynamics and flows within the Delta that may disorient or delay outmigrating salmonids, leading to increased loss because of predation, entrainment, or exposure to poor water quality. Flow diversions would reduce the area of optimal salinity habitat in the Bay-Delta for some species because of the decrease in freshwater outflow from the Delta; other outflow-related mechanisms such as retention in more suitable estuarine regions may also be affected.

Beneficial releases of Project water for Delta outflow occur in September–November of some years and would increase the amount of habitat available for some species; the increase in fall habitat for subadult delta smelt may increase their survival to adulthood, which in turn may increase the recruitment of juvenile delta smelt the following year.

The combined Project impacts are significant and unavoidable for Chinook salmon, steelhead, delta smelt, longfin smelt, and green sturgeon. In addition to the environmental commitments mentioned above, mitigation for the anticipated impacts on fish includes establishment of a fishery improvement mitigation fund (of an amount that will be determined following consultation with the resource agencies) and establishment of a 200-acre shallow-water conservation easement at Chipps Island. The impacts of the Project on Sacramento splittail and other species are not expected to be significant.

The aforementioned Project impacts apply to both Alternatives 1 and 2. As discussed previously, the fisheries analysis for this Place of Use EIR simulates the effects of the Proposed Project, which is Alternative 2 as amended by the incorporation of measures of the BOs, FOC, WQMP, protest dismissal agreements, and all other environmental commitments as discussed in Chapter 2. The simulation of the Proposed Project encompasses the full range of impacts associated with Alternatives 1 and 2. Project Alternative 1 would give similar but reduced flow-related impacts because less water would be discharged for export and instead could be discharged for beneficial Delta outflow. Project Alternative 3 would give greater impacts than Alternatives 1 and 2 and is analyzed qualitatively.

Table 4.5-1 provides a summary and comparison of the impacts and mitigation measures for fishery resources from the 2001 FEIR, 2001 FEIS, and this Place of Use Draft EIR.

Table 4.5-1. Comparison between Delta Wetlands Project 2010 Place of Use EIR Impacts and 2001 FEIR and FEIS 2001 Impacts and Mitigation Measures Fishery Resources

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
ALTERNATIVES 1 AND 2	
Impact F-1: Alteration of Habitat (LTS) **Mitigation:** No mitigation is required	**Impact FISH-1:** Alteration of Habitat through Construction of Project Facilities (LTS-M) **Mitigation Measure FISH-MM-1:** Conservation of Shallow-Water Vegetated Habitat **Mitigation Measure REC-MM-1:** Reduce the Size or Number of Recreation Facilities **Mitigation Measure FISH-MM-2:** Site Project Facilities to Avoid Existing Shallow-Water Vegetated Habitat **Mitigation Measure FISH-MM-3:** Limit Waterside Construction to Less-Sensitive Time Periods **Mitigation Measure FISH-MM-4:** Implement Best Management Practices for Waterside Construction
	Impact FISH-2: Increase in Organic Materials and Toxics and Decrease in Dissolved Oxygen of Delta Water because of Project Discharges (LTS) **Mitigation:** No mitigation is required.
Impact F-2: Increase in Temperature-Related Mortality of Juvenile Chinook Salmon (LTS) **Mitigation:** No mitigation is required.	**Impact FISH-3:** Temperature-Related Impacts on Chinook Salmon and Other Species (LTS) **Mitigation:** No mitigation is required.
Impact F-3: Potential Increase in Accidental Spills of Fuel and Other Materials (LTS) **Mitigation:** No mitigation is required.	**Impact FISH-4:** Potential Increase in Accidental Spills of Fuel and Other Materials and Boat Wake Erosion (LTS) **Mitigation:** No mitigation is required.
Impact F-4: Potential Increase in the Mortality of Chinook Salmon Resulting from the Indirect Effects of DW Project Diversions and Discharges on Flows (LTS) **Mitigation:** No mitigation is required.	**Impact FISH-5:** Effects of the Project on Juvenile Chinook Salmon (SU) **Mitigation Measure FISH-MM-1:** Conservation of Shallow-Water Vegetated Habitat **Mitigation Measure FISH-MM-5:** Implement a Fishery Improvement Mitigation Fund **Mitigation Measure FISH-MM-6:** Establish a Shallow-Water Aquatic Habitat Conservation Easement
	Impact FISH-6: Effects of the Project on Juvenile Steelhead (SU) **Mitigation Measure FISH-MM-1:** Conservation of Shallow-Water Vegetated Habitat **Mitigation Measure FISH-MM-5:** Implement a Fishery Improvement Mitigation Fund **Mitigation Measure FISH-MM-6:** Establish a Shallow-Water Aquatic Habitat Conservation Easement
Impact F-5: Reduction in Downstream Transport and Increase in Entrainment Loss of Striped Bass Eggs and Larvae, Delta Smelt Larvae, and Longfin Smelt Larvae (LTS) **Mitigation:** No mitigation is required.	Transport and entrainment losses now included in species specific impact assessments.

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
Impact F-6: Change in Area of Optimal Salinity Habitat (LTS) **Mitigation:** No mitigation is required.	Salinity analysis now included in Impact FISH-7 Effects of the Project on Delta Smelt, Impact F-8 Effects of the Project on Longfin Smelt, and Impact FISH-11 Effects of the Project on Other Aquatic Species.
Impact F-7: Increase in Entrainment Loss of Juvenile Striped Bass and Delta Smelt (LTS) **Mitigation:** No mitigation is required.	**Impact FISH-7:** Effects of the Project on Delta Smelt (SU) **Mitigation Measure FISH-MM-1:** Conservation of Shallow-Water Vegetated Habitat **Mitigation Measure REC-MM-1:** Reduce the Size or Number of Recreation Facilities **Mitigation Measure FISH-MM-2:** Site Project Facilities to Avoid Existing Shallow-Water Vegetated Habitat **Mitigation Measure FISH-MM-3:** Limit Waterside Construction to Less- Sensitive Time Periods **Mitigation Measure FISH-MM-4:** Implement Best Management Practices for Waterside Construction **Mitigation Measure FISH-MM-5:** Implement a Fishery Improvement Mitigation Fund **Mitigation Measure FISH-MM-6:** Establish a Shallow-Water Aquatic Habitat Conservation Easement
Impact F-8: Increase in Entrainment Loss of Juvenile American Shad and Other Species (LTS) **Mitigation:** No mitigation is required.	**Impact FISH-11:** Effects of the Project on Other Aquatic Species (LTS) **Mitigation:** No mitigation is required.
	Impact FISH-8: Effects of the Project on Longfin Smelt (SU) **Mitigation Measure FISH-MM-1:** Conservation of Shallow-Water Vegetated Habitat **Mitigation Measure REC-MM-1:** Reduce the Size or Number of Recreation Facilities **Mitigation Measure FISH-MM-2:** Site Project Facilities to Avoid Existing Shallow-Water Vegetated Habitat **Mitigation Measure FISH-MM-3:** Limit Waterside Construction to Less- Sensitive Time Periods **Mitigation Measure FISH-MM-4:** Implement Best Management Practices for Waterside Construction **Mitigation Measure FISH-MM-5:** Implement a Fishery Improvement Mitigation Fund **Mitigation Measure FISH-MM-6:** Establish a Shallow-Water Aquatic Habitat Conservation Easement
	Impact FISH-9: Effects of the Project on Green Sturgeon (SU) **Mitigation Measure FISH-MM-5:** Implement a Fishery Improvement Mitigation Fund

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
	Impact FISH-10: Effects of the Project on Sacramento Splittail (LTS) No mitigation required, but the following will monitor Project measures: **Mitigation Measure FISH-MM-1:** Conservation of Shallow-Water Vegetated Habitat **Mitigation Measure REC-MM-1:** Reduce the Size or Number of Recreation Facilities **Mitigation Measure FISH-MM-2:** Site Project Facilities to Avoid Existing Shallow-Water Vegetated Habitat **Mitigation Measure FISH-MM-3:** Limit Waterside Construction to Less- Sensitive Time Periods **Mitigation Measure FISH-MM-4:** Implement Best Management Practices for Waterside Construction **Mitigation Measure FISH-MM-5:** Implement a Fishery Improvement Mitigation Fund **Mitigation Measure FISH-MM-6:** Establish a Shallow-Water Aquatic Habitat Conservation Easement
ALTERNATIVE 3	
Impact F-9: Alteration of Habitat (LTS-M) **Mitigation Measure F-1:** Implement Fish Habitat Management Actions	**Impact FISH-1:** Alteration of Habitat through Construction of Project Facilities (LTS-M) **Mitigation Measure FISH-MM-1:** Conservation of Shallow-Water Vegetated Habitat **Mitigation Measure REC-MM-1:** Reduce the Size or Number of Recreation Facilities **Mitigation Measure FISH-MM-2:** Site Project Facilities to Avoid Existing Shallow Water Vegetated Habitat **Mitigation Measure FISH-MM-3:** Limit Waterside Construction to Less Sensitive Time Periods **Mitigation Measure FISH-MM-4:** Implement Best Management Practices for Waterside Construction
	Impact FISH-2: Increase in Organic Materials and Toxics and Decrease in Dissolved Oxygen of Delta Water because of Project Discharges (LTS) **Mitigation:** No mitigation is required.
Impact F-10: Increase in Temperature-Related Mortality of Juvenile Chinook Salmon (LTS-M) **Mitigation Measure F-2:** Monitor the Water Temperature of DW Discharges and Reduce DW Discharges to Avoid Producing Any Increase in Channel Temperature Greater Than 1°F.	**Impact FISH-3:** Temperature-Related Impacts on Chinook Salmon and Other Species (LTS) **Mitigation:** No mitigation is required
Impact F-11: Potential Increase in Accidental Spills of Fuel and Other Materials (LTS) **Mitigation:** No mitigation is required.	**Impact FISH-4:** Potential Increase in Accidental Spills of Fuel and Other Materials and Boat Wake Erosion (LTS) **Mitigation:** No mitigation is required.

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
Impact F-12: Potential Increase in the Mortality of Chinook Salmon Resulting from the Indirect Effects of DW Project Diversions and Discharges on Flows (LTS-M) **Mitigation Measure F-3:** Operate the DW Project under Operations Objectives That Would Minimize Changes in Cross-Delta Flow Conditions during Peak Out-Migration of Mokelumne and San Joaquin River Chinook Salmon	**Impact FISH-5:** Effects of the Project on Juvenile Chinook Salmon (SU) **Mitigation Measure FISH-MM-1:** Conservation of Shallow-Water Vegetated Habitat **Mitigation Measure FISH-MM-5:** Implement a Fishery Improvement Mitigation Fund **Mitigation Measure FISH-MM-6:** Establish a Shallow-Water Aquatic Habitat Conservation Easement
	Impact FISH-6: Effects of the Project on Juvenile Steelhead (SU) **Mitigation Measure FISH-MM-1:** Conservation of Shallow-Water Vegetated Habitat **Mitigation Measure FISH-MM-5:** Implement a Fishery Improvement Mitigation Fund **Mitigation Measure FISH-MM-6:** Establish a Shallow-Water Aquatic Habitat Conservation Easement
Impact F-13: Reduction in Downstream Transport and Increase in Entrainment Loss of Striped Bass Eggs and Larvae, Delta Smelt Larvae, and Longfin Smelt Larvae (LTS-M) **Mitigation Measure F-4:** Operate the DW Project under Operations Objectives That Would Minimize Adverse Transport Effects on Striped Bass, Delta Smelt, and Longfin Smelt	Transport and entrainment losses now included in species specific impact assessments of Alternative 2; qualitative analysis of Alternative 3 carried out in relation to impacts determined for Alternative 2.
Impact F-14: Change in Area of Optimal Salinity Habitat (LTS) **Mitigation:** No mitigation is required.	Salinity analysis now included in Impact FISH-7 Effects of the Project on Delta Smelt, Impact F-8 Effects of the Project on Longfin Smelt, and Impact F-11 Effects of the Project on Other Aquatic Species for Alternatives 1 and 2. Effects of Alternative 3 qualitatively considered to be somewhat greater than for Alternative 2.
Impact F-15: Increase in Entrainment Loss of Juvenile Striped Bass and Delta Smelt (LTS-M) **Mitigation Measure F-5:** Operate the DW Project under Operations Objectives That Would Minimize Entrainment of Juvenile Striped Bass and Delta Smelt	**Impact FISH-7:** Effects of the Project on Delta Smelt (SU) **Mitigation Measure FISH-MM-1:** Conservation of Shallow-Water Vegetated Habitat **Mitigation Measure REC-MM-1:** Reduce the Size or Number of Recreation Facilities **Mitigation Measure FISH-MM-2:** Site Project Facilities to Avoid Existing Shallow-Water Vegetated Habitat **Mitigation Measure FISH-MM-3:** Limit Waterside Construction to Less- Sensitive Time Periods **Mitigation Measure FISH-MM-4:** Implement Best Management Practices for Waterside Construction **Mitigation Measure FISH-MM-5:** Implement a Fishery Improvement Mitigation Fund **Mitigation Measure FISH-MM-6:** Establish a Shallow-Water Aquatic Habitat Conservation Easement

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
Impact F-16: Increase in Entrainment Loss of Juvenile American Shad and Other Species (LTS) **Mitigation:** No mitigation is required.	**Impact FISH-11:** Effects of the Project on Other Aquatic Species (LTS) **Mitigation:** No mitigation is required.
	Impact FISH-8: Effects of the Project on Longfin Smelt (SU) **Mitigation Measure FISH-MM-1:** Conservation of Shallow-Water Vegetated Habitat **Mitigation Measure REC-MM-1:** Reduce the Size or Number of Recreation Facilities **Mitigation Measure FISH-MM-2:** Site Project Facilities to Avoid Existing Shallow-Water Vegetated Habitat **Mitigation Measure FISH-MM-3:** Limit Waterside Construction to Less- Sensitive Time Periods **Mitigation Measure FISH-MM-4:** Implement Best Management Practices for Waterside Construction **Mitigation Measure FISH-MM-5:** Implement a Fishery Improvement Mitigation Fund **Mitigation Measure FISH-MM-6:** Establish a Shallow-Water Aquatic Habitat Conservation Easement
	Impact FISH-9: Effects of the Project on Green Sturgeon (SU) **Mitigation Measure FISH-MM-6:** Implement a Fishery Improvement Mitigation Fund
	Impact FISH-10: Effects of the Project on Sacramento Splittail (LTS) No mitigation required, but the following will monitor Project measures: **Mitigation Measure FISH-MM-1:** Conservation of Shallow-Water Vegetated Habitat **Mitigation Measure REC-MM-1:** Reduce the Size or Number of Recreation Facilities **Mitigation Measure FISH-MM-2:** Site Project Facilities to Avoid Existing Shallow-Water Vegetated Habitat **Mitigation Measure FISH-MM-3:** Limit Waterside Construction to Less- Sensitive Time Periods **Mitigation Measure FISH-MM-4:** Implement Best Management Practices for Waterside Construction **Mitigation Measure FISH-MM-5:** Implement a Fishery Improvement Mitigation Fund **Mitigation Measure FISH-MM-6:** Establish a Shallow-Water Aquatic Habitat Conservation Easement

Note: SU = Significant and unavoidable; LTS = Less than significant; LTS-M = Less than significant with mitigation; B = Beneficial.

Summary of Changes, New Circumstances, and New Information

Changes that may potentially affect the environment, regulatory setting, or environmental effects of the Project on fishery resources are described briefly below.

Substantial Changes in the Project

Since the 2001 FEIR and 2001 FEIS, there have been no substantial changes to the Project design regarding fishery resources. Fish screen designs have continued to improve and the Project will use the latest fish screen technology in the implementation of the Project. Project operations have not substantially changed, though the diversion and discharge periods will likely change to be more protective of fishery resources consistent with new circumstances and new information. Many of the fish protection measures agreed to in the previous FOC have been assumed to apply for the Place of Use EIR. The Project will obtain revised BOs from DFG, USFWS, and NMFS and four of the provisions in the 1997 FOC are now included as environmental commitments.

New Circumstances and New Information

Major changes to the environmental setting have occurred since 2001 that may affect the FOC and/or RPMs in the BOs for the Project:

- the in-progress Bay Delta Conservation Plan (BDCP), described in more detail in Chapter 2, "Project Description";
- the measured decrease in the abundance of four San Francisco estuary fish species (delta smelt, longfin smelt, striped bass and threadfin shad) known as the pelagic organism decline (POD);
- fluctuating abundance of salmonids, with fall-run Chinook salmon generally decreasing and other runs such as winter-run and late fall–run Chinook salmon showing some increases coupled with variability, but with all runs being low in abundance in 2007 and 2008 primarily because of poor ocean conditions (Lindley et al. 2009);
- several years of drought conditions; and
- the revised BOs for OCAP requiring Reclamation and DWR to manage CVP and SWP Delta operations to protect
  - delta smelt (2008 USFWS BO) and
  - winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, southern DPS of North American green sturgeon, and southern resident killer whales (2009 NMFS BO).

The implications of these changes have necessitated a review and update of all fishery resource effects.

Affected Environment

This section provides an overview of federal and state regulations, life histories of selected Delta-resident or migratory fish species with major factors affecting their population abundance, and summaries of recent Delta programs (planning efforts).

Regulatory Setting

The following section describes new or modified regulations affecting fish relative to the Project and summarizes previously identified regulations.

Federal

Federal Endangered Species Act

The federal Endangered Species Act (ESA) protects fish and wildlife species, and their habitats identified by the USFWS and NMFS as Threatened or Endangered. *Endangered* refers to species, subspecies, or distinct population segments (DPSs) that are in danger of extinction through all or a significant portion of their range; *Threatened* refers to species, subspecies, or DPSs that are likely to become Endangered in the near future. *Species of concern* refers to species, subspecies, or DPSs that NMFS or USFWS are concerned about because of status and threats and for which there is insufficient information to warrant listing under the ESA. The ESA is administered by the USFWS and NMFS. In general, NMFS is responsible for protection of ESA-listed marine species and anadromous fishes, whereas other listed species are under USFWS jurisdiction.

Five Delta fish species are listed currently under the ESA (Table 4.5-2). NMFS administers ESA for marine fish species, including anadromous salmonids such as Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and green sturgeon. USFWS administers ESA for non-anadromous and non-marine fish species such as delta smelt (and longfin smelt, which has been recently proposed for listing). Although delisted in 2003, the Sacramento splittail remains a species of concern.

The ESA requires the federal government to designate “critical habitat” for any species it lists under the ESA. “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.

Current ESA status of fish species in the Delta is presented in Table 4.5-2.

Table 4.5-2. Special-Status ESA Fish Species in the Sacramento–San Joaquin River Delta

Evolutionarily Significant Unit/Distinct Population Segment	ESA Status	Listing Agency
Central Valley spring-run Chinook salmon ESU	Threatened	NMFS
Sacramento River winter-run Chinook salmon ESU	Endangered	NMFS
Central Valley fall- and late fall–run Chinook salmon ESU	Species of Concern	NMFS
Central Valley steelhead DPS	Threatened	NMFS
Green sturgeon-southern DPS	Threatened	NMFS
Delta smelt	Threatened	USFWS (ESA status review in progress)
Sacramento splittail	Species of Concern	USFWS

Sources: California Department of Fish and Game 2009a; National Marine Fisheries Service Southwest Regional Office 2008; 68 FR 55140.

ESU = evolutionarily significant unit; DPS = distinct population segment.

[1] An Evolutionarily Significant Unit is a population or group of populations that is substantially reproductively isolated from other population units of the same species and represents an important component in the evolutionary legacy of the species. ESUs refer only to Pacific salmon species. A Distinct Population Segment is the smallest division of a taxonomic vertebrate species that is permitted to be protected under the ESA. Individuals within a DPS may interbreed when mature, but do not interbreed with individuals from other DPSs.

[2] Delta smelt were listed by the USFWS as Threatened under the ESA on March 5, 1993. A recovery plan for the Delta was approved by USFWS on November 26, 1996, including appointment of a Recovery Team. The Native Fishes 5-Year Review completed on March 31, 2004, concluded that no change in ESA classification was warranted. Since then, USFWS initiated a 5-year status review on March 24, 2009, to determine whether up-listing delta smelt to an Endangered status is warranted.

Section 9—Endangered Species Act Prohibitions

Section 9 of ESA prohibits the take of any fish or wildlife species listed under ESA as Endangered. Take of Threatened species is also prohibited under Section 9, unless otherwise authorized by federal regulations. *Take*, as defined by ESA, means “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct” (Section 3 of the ESA; 16 USC Section 1532[19]). *Harm* is defined by regulation as “any act that kills or injures the species, including significant habitat modification” (50 CFR Sections 17.3; 222.102). In addition, Section 9 prohibits removing, digging up, cutting, and maliciously damaging or destroying federally listed plants on sites under federal jurisdiction. Section 9 does not prohibit take of federally listed plants on sites not under federal jurisdiction. If the Project may result in take prohibited by Section 9, this take would need to be authorized through ESA Sections 7 or 10 (providing for the issuance of “incidental take” permits).

Section 7—Endangered Species Act Consultation Process

Section 7 consultation provides a means for authorizing *take* of listed species for actions by federal agencies. Federal agency actions include activities that are:

- on federal land,
- conducted by a federal agency,
- funded by a federal agency, or
- authorized by a federal agency (including issuance of federal permits and licenses).

Under Section 7, the federal agency conducting, funding, or permitting an action (the federal lead agency) must, in consultation with USFWS or NMFS, as appropriate, ensure that its proposed action will not jeopardize the continued existence of an Endangered or Threatened species or destroy or adversely modify designated critical habitat. If a proposed project "may affect" a listed species or designated critical habitat, the lead agency is required to prepare a BA evaluating the nature and severity of the expected effect. The BA is prepared for the proposed action and is submitted to USFWS and/or NMFS to initiate consultation. In response to a BA, USFWS and/or NMFS issues a BO, with a determination that the proposed action either:

- may jeopardize the continued existence of one or more listed species (jeopardy finding) or result in the destruction or adverse modification of critical habitat (adverse modification finding), or
- will not jeopardize the continued existence of any listed species (no jeopardy finding) or result in adverse modification of critical habitat (no adverse modification finding).

The BO issued by USFWS and/or NMFS may stipulate discretionary "reasonable and prudent" conservation measures. If the proposed action would not jeopardize a listed species, USFWS and/or NMFS may issue an incidental take statement to authorize the proposed activity and may include appropriate measures to offset the impacts of take.

Section 10—Incidental Take

In cases where a nonfederal entity is undertaking an action that does not require federal authorization, the take of listed species must be permitted by USFWS and/or NMFS through Section 10 of the ESA. If the proposed action would result in the incidental take of a listed species, the applicant must first obtain a Section 10(a)(1)(B) incidental take permit (ITP). *Incidental take* under Section 10 is defined as take of federally listed fish and wildlife species "that is incidental to, but not the purposes of, otherwise lawful activities." To receive an ITP, the nonfederal entity is required to prepare a Habitat Conservation Plan (HCP). The HCP must include conservation measures that avoid, minimize, and mitigate the project's impacts on listed species and their habitat.

Summary of Past Project Endangered Species Act Compliance

In 1997 and 1998, the following no-jeopardy BOs were issued that addressed effects of the Project, as modified by the Project operating parameters referred to as the FOC, on delta smelt and winter-run Chinook salmon:

- **USFWS opinion (May 1997).** USFWS addressed Project effects on delta smelt and critical habitat for delta smelt; this BO also incorporated a conference opinion on Project effects on splittail, which had been proposed for listing as Threatened.

- **NMFS opinion (May 1997).** NMFS addressed Project effects on winter-run Chinook salmon and its critical habitat; this BO also incorporated a draft conference opinion on Project effects on the Central Valley steelhead evolutionarily significant unit (ESU), which had been proposed for listing as Endangered.

The USFWS and NMFS BOs incorporated conference opinions on splittail and steelhead, respectively, which were not listed at that time. The conference opinions found that the Project, as modified by the FOC, would not jeopardize the continued existence of these species. USFWS formally adopted the conference opinion as its BO on splittail for the Project in April 2000. USFWS's letter notifying the Corps of the adoption was included in Appendix E of the 2000 RDEIR/EIS. NMFS formally adopted the conference opinion as its BO on steelhead for the Project in May 2000.

In 1999, to address potential Project effects on Central Valley spring-run Chinook salmon ESU, the Corps requested consultation with NMFS in accordance with Section 7 of the ESA. The Corps noted that the protective measures included in the BOs for previously listed species cover the period when spring-run Chinook salmon occur in the Delta and concluded that these measures therefore would also minimize adverse effects of the Project on spring-run Chinook salmon. NMFS concurred with this conclusion and issued a BO that stated that the Project was not likely to jeopardize the continued existence of spring-run Chinook salmon or result in the adverse modification of its critical habitat or that of Central Valley steelhead ESU in August 2000. The requirements of the final BOs were incorporated into the FOC.

Biological Opinions and Federal Court Rulings Related to the State Water Project/Central Valley Project Operations Criteria and Plan

The U.S. District Court recently issued several rulings affecting the CVP and SWP operations and conditions in the Delta. These rulings were based on a challenge to the sufficiency of the 2004 Long-Term CVP OCAP and the 2005 BO to protect ESA-listed fish species (delta smelt, Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead).

As a result of lawsuits challenging the ESA compliance of the OCAP and coordinated operations of the CVP and SWP, USFWS issued a new BO on the OCAP operational effects on delta smelt on December 15, 2008, which concluded that the continued operation of the CVP and SWP will jeopardize the continued existence of delta smelt and adversely modify its critical habitat. The BO prescribed a Reasonable and Prudent Alternative (RPA) intended to protect all life stages of delta smelt and avoid adverse modification to critical habitat. Components of the RPA included:

- reduced entrainment of pre-spawning adult delta smelt during December to March by controlling Old and Middle River (OMR) flows during vulnerable periods;
- reduced entrainment of larval and juvenile smelt by controlling OMR flow during spring periods, allowing smelt to successfully rear in the Central Delta and move downstream when appropriate;
- improved fall habitat for delta smelt by increasing Delta outflow during the fall months;
- enhanced delta smelt habitat via creation or restoration of at least 8,000 acres of intertidal and subtidal habitat in the Delta and Suisun Marsh; and
- collecting and reporting of monitoring information to establish compliance with the RPA intention and inform the adaptive management process.

In accordance with the RPA, incidental take of the delta smelt by CVP and SWP is permitted.

On July 18, 2008, Judge Wanger also ruled that the operation of the SWP and CVP pumps would "appreciably increase jeopardy" of Central Valley spring Chinook salmon, Sacramento River winter Chinook salmon, and steelhead. This decision was related to his judgment on the 2004 and 2005 OCAP BO described above. While concluding that operation of the pumps under OCAP adversely affected these listed species, Judge Wanger did not order any restrictions of existing water projects related to these species. The RPA from the USFWS (2008a) OCAP BO is summarized below in the section entitled Environmental Setting and is detailed in Appendix B.

The NMFS OCAP BO released in June 2009 concluded that the CVP and SWP OCAP would jeopardize the continued existence of federally listed Endangered Sacramento River winter-run Chinook salmon, Threatened Central Valley spring-run Chinook salmon, Threatened Central Valley steelhead, Threatened southern DPS of North American green sturgeon, and Endangered southern resident killer whales. The 2009 NMFS BO contained a suite of RPA measures to avoid the likelihood of jeopardy to the species and to avoid adverse modification of designated and proposed critical habitat. The RPA grouped action measures according to geographic divisions of the SWP/CVP project area, including the Sacramento River Division, American River Division, East Side Division, and Delta Division, as well as a Fish Passage Program incorporating near- and long-term measures. With regard to operations in the Delta, the main actions included changes in operations to the Delta Cross Channel (DCC) to reduce the number of salmonids entering the central Delta; maintenance of adequate flows in the Sacramento and San Joaquin Rivers to increase survival of migrating salmonids; reduction of the likelihood of entrainment/salvage at the south Delta fish collection facilities; and improved efficiency of the fish collection facilities. A full summary of the NMFS (2009) RPA is provided in Appendix B. At the time of this EIR, the Bureau of Reclamation and DWR have started implementing various components of the RPA from the USFWS (2008a) and NMFS (2009) BOs.

State

California Endangered Species Act

The California Endangered Species Act (CESA) generally parallels the main provisions of the ESA and is administered by DFG.

Under CESA, *Endangered species* is defined as a species of plant, fish, or wildlife that is "in serious danger of becoming extinct throughout all, or a significant portion of its range" and is limited to species or subspecies native to California (California Fish and Game Code Section 2062). *Threatened species* means a native species or subspecies of a bird, mammal, fish, amphibian, reptile, or plant that, although not presently threatened with extinction, is likely to become an Endangered species in the foreseeable future in the absence of the special protection and management efforts (California Fish and Game Code Section 2062). Section 2080 of the act prohibits the take of Endangered and Threatened species, except as otherwise provided under Fish and Game Code Sections 2080.1 (if the species is listed under both ESA and CESA and take authorization has already been provided through the ESA, DFG can write a consistency determination where it determines that the avoidance, minimization, and compensation measures are consistent with the provisions of CESA), 2081(b) (where DFG makes findings that, among other things, the impacts of take are minimized and fully mitigated and that the take would not lead to jeopardy), and 2835 (as part of a Natural Communities Conservation Planning Act (NCCPA), where it has been covered under an approved Natural Communities Conservation Plan). Unlike its federal counterpart, CESA also applies the take prohibitions to species petitioned for listing (state candidates).

Nineteen fish species are listed currently under CESA, plus one *species of special concern*[1], the Sacramento splittail. Of these species, five are found in the Delta (Table 4.5-3).

Table 4.5-3. Special-Status CESA Fish Species in the Sacramento–San Joaquin River Delta

Evolutionarily Significant Unit/Distinct Population Segment	CESA Status
Sacramento River winter-run Chinook salmon ESU	Endangered
Central Valley spring-run Chinook salmon ESU	Threatened
Delta smelt	Threatened (Candidate Endangered)
Longfin smelt	Threatened
Sacramento splittail	Species of Special Concern

Source: California Department of Fish and Game 2009b; California Fish and Game Commission 2009.
ESU = Evolutionarily Significant Unit.

[1] A species of special concern has population numbers that are declining at a rate that could result in its becoming threatened or Endangered in the future if efforts to stop or slow its declines are not successful, or, in some cases, because it historically occurred in low numbers and there are known threats to its persistence. *Species of special concern* is an administrative designation and carries no formal legal status; DFG has assigned the designation to provide management intended to reduce the need to give the species formal protection.

Summary of Past Project CESA Compliance

DFG issued a no-jeopardy BO addressing the effects of the Project, as modified by the FOC, on state-listed species including delta smelt and winter-run Chinook salmon. DFG's BO on Project effects on delta smelt and winter-run Chinook salmon also assessed Project impacts on spring-run Chinook salmon, but made no conclusions about effects on this species because the species was not listed at the time. The reasonable and prudent measures (RPMs) described in the BO were indicated as minimizing adverse impacts of the incidental taking of spring-run Chinook salmon and of the fish species that were listed then. In accordance with Section 2081 of the California Fish and Game Code, the Project requested concurrence directly from DFG that the protective measures in the existing BO adequately addressed potential Project effects on spring-run Chinook salmon.

Other Provisions of the California Fish and Game Code

The California Fish and Game Code Section 5515 prohibits take of *fully protected* fish species, i.e., species that cannot be taken for any reason other than scientific research; however, none reside in the Delta. DFG also regulates work that will substantially affect resources associated with rivers, streams, and lakes in California, pursuant to Fish and Game Code Sections 1600–1607. Any action that would alter the flow or bed of a water body or occur within its annual high water mark requires a Lake or Streambed Alteration Agreement. The Project will need a Streambed Alteration Agreement.

Environmental Water Account

The Environmental Water Account (EWA) is a cooperative program to protect the native fish species of the Bay-Delta estuary through environmentally beneficial changes to CVP and SWP operations at no uncompensated water cost to the CVP/SWP water users. The EWA was developed to address fish protection and recovery in the Delta, while improving water supply reliability for CVP and SWP customers.

The EWA benefits conditions for fish species in the Delta by curtailing export pumping at the CVP and SWP pumps. Water not diverted from the Delta into the state water supply system is replaced by purchases of water from willing sellers. EWA establishes a water "bank" in upstream reservoirs that can be released to enhance conditions for fish and other aquatic species. Management of the EWA is the responsibility of an interagency committee with members from DFG, USFWS, and NMFS. DWR and Reclamation are responsible for acquiring, storing, and conveying water assets. A recent quantitative analysis of the benefits of the EWA found that, over the first 5 years of the EWA, the survival of winter-run Chinook salmon was increased by 0–6% and the survival of adult and juvenile delta smelt increased by 0–1% and 2–4%, respectively (Brown et al. 2009). These benefits were deemed "rather small" for winter-run Chinook salmon (although it was acknowledged that more information was needed on prescreen losses at the SWP/CVP fish salvage facilities) and "modest" for delta smelt (Brown et al. 2009: 365). Further, it was noted that focusing EWA actions on a single life stage of a single species may produce better overall results (Brown et al. 2009).

A limited EWA program is assumed in the 2008 OCAP modeling, consisting of only the 60 taf/year that has been purchased by DWR from the Yuba Water Agency. A slightly larger EWA was assumed in the baseline Delta modeling used for evaluation of the Project operational effects.

Local

Bacon and Bouldin Islands are located in San Joaquin County and Webb and Holland Tracts are located in Contra Costa County. Fishery resources are protected primarily under state and federal regulations and codes pertaining to water quality and endangered species protection. There are no local regulations that pertain to fish protection beyond non-specific measures identified in the General Plans to protect aquatic resources.

Sources of Information

The following key sources of information were used in the preparation of this section:

- Delta Wetlands 1995 DEIR/EIS
- Delta Wetlands 2000 RDEIR/EIS
- Delta Wetlands 2001 FEIS
- Delta Wetlands BOs
- USWFS (2008a) OCAP delta smelt BO
- NFMS (2009) OCAP BO
- California Department of Fish and Game (2009a) Central Valley Bay-Delta Branch FTP server
- Relevant published and unpublished scientific studies
- Other information, including online sources

Environmental Setting

Changes since the 2001 FEIR and 2001 FEIS

Major changes to the environmental setting have occurred since 2001 that may affect the FOC and/or RPMs in the BOs for the Project and the implications of these changes are described in some detail below.

Pelagic Organism Decline

The Interagency Ecological Program (IEP) is a consortium of nine state and federal agencies, which has been monitoring fish populations in the San Francisco Estuary for decades. IEP biologists became concerned when FMWT abundance indices for four of the dominant pelagic fishes in the upper San Francisco estuary (Suisun Bay and Delta) declined in 2002 and fluctuated around near-record lows. Abundance indices for 2002–2005 included record lows for delta smelt and age-0 striped bass, and near-record lows for longfin smelt and threadfin shad. By 2004, these declines became widely discussed as a serious issue, and collectively became known as the POD (i.e., pelagic organism decline). Longfin smelt and age-0 striped bass showed some recovery in 2006, but declined in 2007 to the lowest value on record and the third lowest on record, respectively. Abundance indices for delta smelt and threadfin shad have remained low. The abundance of delta smelt is of particular concern because it is listed as a Threatened species under both ESA and CESA. Table 4.5-4 summarizes the decline of the POD species as indexed by the FMWT abundance (i.e., catch).

Table 4.5-4. Comparison of Fall Midwater Trawl Abundance Indices for the Four Pelagic Organism Decline Species during the Pelagic Organism Decline Years (2002–2008) and Pre-POD Years (1967–2001)

Species	2008 FMWT Index	Mean FMWT Index 2002–2008	Mean FMWT Index 1967–2001	Percent Mean POD Abundance Relative to Pre-POD Abundance	Comments
Delta smelt	23	77	585	13%	Five of the seven POD years are among the lowest seven years on record; 2008 was the lowest year on record.
Longfin smelt	139	514	10,506	5%	Four of the seven POD years are among the lowest seven years on record.
Striped bass	220	146	3,644	4%	The seven POD years are the lowest seven years on record.
Threadfin shad	450	1,958	5,505	36%	Three of the seven POD years are among the lowest seven years on record; 2008 was the lowest year on record.

Source: California Department of Fish and Game 2008.

These declines for delta smelt, longfin smelt, and striped bass were not expected because they occurred in years with moderate winter-spring outflows. The IEP has speculated that the abundances of delta smelt and longfin smelt may have declined to the point that reproduction and survival are declining (Baxter et al. 2008). The IEP has developed a conceptual model including four general mechanisms that collectively might be responsible for the POD (i.e., fish population changes). These mechanisms include the impacts of low spawning stock ("stock effects"), perturbation of the food web leading to decreased carrying capacity for POD species ("bottom up effects"), environmental changes exacerbating the impact of predators and entrainment (“top-down effects”), and general deterioration of habitat quality (“habitat effects”).

2008 Operations Criteria and Plan Delta Smelt Biological Opinion (U.S. Fish and Wildlife Service)

The USFWS (2008a) delta smelt BO, as previously described, prescribes alternatives specifically to allow continued SWP and CVP operations under the jeopardy opinion. While the BO does not assess the Project, the BO will be considered when assessing potential fishery impacts as it sets the baseline conditions under which Delta waters will be managed. The BO restrictions are discussed first, and a description of how the Project could affect south Delta flows controlled by the BO follows.

Biological Opinion Actions and Limits on Old and Middle River Reverse Flows

The RPA provides Reclamation and DWR with actions to minimize entrainment risk to delta smelt and avoid adverse habitat modification. Most of the actions set the maximum allowable reverse flows in the OMR during three general time periods corresponding to delta smelt life stages and entrainment risk. Meeting the actions will require Reclamation and DWR to manage SWP and CVP export rates accordingly. Other actions set fall X2 limits and determine whether installation of south Delta temporary barriers will be allowed during the year.

The flow actions provide a range of maximum allowable reverse OMR flows. Based on the best available information concerning the distribution and status (i.e., abundance) of delta smelt, the specific biological flow objective within this range is set by USFWS, in consultation with Reclamation, DWR, DFG, and Smelt Working Group (SWG) scientists.

Action 1: Adults Migration and Entrainment (First Flush)

Flow management during the earliest time period is characterized as a first flush, the purpose of which is to provide advantageous hydrodynamic conditions early in the migration period and exclude large numbers of adult delta smelt from the vicinity of the SWP and CVP export facilities. During the first flush period, which lasts for 14 days, average net reverse OMR flow may not exceed 2,000 cfs. December 1 to 20 is considered a low-risk entrainment period. During this time the start date, if any, will be determined by USFWS. After December 20, if the first flush has not been initiated, implementation begins when mean turbidity[2] is greater than 12 nephelometric turbidity units (NTU). First flush operation ends when mean water temperature at Mossdale, Antioch, and Rio Vista reaches 12ºC[3] or at onset of spawning, as determined by presence of spent females in the spring kodiak trawl or at SWP or CVP salvage facilities.

[2] Turbidity is expressed in terms of the mean at Prisoner’s Point, Holland Tract, and Victoria Canal.
[3] The temperature at which Delta smelt begin to spawn is 12ºC.

Action 2: Adult Migration and Entrainment
The second flow management period is designed to protect adult migration prior to spawning. It begins immediately after the first flush or as determined by USFWS if Action 1 has not been implemented. During this management period, the mean, 7-day reverse flow in OMR is not allowed to exceed 1,250 to 5,000 cfs[4]. Criteria to end the second flow management period are the same as in Action 1. The management period can be suspended temporarily whenever a 3-day average flow is greater than or equal to 90,000 cfs at Rio Vista in the Sacramento River and 10,000 cfs at Vernalis in the San Joaquin River.

Action 3: Entrainment Protection of Larval Smelt
The third flow management period is designed to protect delta smelt larvae spawned in the south and central Delta. Once spawning has begun or temperatures are above 12ºC, the maximum mean, 14-day reverse flow in OMR is not allowed to exceed 1,250 to 5,000 cfs. This management period ends on June 30 or when water temperatures at Clifton Court Forebay (CCF) reach a daily average of 25ºC for 3 consecutive days.

Action 4: Estuarine Habitat during Fall
Aimed at minimizing adverse effects on smelt habitat, Delta outflow will be managed in order to maintain a protective X2 location. During September and October the monthly averaged X2 is not to exceed 74 km following wet water years[5] and 81 km following an above-normal water year. In November, inflows to CVP and SWP reservoirs in the Sacramento Basin are to be released, in addition to reservoir releases, to augment Delta outflow to meet the same X2 target criteria of the previous months.

Action 5: Temporary Spring Head of Old River Barrier (HORB) and the Temporary Barrier Project (TBP)
The head of Old River barrier (HORB) and other components of the Temporary Barrier Program (TBP) are to be operated in a manner that protects larval and juvenile delta smelt from entrainment. The TBP has operated since 1991 and consists of three rock barriers (Middle River near Victoria Canal, Old River near Tracy, and Grant Line Canal near Tracy Boulevard Bridge) to improve water levels for agricultural diversions and one rock barrier (HORB at the confluence of the San Joaquin River and Old River) to reduce the number of outmigrating Chinook salmon smolts entering the Old River (and hence becoming more susceptible to entrainment by the SWP and CVP south Delta export facilities). The HORB will be installed only when DFG's Particle Tracking Model predicts that entrainment levels would not increase more than 1% at FMWT Station 815 as a result of HORB installation. If HORB is installed, TBP flap gates are to be tied in the open position until May 1.

[4] Under most conditions, SWG will recommend the reverse OMR flow not to exceed 2,000 to 3,500 cfs. Only under years of high and low predicted entrainment risk will reverse OMR flows of 1,250 or 5,000 cfs be recommended.
[5] The water year classification system, based on Sacramento Basin 40-30-30Index, is set in the 1995 Water Quality Control Plan used to implement D-1641.

Action 6: Habitat Restoration

This action is not flow-related, instead being a program to "create or restore a minimum of 8,000 acres of intertidal and subtidal habitat in the Delta and Suisun Marsh" and monitor the effectiveness of the action (U.S. Fish and Wildlife Service 2008: 379). The habitat restoration program aims to supplement the flow-related benefits to delta smelt from actions 1–4 over a 10-year period beginning within a year of the biological opinion.

Implications for Project Operations

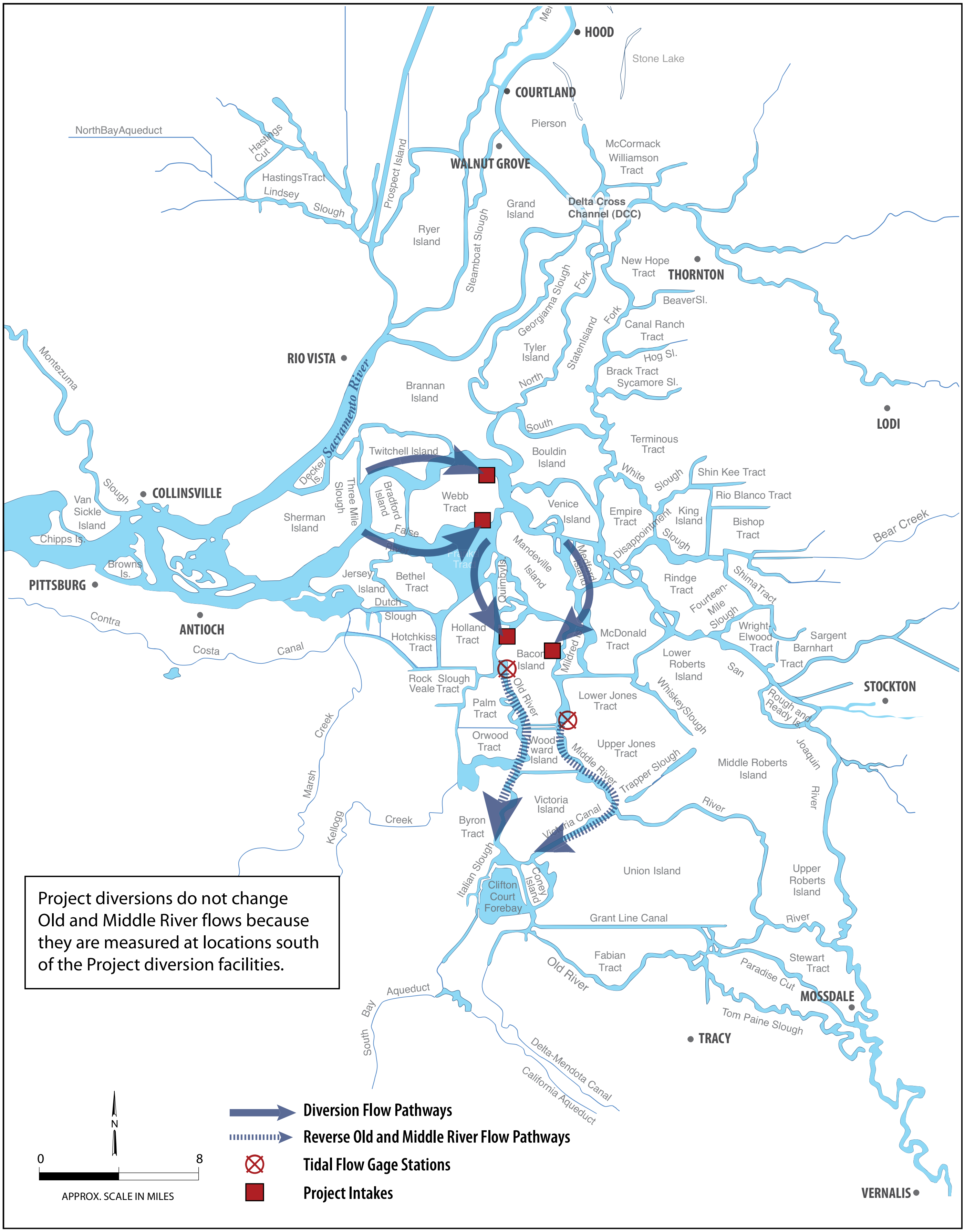
The Project was not considered in the BO evaluations of the OCAP operations of the existing CVP and SWP facilities. However, reductions in CVP and SWP pumping mandated by the 2008 OCAP BO to limit reverse OMR flows to protect delta smelt have implications for Project operations because these same fish management agencies will likely issue revised BOs for the Project operations.

Operation of the CVP and SWP pumps will increase "reverse" flow southward from the Central Delta via OMR channels if combined pumping is greater than the San Joaquin River flow diverted at the head of Old River, near Mossdale, to Old River and Middle River. This head of Old River diversion is about half of the San Joaquin River flow at Vernalis. BO provisions to limit reverse OMR flows were based on arguments by the fishery managers that increased southward flow of water from the central Delta because of operation of the pumps would draw adult delta smelt into the south Delta. Adult smelt in the vicinity of the pumps would be entrained, as would the progeny (i.e., juveniles) of adults that were not entrained before spawning.

The effects of Project diversions on OMR flows are illustrated in Figure 4.5-1, which shows the Project Reservoir Islands (Webb Tract and Bacon Island) and the Central Delta channels. The Old River tidal flow gage used to monitor Old River flows is located just south of Rock Slough, between Palm Tract and Bacon Island. The Middle River USGS tidal flow gage is located just north of Santa Fe Cut, between lower Jones Tract and Bacon Island. The sum of these two tidal flow gages (positive flow is downstream toward the estuary) is the technical OMR flow variable that is regulated by the reverse OMR limits in the USFWS BO and the NMFS BO for OCAP.

Project diversions onto Bacon Island or Webb Tract would not change measured reverse (i.e., upstream, southward) flows in OMR because the USGS flow gages are located upstream (i.e., south) of the proposed diversion stations. However, diversions from the Old River diversion station on Bacon would increase reverse flows in the lower Old River downstream of the diversion station, and downstream of the regulated USGS gages, drawing more water from the mouth of Old River and from Franks Tract. Similarly, diversions from the Middle River diversion station on Bacon would increase Middle River reverse flows between the mouth of Middle River (or Columbia Cut) and the Middle River diversion station, located opposite Mildred Island.

Webb Tract diversions would not affect measured reverse OMR flows but would reduce flows in the San Joaquin River upstream of Antioch. The False River (i.e.,



Graphics/Projects/00152.08 WDS Delta Wetlands/DW Diversions (10-09) SS

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Figure 4.5-1
Effects of Project Diversions on Old and Middle River Flow Measurements

Franks Tract) diversion station on Webb Tract may increase the flows from the mouth of Old River into Franks Tract.

Reverse OMR flows will be increased by export of discharged Project water. To be exported, water must be discharged from the Project reservoirs and flow upstream in OMR channels to the SWP pumps. However, Project discharges for export would transport water between the discharge stations and the SWP pumps. This increased reverse OMR flow would increase the upstream movement if the fish were already located between the Project islands and the pumps. This EIR assumes that Project discharges for export will occur in July–November and thus largely would occur in the water transfer window highlighted by the USFWS (2008) OCAP BO (July–September). The July–November discharge-for-export period is likely to limit impacts on most listed fish species, with the exception of green sturgeon, which tend to be present year-round in low numbers but have a somewhat higher abundance in summer. Occasional releases of Project water in fall (September–November) for increased outflow (i.e., not for export) will provide beneficial fish effects by moving X2 further downstream.

2009 OCAP Biological Opinion (National Marine Fisheries Service)

Among the numerous actions listed under the RPA for the 2009 NMFS OCAP BO are a number of actions within the Delta division; these Delta-related actions are of potential importance to the Project and are discussed below and detailed in Appendix B.

Biological Opinion Actions

The NMFS BO is similar to the USWFS BO for delta smelt in that flow-based actions are detailed, including restrictions to OMR reverse flows, as well as other measures such as minimum flows required at Vernalis (San Joaquin River). In addition, actions to reduce the risk of Sacramento River–origin outmigrating fish entering the central Delta are detailed, as are actions to improve salvage efficiency at the SWP/CVP fish facilities in the south Delta.

Action IV.1.1 Monitoring and Alerts to Trigger Changes in Delta Cross Channel Operations

In order to reduce the likelihood of emigrating salmonids entering the central Delta through the DCC, this action continues funding for monitoring programs that provide information used to alert managers as to when juvenile Chinook salmon will be approaching the Delta. The *First Alert* is triggered by one of two conditions and determines when the DCC gates should be closed: either capture of yearling-sized (>70 mm) spring-run Chinook salmon at the mouths of natal tributaries between October and April, or an increase in tributary flow of more than 50% over levels preceding the flow spike from October onward. The *Second Alert* is triggered by Sacramento River flows greater than 7,500 cfs at Wilkins Slough and water temperatures less than 13.5°C (56.3°F) at Knights Landing.

Action IV.1.2 DCC Gate Operation
The DCC gates will be operated to reduce mortality of emigrating juvenile salmonids and green sturgeon in November, December, and January (see related Decision Tree in Appendix B).

Action Suite IV.2 Delta Flow Management
Action Suite IV.2 describes a number of related actions aimed at maintaining adequate flows within the Delta in order to increase survival of outmigrating salmonids. These actions would occur from January 1 until June 15 each year (Appendix B).

For interim operations (2010–2012), Action IV.2.1 restricts exports and requires minimum flows at Vernalis on the San Joaquin River. Minimum long-term flows at Vernalis would be achieved by Reclamation/DWR seeking supplemental agreement with the San Joaquin River Group Authority.

Beginning in 2012, exports would be restricted to a specified fraction of Vernalis flows (Appendix B). Exceptions would arise during multiple dry years (see NMFS 2009, 644, for definitions) or when exports of at least 1,500 cfs may not be achievable (the minimum requirement for human health and safety).

Action IV.2.2 consists of a 6-year acoustic tag experiment to confirm proportional causes of salmonid mortality attributable to flows, exports, and other SWP/CVP project or non-project adverse effects during outmigration through the Delta.

Whereas the USFWS (2008) delta smelt OCAP BO RPA focuses mostly on managing OMR flows, the NMFS (2009) OCAP BO RPA details measures specific not only to OMR flows but also to SWP/CVP exports themselves (see Action IV.3 below). Action IV.2.3 aims to manage OMR flows between January 1 and June 15 in order to reduce the vulnerability of emigrating listed salmonids within the lower Sacramento and San Joaquin Rivers to entrainment into the channels of the south Delta and at the export pumps. The action consists of three stages of increasingly restrictive measures (Table 4.5-5).

Table 4.5-5. Decision Tree Related to Management of Flows in the Old and Middle Rivers, as Stated in the Reasonable and Prudent Alternative from the National Marine Fisheries Service Operations Criteria and Plan Biological Opinion

Date	Triggers	Action
January 1–June 15	January 1–June 15	Exports are managed to a level that produces a 14-day running average of the tidally filtered flow of (minus) -5,000 cfs in Old and Middle River (OMR). A 5-day running average flow will be calculated from the daily tidally filtered values and be no more than 25% more negative than the targeted requirement flow for the 14-day average flow.
January 1–June 15 (first stage trigger)	Daily SWP/CVP older juvenile loss density (fish per taf): (1) is greater than incidental take limit divided by 2,000 (2% WR JPE[1] ÷ 2,000), with a minimum value of 2.5 fish per taf; or (2) daily loss is greater than daily measured fish density divided by 12 taf; or (3) CNFH CWT LFR[2] or LSNFH CWT WR[3] cumulative loss greater than 0.5%; or (4) daily loss of wild steelhead (intact adipose fin) is greater than the daily measured fish density divided by 12 taf	Reduce exports to achieve an average net OMR flow of (minus) -3,500 cfs for a minimum of 5 consecutive days. The 5-day running average OMR flows will be no more than 25% more negative than the targeted flow level at any time during the 5-day running average period (e.g., -4,375 cfs average over 5 days). Resumption of (minus) -5,000 cfs flows is allowed when average daily fish density is less than trigger density for 3 consecutive days following the 5 consecutive days of export reduction. Reductions are required when any one criterion is met.
January 1–June 15 (second stage trigger)	Daily SWP/CVP older juvenile loss density (fish per taf) is: (1) greater than incidental take limit (2% of WR JPE) divided by 1,000, with a minimum value of 2.5 fish per taf; or (2) daily loss is greater than daily fish density divided by 8 taf ; or (3) CNFH CWT LFR or LSNFH CWT WR cumulative loss greater than 0.5%, or (4) daily loss of wild steelhead (intact adipose fin) is greater than the daily measured fish density divided by 8 taf	Reduce exports to achieve an average net OMR flow of (minus) -2,500 cfs for a minimum of 5 consecutive days. Resumption of (minus) -5,000 cfs flows is allowed when average daily fish density is less than trigger density for 3 consecutive days following the 5 consecutive days of export reduction. Reductions are required when any one criterion is met.
End of triggers	Continue action until June 15 or until average daily water temperature at Mossdale is greater than 72ºF (22ºC) for 7 consecutive days (1 week), whichever is earlier	If trigger for end of OMR regulation is met, the restrictions on OMR are lifted.

Source: National Marine Fisheries Service 2009: 648–650.

[1] WR JPE is the winter-run Chinook salmon Juvenile Production Estimate, which is based on the number of spawning adult females (from carcass surveys), female fecundity, and egg-to-fry survival (Gaines and Poytress 2004).

[2] CNFH CWT LFR is coded wire–tagged late fall–run Chinook salmon from Coleman National Fish Hatchery on Battle Creek.

[3] LSNFH CWT WR is coded wire–tagged winter-run Chinook salmon from Livingston Stone National Fish Hatchery on the Sacramento River.

Action IV.3 Reduce Likelihood of Entrainment or Salvage at the Export Facilities
In order to reduce entrainment from November 1 to December 31, exports may be reduced based on various triggers (Appendix B). Advance warning will be provided by the *Third Alert* (see Action IV.1.2 above for a description of the First and Second Alerts), consisting of catch indices of more than 10 fish captured per day (November 1–February 28) or more than 15 fish captured per day (March 1–April 30) from either the Knights Landing or Sacramento catch indices. Action IV.2.3 will be implemented from January 1 to April 30 to control export levels during this time.

Action Suite IV.4 Modifications of the Operations and Infrastructure of the CVP and SWP Fish Collection Facilities
A number of related actions are identified in Action Suite IV.4, each contributing to the overall objective of a 75% performance goal for whole-facility salvage at the SWP and CVP fish collection facilities (Appendix B).

Action IV.5 Formation of Delta Operations for Salmon and Sturgeon (DOSS) Technical Working Group
Action IV.5 involves formation of a technical working group that will provide recommendations for real-time management of Delta division SWP/CVP operations; annually review project operations and associated monitoring data; track implementation of Delta Actions IV.1–IV.5 and evaluate their effectiveness; oversee implementation of the San Joaquin acoustic fish tag experiment (Action IV.2.2); coordinate with the Smelt Working Group (SWG) to benefit both USFWS- and NMFS-listed species; and coordinate with other technical teams to ensure consistent PRA implementation.

Action IV.6 South Delta Improvement Program—Phase I (Permanent Operable Gates)
Action IV.6 consists of DWR not implementing Phase I of the South Delta Improvements Program to replace temporary barriers with permanent operable gates. NMFS is of the opinion that installation of permanent operable gates will adversely modify critical habitat.

Implications for Project Operations

As with the USFWS (2008) OCAP delta smelt BO, the NMFS (2009) OCAP BO may have several important implications for the Project. More restrictive DCC gate operations, requiring the DCC gates to be closed for a greater proportion of the time than currently occurs, are likely to reduce the overall proportion of outmigrating salmonids that enter the central Delta and are exposed to the effects of the Project. A variety of measures related to fish salvage improvements at the SWP fish facility would reduce the effects of fish entrainment during export of discharged Project water. As noted above, Project diversions to Webb Tract and Bacon Island could cause changes in flow patterns that would not be measured at the OMR gauging stations because the Project diversions are downstream of the gauging stations.

Species Summaries

Chinook Salmon

The Chinook salmon (*Oncorhynchus tshawytscha*) is an important fish species, supporting valuable commercial and sport fisheries (Allen and Hassler 1986). The Sacramento–San Joaquin River system supports four runs of Chinook salmon: fall, late fall, winter, and spring. Separation of the runs is defined by the timing of upstream migration of adults.

The population abundance of all four runs of Chinook salmon has declined relative to historical levels. Spring-run Chinook salmon was listed in 1999 as Threatened under both the California and federal Endangered Species Acts (64 FR 50394). Sacramento winter-run Chinook salmon are listed as Endangered under both CESA and the ESA. The abundance of Central Valley fall-run Chinook salmon increased dramatically over the period from 1992 through 2002 but declined sharply after 2002 (Pacific Fishery Management Council 2008). Natural-origin abundance in 2008 was at an all-time low, with an estimated total production of just over 42,000 fish (Anadromous Fish Restoration Program 2009). This was less than half of the already very depressed total of about 110,000 fish from 2007, well below the recent highs of more than 500,000 fish from 2000 to 2004. The low abundance of fall-run Chinook salmon returning to the Central Valley in 2008 resulted in nearly complete closure of the west coast ocean troll and sport fishing season; the same is true in 2009. The principal reason for the low abundance was ocean conditions, with long-term freshwater and estuarine degradation contributing to low population resiliency (Lindley et al. 2009). While fall-run and late fall–run are not listed, both runs 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.

Life History

Adult Chinook salmon 2–7 years old migrate from the ocean to spawn in the upstream reaches of the major tributaries to the Sacramento and San Joaquin Rivers and in the upper mainstem Sacramento River. Eggs are deposited in gravel nests and fry emerge after incubating for about 2 months (Moyle 2002). Juvenile salmon migrate from upstream spawning areas to downstream habitats and to the ocean.

The Delta serves as an immigration path and holding area for adult Chinook salmon returning to their natal rivers to spawn. Sacramento River Chinook salmon migrate primarily up the mainstem Sacramento River, but some fish use the distributaries of the Mokelumne River and enter the Sacramento River through Georgiana Slough or the DCC (Figure 1-1b in Chapter 1). San Joaquin River Chinook salmon migrate primarily up the mainstem San Joaquin River.

Adult Central Valley fall-run Chinook salmon begin moving through the Delta to the Sacramento and San Joaquin Rivers in late August or early September, and peak spawning occurs in late October and November (Myers et al. 1998). Spring-run Chinook salmon return to the Sacramento River in March through July and spawn in late August through October. Spring-run Chinook salmon apparently have been extirpated from the San Joaquin River watershed (Myers et al. 1998), and wild populations are currently found only in Mill, Deer, and Butte Creeks in the Sacramento River watershed. Sacramento winter-run Chinook salmon have a life cycle unique to the species. Adults move through the Delta and into the Sacramento River from November to June and spawn from late April to mid-summer.

Emigrating juvenile Chinook salmon are found in the Delta and Bay throughout the year, but primarily from October through June. Migration along the fastest and most direct migration route generally results in the highest survival of Chinook salmon migrating to the ocean through the Delta.

Factors Affecting Abundance

The main factors associated with the historical decline of Chinook salmon populations are deleterious water temperatures in spawning and rearing habitat and blockage of adult passage to suitable spawning and rearing areas. Other factors that may affect population abundance include diversion of juveniles off the primary migration path through the Delta, entrainment of juveniles in diversions, predation during juvenile migration, toxic discharge to the rivers, and ocean fishing.

Temperature is a primary factor influencing the survival of Chinook salmon in the Delta, especially during May and June (Kjelson et al. 1989a). Survival of juvenile fall-run Chinook salmon during migration through the Delta appears to decline when water temperature exceeds 60°F (Kjelson et al. 1989b; U.S. Fish and Wildlife Service 1992). The relationship between temperature and Chinook salmon survival is discussed in detail in Appendix F2 of the 1995 DEIR/EIS. Temperature may also affect upstream spawning migration by adults: Boles (1988 as cited by National Marine Fisheries Service 2009: 77) recommended that temperatures below 65°F are required for upstream migration and McCullough (1999 as cited by Lindley et al. 2004) described that migration is blocked by temperatures of 70°F or more.

The most direct routes upstream through the Delta during adult migration to spawning areas are the Sacramento River and San Joaquin River channels. When export rates exceed San Joaquin River inflow, water in the central and south Delta is primarily Sacramento River water moved across the Delta by the DCC and Georgiana Slough or pulled by reverse flow through the lower San Joaquin River. Chinook salmon homing to Sacramento River water may become disoriented and migration may be delayed, potentially reducing adult survival and reproductive capabilities. Recent studies comparing migration through the Sacramento River and two alternative less efficient routes showed that a significantly higher percentage of fish migrated up the Sacramento River than through Georgiana Slough, which was in turn significantly more used than the DCC (McLaughlin and McLain 2004).

Although the most direct route through the Delta for juvenile Sacramento River Chinook salmon is the Sacramento River channel, juveniles may be drawn along an alternate route through the DCC and Georgiana Slough (Figure 1-1b in Chapter 1), where migration is delayed and losses to diversions and predation may increase. The division of Sacramento River flow at the DCC and the number of out-migrant juveniles drawn into the DCC depend primarily on DCC gate position and Sacramento River flow volume. USFWS and DFG (1987) found that when the proportion of Sacramento River flow drawn into the DCC and Georgiana Slough was high (greater than 60%) and the DCC gates were open, survival was about 50% lower for juvenile fall-run Chinook salmon released above the DCC than for juveniles released below Georgiana Slough. When the DCC gates were closed, only Georgiana Slough drew water out of the Sacramento River, and survival was similar for the two release locations.

Similarly, mortality of juvenile Chinook salmon diverted from the San Joaquin River into upper Old River may be greater than that of juveniles migrating down the mainstem San Joaquin River (U.S. Fish and Wildlife Service 1993). Entrainment in diversions (agricultural diversions and CVP and SWP exports) also increases juvenile mortality. Entrainment loss to all Delta diversions may exceed several hundred thousand juvenile Chinook salmon, including substantial numbers lost to predation (California Department of Fish and Game 1992b). The number of Chinook salmon salvaged at the SWP and CVP fish facilities averaged more than 170,000 individuals per year from 1980 to 2007, but less than 46,000 per year from 2000 to 2007 (Table 4.5-6). Kimmerer (2008) estimated that entrainment at the SWP and CVP facilities may result in mortality of 10% of the juvenile Chinook salmon outmigrating from the Sacramento River.

Table 4.5-6. Annual Numbers of Selected Fish Species Salvaged at the SWP and CVP Fish Facilities, 1980–2007

	Chinook Salmon	Steelhead	Striped Bass	White Catfish	American Shad	Threadfin Shad	Sacramento Splittail	Longfin Smelt	Delta Smelt	Green Sturgeon
1980	234,904	2,967	3,983,296	1,030,000	1,174,502	1,937,938	537,702	9,291	85,396	47
1981	176,469	12,876	9,447,156	755,478	1,306,522	2,579,796	141,794	2,740	320,350	685
1982	498,580	19,213	2,672,202	1,383,571	1,435,751	2,232,736	367,338	52	32,564	1,093
1983	281,317	639	335,395	837,970	458,213	6,111,206	438,474	330	13,334	1,476
1984	347,372	841	10,731,051	1,946,803	931,123	1,918,425	140,100	23,364	33,032	844
1985	277,799	3,803	5,614,931	854,581	560,791	1,989,497	70,963	21,456	27,496	1,377
1986	1,187,272	4,746	18,544,652	997,009	1,139,342	1,763,815	2,391,588	2,296	6,380	49
1987	270,601	7,074	14,327,188	403,970	538,843	739,637	69,036	56,847	61,017	128
1988	206,293	9,444	13,823,612	304,350	420,685	547,803	75,016	164,045	63,810	50
1989	149,196	17,475	10,549,877	320,621	644,696	315,867	60,584	67,545	20,074	0
1990	41,403	8,621	2,844,389	235,960	627,401	1,051,622	43,518	50,565	34,126	124
1991	70,396	15,185	3,800,970	305,314	455,804	1,287,340	36,819	9,665	17,822	45
1992	63,878	18,745	4,411,064	228,350	710,154	1,291,772	12,082	3,590	6,178	164
1993	29,149	18,580	13,451,455	884,686	1,156,988	9,022,788	199,917	648	31,218	39
1994	15,689	1,651	2,440,893	353,119	381,235	1,445,120	3,103	6,415	43,558	17
1995	83,562	2,387	1,522,654	690,539	2,142,724	1,460,216	5,333,673	102	2,578	169
1996	54,646	5,434	1,010,642	542,613	2,468,566	2,305,540	87,354	293	45,763	76
1997	66,858	975	1,503,135	224,385	1,206,124	4,763,610	32,154	1,186	44,182	79
1998	171,726	989	516,026	941,972	528,396	6,464,445	3,093,899	688	1,004	160
1999	183,890	2,614	2,455,614	338,275	1,108,469	3,120,452	31,890	805	154,820	60
2000	123,812	9,343	4,143,990	167,776	2,640,890	5,118,357	130,343	1,983	113,712	30
2001	57,806	12,657	1,716,684	113,451	736,598	7,245,588	17,127	6,579	24,913	78
2002	21,921	3,837	1,510,654	169,972	763,570	7,423,916	9,037	97,770	68,219	12
2003	33,989	12,637	918,816	220,005	2,509,320	7,420,616	19,732	5,268	37,910	18
2004	36,628	9,791	826,078	165,031	672,757	5,511,379	18,307	981	20,463	0
2005	38,702	3,543	394,578	249,079	1,558,934	2,294,836	444,963	219	3,752	28
2006	44,284	3,803	178,154	405,576	742,320	1,574,252	5,420,470	0	336	363
2007	9,563	5,629	927,533	166,571	392,762	3,501,384	1,318	107	2,691	14
Grand Total	9,036,702	251,714	399,106,706	69,217,697	57,164,182	119,413,831	20,254,607	1,383,053	7,333,837	18,723
Annual mean	170,632	7,696	4,807,239	544,180	1,050,481	3,301,427	686,725	19,101	47,025	258

Source: California Department of Fish and Game 2009.

Central Valley Steelhead

Steelhead (*Oncorhynchus mykiss*) are the anadromous form of rainbow trout. Steelhead have a complex life history that includes juvenile freshwater rearing in tributaries for 1 to 2 years and growth and maturation for 1 to 3 years in marine waters. Steelhead pass through the Delta and the Project area during both their juvenile and adult migrations.

Central Valley steelhead are designated a DPS and listed as Threatened under ESA. The DPS includes all naturally spawned anadromous *O. mykiss* (steelhead) populations below natural and human-made impassable barriers in the Sacramento and San Joaquin Rivers and their tributaries, excluding steelhead from San Francisco and San Pablo Bays and their tributaries, as well as two artificial propagation programs: the Coleman National Fish Hatchery, and Feather River Hatchery steelhead programs. Central Valley steelhead are not listed for protection under CESA. Critical habitat for Central Valley steelhead includes most of the Delta and the Project area.

Steelhead was not listed under the ESA at the time that the 1995 DEIR/EIS was prepared. However, because of the possibility that the species would become listed, it was discussed in Appendix F2 of the 1995 DEIR/EIS, "Biological Assessment: Impacts of the Delta Wetlands Project on Fish Species."

Life History

Central Valley steelhead are classified as winter-run with peak adult migration through the Delta occurring in September through February (Busby et al. 1996). Spawning typically occurs from December to April in higher gradient and elevation streams and rivers. A significant portion of steelhead, in contrast to anadromous salmon, spawn more than once with adults returning to the ocean and reentering the Delta to spawn in Central Valley tributaries.

Most Central Valley steelhead spend two years in fresh water (Busby et al. 1996) and emigrate through the Delta in late winter and spring. Initially, juvenile steelhead are found in or near their natal spawning streams. As they grow and mature, juvenile steelhead may move downstream into larger stream segments, including the mainstem Sacramento River. By the time juvenile steelhead reach the Delta they are migratory and move through the Delta and into marine areas relatively quickly. Steelhead typically spend two years in the ocean prior to returning to spawn in freshwater. California steelhead, however, have a higher proportion of 1-year ocean fish compared to more northern populations (Busby et al. 1996).

Central Valley streams that presently support steelhead include upper Sacramento River, Mill, Deer, and Butte Creeks, and the Feather, Yuba, American, Mokelumne, Calaveras, and Stanislaus Rivers (McEwan 2001). Steelhead may have been extirpated from the San Joaquin River watershed (Moyle 2002). Although the existence of natural-origin steelhead in the San Joaquin watershed is controversial (McEwan 2001; Williams 2006), there are several lines of evidence to suggest a small self-sustaining population (McEwan 2001).

Factors Affecting Abundance

The primary factor associated with the decline in abundance of steelhead in the Central Valley is the widespread construction of dams in the tributaries to the Sacramento River (Busby et al. 1996; McEwan 2001; Lindley et al. 2006). Water diversions and development dams have blocked access to the majority of steelhead habitat in the Central Valley. Overall decline in the suitability of available habitat has occurred, including increased summer and fall water temperature, reductions in summer flow, toxic discharge to rivers, diversion of juveniles off the primary migration path through the Delta, and entrainment of juveniles in diversions.

The Delta is used primarily as a migrational corridor for adult and juvenile steelhead. The most direct routes upstream through the Delta during adult migration to spawning areas are the Sacramento River and San Joaquin River channels. When export rates exceed San Joaquin River inflow, water in the central and south Delta consists primarily of Sacramento River water moved across the Delta by the DCC and Georgiana Slough or pulled by reverse flow through the lower San Joaquin River. Adult steelhead may become confused and their migration may be delayed, possibly resulting in reduced adult survival and fecundity.

Although the most direct route through the Delta for juvenile steelhead originating in the Sacramento River watershed is the Sacramento River channel, juveniles may be drawn along an alternate route through the DCC and Georgiana Slough (Figure 4.5-1), where migration is delayed and losses to diversions and predation may increase. As noted above for Chinook salmon, the division of Sacramento River flow at the DCC and the number of out-migrant juveniles drawn into the DCC, depend primarily on DCC gate position and Sacramento River flow volume. USFWS (1987) found that when the proportion of Sacramento River flow drawn into the DCC and Georgiana Slough was high (greater than 60%) and the DCC gates were open, survival was about 50% lower for juvenile fall-run Chinook salmon released above the DCC than for juveniles released below Georgiana Slough. When the DCC gates were closed, only Georgiana Slough drew water out of the Sacramento River, and survival was similar for the two release locations. The existence of similar mechanisms for steelhead has yet to be determined.

The average number of steelhead salvaged at the SWP and CVP fish facilities per year from 1980 to 2007 was just under 8,000 (Table 4.5-6). Nobriga and Cadrett (2001) estimated that salvage of steelhead smolts was below 1% of the total number of smolts emigrating but cautioned that the actual loss (mortalities) attributable to SWP and CVP entrainment was probably higher because of louver efficiency being below 100% and prescreen losses from predation.

Striped Bass

Striped bass (*Morone saxatilis*) are large predatory fish introduced to the Bay-Delta estuary in 1879 (Dill and Cordone 1997). Adult striped bass live in the ocean and Bay (most may remain in the Bay) and migrate upstream to the Delta and Sacramento River to spawn (California Department of Fish and Game 1987a). Striped bass support a large sport fishery in the Delta and Bay. Striped bass are one of the four pelagic fish species whose marked decline has sparked considerable debate and research through the POD program**.**

Life History

About 55% of the adult striped bass population spawn in the Sacramento River upstream of the Delta during May and June, and about 45% spawn in the San Joaquin River between Antioch and Venice Island during April and May (California Department of Fish and Game 1987a). Percentages vary from year to year.

Semibuoyant eggs are broadcast-spawned by striped bass in open water and eggs hatch in about 2 days (California Department of Fish and Game 1987a). Eggs and newly hatched larvae drift with the current, and Sacramento River eggs or larvae generally reach the Delta within a few days. Newly hatched larvae are carried downstream to the upstream edge of the entrapment zone where food resources are plentiful (Moyle 2002). Rearing occurs in the bay-Delta and most adults are found in San Francisco and San Pablo Bays, with movement upstream into freshwater in the fall (Moyle 2002). Females mature at 4–6 years of age, males at 2–3 years old (Moyle 2002).

Factors Affecting Abundance

In the past (Turner and Chadwick 1972; Stevens at al. 1985), year-class abundance of striped bass has been assumed to depend primarily on the environmental conditions experienced by the eggs and young fish, and especially salinity conditions as indexed by X2. Although dependent on the natural hydrology of the Sacramento–San Joaquin River system, the timing and volume of Delta outflow have been substantially modified by changes in system characteristics (channelization and flood control projects) and by operations of water project facilities (reservoirs and diversions) (Herbold et al. 1992). In general, water projects have increased summer and fall outflow and reduced winter and spring outflow (Herbold et al. 1992). Kimmerer et al. (2009) provided evidence that juvenile striped bass abundance is linked to the volume of physical habitat (defined by salinity) that exists and that this volume increases with increasing outflow. They acknowledged that other mechanisms explaining this correlation also could exist.

A number of earlier studies (reviewed in Kimmerer 2004) have found the egg-to-fry survival or young-of-the-year (YOY) abundance of striped bass to be significantly negatively correlated with X2 during the April–June egg/larval period. Although more recent analyses (especially Kimmerer 2002) still find significant correlations between juvenile striped bass abundance or egg-to-fry survival and X2/outflow, the impact of Delta outflow on the abundance of YOY striped bass has declined significantly during the POD years, and additional factors have come to light. Specifically, it has been discovered that survival from egg to age-3 recruit is density-dependent[6] (Kimmerer et al. 2000) and that adult

[6] When Kimmerer et al. (2000) regressed age-3 recruits against X2, YOY abundance, and a YOY-by-X2 interaction term, all factors were significant and the coefficients of X2 and YOY abundance were negative. This regression

survival rates have declined substantially since sea surface temperatures increased following a phase shift in the Pacific Decadal Oscillation in 1977[7] (Bennett and Howard 1997, 1999). All of these factors have probably combined to reduce striped bass abundance to its current low level.

Other factors influencing young striped bass abundance are entrainment of eggs, larvae, and juveniles in Delta diversions (California Department of Fish and Game 1992b) and discharge of toxic materials into rivers tributary to the Delta and into the estuary (Bailey et al. 1994; Baxter et al. 2008). Additionally, declines in the availability of major prey organisms and competition with other introduced exotic fish and invertebrate species may adversely affect striped bass abundance (California Department of Fish and Game 1992a), possibly by reducing carrying capacity for juveniles (Kimmerer et al. 2000).

Regardless of the relative importance of CVP/SWP entrainment in limiting the abundance of the San Francisco estuary population of striped bass, it is true that young bass are more vulnerable to entrainment in diversions when they are located in the Delta than when they are located in Suisun Bay. It is also true that the proportion of the juvenile striped bass population in the Delta is lower when X2 is in the Delta (California Department of Fish and Game 1992a). Significant egg, larval, and juvenile mortality results annually from entrainment in SWP and CVP exports and other Delta diversions. The average number of striped bass salvaged annually at the SWP and CVP fish facilities was more than 6,200,000 from 1980 to 1999, but declined to just over 1,300,000 striped bass per year from 2000 to 2007 following the onset of the POD (Table 4.5-6). Net reverse flow in the lower San Joaquin River and in OMR transports striped bass eggs and larvae toward the SWP and CVP export facilities and may increase entrainment loss.

American Shad

The American shad (*Alosa sapidissima*) is the largest member of the herring family and may reach a weight of more than 5 kg (11 pounds) (Facey and Van Den Avyle 1986). American shad were introduced to the Bay-Delta estuary in 1871 and support a sport fishery (Dill and Cordone 1997).

indicates that, at low values of X2 (high outflow), egg-to-recruit survival decreases as juvenile abundance (YOY index) increases, suggesting density dependence. On the other hand, at low juvenile abundance, egg-to-recruit survival increases as X2 decreases (outflow increases), suggesting a density-independent effect of outflow on survival of egg to larval or early post-larval life stages.

[7] Bennett found an abrupt and persistent increase in surface temperature near the Golden Gate Bridge in 1976. Estimated abundance of adult striped bass decreased at the same time: comparisons before (1969–1975) and after (1977–1983) the climate shift showed mean abundance of striped bass declined by 52% for ages 5–7, 65% for ages 6–7 and 69% for ages >7 years. Oceanic recoveries of tagged adults also increased by 37% for age 6–7 and 48% for 7+, while tag returns in San Francisco Bay declined by 60% for both age groups. Ocean catch per unit effort also increased by 87% after 1976. Finally, because egg production is strongly influenced by female size, the loss of older adults after 1976–1977 caused a 60% decline in egg production. These changes in adult survival and abundance were attributed to increased distance and duration of ocean migrations by adults moving in response to increased ocean water temperatures.

Life History

Adult American shad migrate to fresh water from the ocean and the Bay during March, April, and May. The primary spawning grounds are in the upper Sacramento River and its tributaries. The northern Delta and the northern portion of Old River also have supported shad spawning (California Department of Fish and Game 1987b). During May–July, shad broadcast-spawn their eggs and sperm into the currents where the semi-buoyant eggs sink slowly and drift with the flow.

Shad spawned in the Sacramento River system generally rear in the tributary rivers downstream of the spawning area. Shad spawned in the Delta appear to rear primarily in the Delta. Most juvenile American shad emigrate from their freshwater rearing areas and pass through the Delta to estuarine and marine habitats between September and December of their first year (Stevens 1966).

Factors Affecting Abundance

The abundance of American shad may be determined by a combination of factors, including the magnitude of runoff in the Sacramento River watershed (particularly in major spawning tributaries), Delta outflow and X2, toxic contamination, ocean conditions affecting adult survival, and entrainment in CVP/SWP pumps (Moyle 2002). Although shad generally are assumed to home to their natal tributary, there is evidence that numbers of fish spawning in major tributaries are proportional to flows of each river at the time the shad arrive. Moyle (2002) states that the lack of strong attraction flows in major spawning tributaries, like the American River, may have played a significant role in the decline of the population. American shad have a weak but significant relationship to X2 (and therefore to Delta outflow), although the abundance expected at a given X2 has *increased* since the establishment of the overbite clam, *Corbula,* in 1987 (Kimmerer 2002a: 47). Abundance of American shad in the FMWT is correlated with the log of net Delta outflow in the previous spring, and therefore also with X2 and inflow. Several recent years have been above the values predicted by the regression (Baxter et al. 2008). Kimmerer et al. (2009) provided evidence that American shad abundance is linked to the volume of physical habitat (defined by salinity) that exists and that this volume increases with increasing outflow. They acknowledged that other mechanisms explaining this correlation also could exist.

Hundreds of thousands of American shad larvae and juvenile fish are entrained each year at the SWP and CVP export facilities and in other Delta diversions (California Department of Fish and Game 1987b). Shad spawned in the Delta are entrained as larvae and juveniles primarily during July–August. Shad spawned upstream of the Delta are entrained as juveniles primarily during November and December. The number of American shad salvaged annually from 1980 to 2007 was about 1,000,000 individuals (Table 4.5-6).

Threadfin Shad

The threadfin shad is a short-lived member of the herring family: few live longer than 2 years (10 cm total length; Moyle 2002). It was introduced to the

Sacramento–San Joaquin drainage in 1959 as forage for predatory sport fish (Burns 1966 as cited by Moyle 2002; Dill and Cordone 1997).

Life History

Threadfin shad are found throughout the Delta, but abundance decreases with movement westward (Turner 1966). Abundance is greatest in backwaters with low net water velocity and high concentrations of crustacean plankton prey (Turner 1966; Moyle 2002). Spawning is from April to August and peaks from May to July, occurring in the Sacramento and San Joaquin Rivers and Delta (Wang 1986). Most spawners are 2 years old, but some spawn at the end of their first summer. The eggs are adhesive and are deposited onto submerged vegetation and other substrates (Wang 1986). Newly hatched larvae are found near the surface by day and in middle to lower depths by night, both in nearshore and open water (Wang 1986). Threadfin shad growth is rapid (4–6 cm TL by the end of the first year), and large schools of juveniles are found in the Delta from August to November (Turner 1966).

Factors Affecting Abundance

On an annual basis, the abundance of threadfin shad may decrease because of cold kills in the winter (Turner 1966). As noted above, threadfin shad are one of several species included in the POD (Sommer et al. 2007). This is not reflected by a decline in salvage numbers at the SWP and CVP fish facilities: in fact, abundance from 2000 to 2007 averaged just over 5,000,000 fish per year compared to approximately 2,600,000 fish per year from 1980 to 1999 (Table 4.5-6). Correcting for increased pumping volume between the two time periods still results in considerably greater quantities (density) of fish from 2000 to 2007 (895 fish/taf) than from 1980 to 1999 (575 fish/taf). Mechanisms involved in the POD decline are under investigation. There is no relationship between threadfin shad FMWT abundance and X2 (Kimmerer et al. 2009).

Delta Smelt

The delta smelt is a small (2- to 3-inch-long), translucent, slender-bodied fish with a steely blue sheen. The delta smelt is found only in the Bay-Delta estuary (including the Delta, Suisun Bay, Suisun Marsh, and sometimes San Pablo Bay). The delta smelt population in California recently was reclassified as Endangered under CESA because “the delta smelt population in California has declined significantly since its listing as Threatened and the species’ abundance is now extremely low” (California Fish and Game Commission 2008). The continued decline in delta smelt abundance has resulted in a review of the species by the USFWS with a likely reclassification of the species to Endangered under the ESA. As mentioned, the depressed status of delta smelt is part of the overall decline of several pelagic fish species in the Bay/Delta referred to as the POD. The decline in pelagic fish species is the focus of a concerted research and monitoring effort by the state and federal fishery agencies (Baxter et al. 2008).

Life History

Delta smelt are found in the Delta where salinity is generally less than 2 ppt (56 FR 50075). Delta smelt adults disperse widely into fresher water in late fall and winter as the spawning period approaches, moving as far upstream as Mossdale on the San Joaquin River and the confluence with the American River on the Sacramento River. Spawning occurs in fresh water from February through June and may peak during late April and early May (Wang 1991; Sweetnam and Stevens 1991; Stevens et al. 1990). Most adult (1-year-old) delta smelt die after spawning (56 FR 50075).

After the eggs hatch (in about 12–14 days), delta smelt larvae float to the surface and are carried by the currents (Stevens et al. 1990). Under natural outflow conditions, the larvae are carried downstream to near the upstream edge of the entrapment zone (2-ppt salinity), where they typically remain and grow to adult size.

Factors Affecting Abundance

Factors that may adversely affect abundance of delta smelt include a decline in the availability of major food organisms, low adult population levels resulting in low reproductive success, water diversions from the Delta, reduced Delta outflow, introduced exotic species of fish and invertebrates, toxic substances, and reduced habitat resulting from channelization in the Delta and draining and filling of tidelands (Stevens et al. 1990; Moyle and Herbold 1989; Wang 1986). As with striped bass, an important determinant of smelt abundance may be the location of the population in the estuary, which determines the effect of other factors, such as entrainment in diversions.

Delta outflow probably affects delta smelt abundance in some manner and definitely affects distribution. High outflow transports smelt larvae and early juveniles downstream of the Delta into areas favorable for feeding and away from entrainment risks of the Delta (U.S. Fish and Wildlife Service 1994). Stevens et al. (1990) showed that more than 50% of the variation in the proportion of the smelt population found in Suisun Bay is explained by variation in Delta outflow. Dege and Brown (2004) found that outflow strongly influenced the geographic distribution of juvenile delta smelt in spring but did not affect distribution relative to X2: whether outflow was high or low, delta smelt consistently were found within a narrow range of distances from X2. These results are consistent with studies showing that larval fishes (including striped bass, longfin smelt, yellowfin goby, and delta smelt) exhibit local vertical and horizontal migratory behaviors that tend to keep them near the low-salinity zone characterized by X2 (Bennett et al. 2002). To the degree that the location of X2 affects survival by providing greater or lesser rearing areas, the location of X2 can affect the abundance of delta smelt and other pelagic fishes. The area or volume of habitat in a selected salinity range increases or decreases as a function of the location of X2 within the highly irregular shorelines of the San Francisco estuary. Thus it is possible that the area of preferred low-salinity habitat could increase when X2 moves from the Delta into the broad shoals of Suisun Bay. Unger (1994) examined the impact of area of optimal salinity habitat for ten species, including delta smelt. He found a weak, positive correlation ($p<0.10$) between delta smelt abundance and optimal habitat area defined in terms of a salinity interval. In addition, Kimmerer (2002b) determined that increasing outflow (decreasing X2) compressed the longitudinal distribution of longfin smelt and striped bass, concluding that data for striped bass and longfin smelt both fail to support a mechanism by which an increase in habitat associated with an increase in outflow caused an increase in abundance. Thus the hypothesis that increased outflow increases abundance of delta smelt and other pelagic species by increasing rearing area requires further examination.

Whatever the mechanism, evidence still exists that the abundance of delta smelt as indexed by the FMWT is highest when February–June X2 is located in Suisun Bay (U.S. Fish and Wildlife Service 1994). However, there is no direct correlation between X2 and delta smelt abundance. Kimmerer (2002a) found no significant correlation between the February–June summer abundance index of delta smelt and X2. Moreover, the (insignificant) correlation coefficient was positive for the pre–*Corbula* clam era and negative for the post–*Corbula* clam period. Kimmerer et al. (2009) recently updated previous analyses with additional data. They concluded:

> …abundance of delta smelt did not vary with X2. Most delta smelt live 1 year, resulting in less autocorrelation due to stock size than is the case for striped bass. Adding the previous year's fall midwater trawl index as a covariate did not improve the fit of the X2 model for the fall index of delta smelt abundance. Despite the evident increase in the amount of habitat, delta smelt abundance appears to be regulated by other factors so far unidentified, or it may be at a low enough abundance to preclude density dependence, which may be necessary for abundance to track habitat quantity.

However, in recent years (1987 onward) a correlation has existed between the abundance of older juvenile/subadults collected in the FMWT survey and the abundance of juveniles from the summer townet survey in the following year. Inclusion of a salinity-based covariate serving as a proxy for habitat quantity (either mean conductivity or mean X2 position during the fall period) greatly increases this correlation (Feyrer et al. 2008; U.S. Fish and Wildlife Service 2008a), suggesting that both adult abundance and habitat quantity (or the ability to be spread over a larger area and avoid localized adverse stochastic events [U.S. Fish and Wildlife Service 2008a]) may be an important determinant of delta smelt abundance under current conditions.

The 2008 OCAP delta smelt BO noted that zooplankton losses to entrainment may be important because delta smelt feed on zooplankton. In particular, a shift in the diet of delta smelt from the copepod *Eurytemora affinis* and the mysid shrimp *Neomysis mercedis* to the introduced *Pseudodiaptomus forbesi* is potentially significant because the decline of *E. affinis* and *N. mercedis* (probably caused by the introduced overbite clam) occurred mostly downstream of the region most affected by entrainment; *P. forbesi* is found in high numbers in upstream regions susceptible to entrainment, in addition to downstream areas. Kimmerer (2008) found a significant positive correlation between the survival of delta smelt (represented by the FMWT index divided by the summer townet index) and the average July–September biomass of zooplankton within the central portion of the delta smelt's range (between salinities 0.15 and 2.09). He suggested that this could indicate food limitation as an important mechanism driving the fiftyfold difference in survival between years and cited Bennett's (2005) study demonstrating evidence for food limitation and slow growth.

Delta smelt are vulnerable to entrainment in diversions throughout their life cycle, particularly in dry years when they are concentrated in the Delta where most fresh water is diverted (Sweetnam 1999, cited by Moyle 2002: 230). The number of delta smelt entrained at the SWP and CVP fish facilities and in other Delta diversions has exceeded 1 million during some years (e.g., in the late 1960s). Average annual salvage at the fish facilities was just over 50,000 fish per year from 1980 to 1999; in the first 5 years of the POD (2000–2004), average salvage was still around 50,000 but declined to fewer than 2,300 fish per year from 2005 to 2007 (Table 4.5-6). Peak entrainment losses of juveniles occur during May, June, and July. High entrainment of larvae probably occurs during late March, April, and May. Entrainment may increase when net flows are reversed in the lower San Joaquin River and in OMR. Net reverse flow increases transport of delta smelt larvae toward the SWP and CVP export facilities. Kimmerer (2008) estimated the mortality of adult delta smelt attributable to SWP and CVP entrainment to be between 1 and 50% of the total adult population; he also estimated the loss of juveniles at between 0 and 25% of the total juvenile population.

Sacramento Splittail

Sacramento splittail (*Pogonichthys macrolepidotus*) are large (more than 30 cm long) cyprinids (minnow family) endemic to the lakes and rivers of the Central Valley (Moyle et al. 1989). Sacramento splittail abundance steadily declined after 1983. Although the species was listed as Threatened under the ESA in 1999 (64 FR 5963), it is a state species of special concern and was delisted as a Threatened species in 2003 by the USFWS, amid controversy.

Life History

Sacramento splittail are freshwater fish capable of tolerating moderate levels of salinity (10–18 ppt) (59 FR 862). Splittail are confined largely to the Delta, Suisun Bay, Suisun Marsh, and Napa Marsh and, outside of the spawning season, are rarely found more than 5–10 miles above the upstream boundaries of the Delta (Moyle et al. 1989; Natural Heritage Institute 1992). Spawning runs, however, are more extensive, with major spawning and nursery areas in the Yolo and Sutter Bypasses and riparian areas on the lower Cosumnes River during years of high runoff when floodplains are inundated (Sommer et al. 1997, 2001a; Crain et al. 2004). Incidental catches of large splittail in fyke traps set by DFG in the lower Sacramento River during spring indicate that splittail migrate from Suisun Bay, the Delta, and the lower river reaches to upstream spawning habitats.

Splittail spawn adhesive eggs over flooded streambanks or aquatic vegetation when water temperatures are between 9°C and 20°C (Moyle 1976; Wang 1986). Spawning has been observed to occur as early as January and to continue through July (Wang 1986). Peak spawning occurs during March through May.

Larval splittail are commonly found in the shallow, weedy areas where spawning occurs. Larvae eventually move into deeper, open-water habitats as they grow and become juveniles (Wang 1986).

Factors Affecting Abundance

Habitat modification is probably the major factor contributing to the decline of splittail (California Department of Fish and Game 1992c). Dams, diversions, pollution, and agricultural development have eliminated or altered splittail habitat. Year-class survival is affected by Delta inflow, possibly because spawning success depends on spawning habitat availability (Moyle et al. 1989). The storage of water in upstream reservoirs and diversions reduces the frequency and magnitude of floodflows, thereby affecting the availability of flooded vegetation during the spawning season. Additionally, entrainment in diversions reduces survival of adult and juvenile fish.

The FMWT index of splittail abundance is positively correlated with Delta outflow during March–May (see Appendix F2 of 1995 DEIR/EIS), indicating that variability in abundance is at least partially explained by flow. Because spawning and early rearing of larval splittail are associated with shallow vegetated areas, inundation of riparian and seasonally flooded habitats may be an important factor determining year-class success. River flow determines the availability of shallow-water habitats with submerged vegetation during late winter and spring (Daniels and Moyle 1983).

Upstream water storage facilities and water diversions have changed the seasonal magnitude and duration of flows to upstream habitats and to the Delta. Reduced duration of flooding may degrade conditions necessary for spawning and larval development. Spawning habitat may be dewatered before larvae have moved to channels that provide permanent rearing conditions.

Thousands of splittail juveniles and adults are entrained in exports at the CVP and SWP pumping facilities. Juvenile splittail are salvaged at the state and federal fish protection facilities primarily during May–July. Juveniles from the current year's spawn first appear in salvage during April. Substantial numbers of small juveniles (less than 30 millimeters [mm] long) and larvae also may be entrained (but not salvaged), but entrainment of larvae and early juveniles depends on the proximity of spawning habitat to a given diversion. Salvage varies greatly from year to year: the annual average number of Sacramento splittail salvaged from 1980 to 2007 was nearly 690,000 fish, but consecutive years such as 1994 (just over 3,000 fish salvaged) and 1995 (more than 5,300,000 fish salvaged) had differences in abundance of several orders of magnitude (Table 4.5-6). This reflects year-class strength, which is probably determined by the amount of inundated floodplain habitat (Sommer et al. 1997).

Longfin Smelt

Longfin smelt (*Spirinchus thaleichthys*) is a 3- to 6-inch-long silvery fish that is endemic to the Bay-Delta estuary and other estuaries along the Pacific Coast north of San Francisco Bay. Longfin smelt were the most abundant smelt species in the estuary prior to 1984 and have been commercially harvested (Wang 1986). However, recent population abundance indices have been among record lows. This, in combination with other factors, resulted in longfin smelt being listed as

Threatened under CESA in early 2009. The California Fish and Game Commission (2009: 1) stated:

> In making the recommendation to list the longfin smelt pursuant to the California Endangered Species Act, the Department relied most heavily on the following: (1) longfin smelt is short-lived, (2) introductions of exotic organisms have altered its habitat, distribution, food supply, and possibly abundance, (3) water projects have adversely modified its habitat, distribution, food supply, and probably abundance, and (4) contaminants identified in ambient water samples have periodically adversely affected test organisms and may be affecting longfin smelt abundance. Threats to the longfin smelt population are likely to continue or increase, and several measures of longfin smelt abundance were examined and the Department found that they all indicate that the population has declined substantially.

Longfin smelt are one of four Delta fish species whose decline has been characterized and studied as part of the POD. Abundance indices for longfin smelt are positively correlated with freshwater inflow during winter and spring spawning periods. However, the relationship of abundance to flow has weakened in recent years in response to the introduction of the *Corbula* clam and the likely resulting competition for pelagic food resources (Baxter et al. 2008).

Life History

Except when spawning, longfin smelt are most abundant in Suisun and San Pablo Bays, where salinity generally ranges between 2 ppt and 20 ppt (Natural Heritage Institute 1992). Longfin smelt migrate upstream to the Delta and spawn in fresh water primarily during February through April (Natural Heritage Institute 1992). The eggs are adhesive and probably are deposited on rocks or aquatic plants.

Eggs hatch in 37–47 days at 45°F (Dryfoos 1965). Larval abundance in the Bay-Delta estuary peaks during February–April (California Department of Fish and Game 1992d). Shortly after hatching, a longfin smelt larva develops a gas bladder that allows it to remain near the water surface (Wang 1991). Larvae are swept downstream into nursery areas in the western Delta and Suisun and San Pablo Bays (Baxter et al. 1999, cited by Moyle 2002: 236).

Factors Affecting Abundance

Longfin smelt populations have been on the decline for several decades. Multiple and interacting factors probably have caused the declines in abundance observed in the past few decades. In addition to the inverse relationship between longfin abundance and Delta outflow, the decline in longfin abundance has been attributed to a decline in carrying capacity for juvenile fish associated with the invasion of the *Corbula* clam and several zooplankton (Kimmerer 2002a; Baxter et al. 2008), increased export diversions and entrainment (Moyle 2002; Baxter et al. 2008), low spawner abundance (Moyle 2002; Baxter et al. 2008), toxic contamination (Moyle 2002; Bay Institute 2007), and predation (Baxter et al. 2008; Moyle 2002).

Year-class abundance of longfin smelt appears to depend, in part, on the environmental conditions experienced by the eggs and young fish. One such factor is Delta inflow and outflow during larval and early juvenile life stages.

Outflow affects the downstream distribution of smelt and their vulnerability to entrainment in diversions. Both inflows and outflows move larvae and juveniles into the low-salinity zone where feeding conditions are optimal (Kimmerer 2002a). Freshwater flows during the late winter and early spring clearly are related to increased production of YOY longfin smelt (Stevens and Miller 1983; Jassby et al. 1995; Meng and Matern 2001; Kimmerer 2002a; Rosenfeld and Baxter 2007). Moyle (2002) attributed the relationship between smelt abundance and outflow to reduced availability of brackish water habitat for larvae and juveniles. Baxter (2000 in Moyle 2002) found that smelt numbers are a function of the number of spawners and of outflow during spawning and larval periods in the previous year. Herbold (1998 pers. comm. to Moyle 2002: 237) developed a regression indicating that mean spring (March–May) outflows much less than 3,400 cfs would cause reproductive failure. Outflow in the drought years 1986–1994 was close to this level. Although not highlighted by these authors, relationships with Delta outflow also would hold true for Delta inflow because of the correlation between inflow and outflow.

Kimmerer (2002a) found a negative relationship between abundance and X2, indicating higher abundance at higher flows. This was the strongest fish-X2 relationship found, although it declined by a factor of 4 after 1987 (Kimmerer 2002a: 46) and the establishment of the *Corbula* clam. Dege and Brown (2004) found a strong relationship between X2 and the distribution of longfin smelt: although the geographic distribution of YOY longfin varied over the years 1995–2001, annual distributions always were centered on the location of X2. As mentioned for delta smelt, Dege and Brown's (2004) findings are consistent with the hypothesis that abundance is controlled in part by an X2 location affording maximum rearing habitat. However, a recent examination by Kimmerer et al. (2009) indicated that "the mechanism chiefly responsible for the X2 relationship for longfin smelt remains unknown." This was because changes in habitat availability (defined by salinity) were insufficient to support observed changes in abundance. Kimmerer et al. (2009) suggested that the mechanism may be related to juvenile longfin smelt increasing retention in preferred waters by occupying deeper waters under higher salinity conditions.

Moyle (2002) speculated that the continuing decline of longfin smelt abundance is attributable to multiple factors acting synergistically. Besides outflow/X2, Moyle identified entrainment (SWP, CVP, and in-Delta agricultural) and take during salvage, the impact of introduced species on longfin food supply, extreme flooding during spawning, impacts of introduced predators, and toxic substances as possible contributors. In its petition for the listing of longfin smelt under the ESA, the Bay Institute (2007) also cited outflow, entrainment, food-related impacts of invasive species, and toxic pollutants as probable contributors to the decline of longfin abundance. They did not list predation by invasive species or flooding but did include water temperature increase and physical disruption of spawning habitat and critical prey species habitat by dredging.

Entrainment of longfin smelt by Delta diversions affects spawning adults, larvae, and early juveniles. Entrainment of larval and juvenile smelt in the SWP and CVP facilities is believed to be significant but has not been measured because these life stages are not retained by the salvage facilities' screens. Older juveniles and pre-spawning adults generally inhabit areas downstream of the Delta. In normal and wetter years, longfin smelt larvae and young juveniles are transported out of the Delta quickly, except during periods of low Delta outflow, and therefore are unlikely to be entrained in diversions. During the 1987–1992 drought, many juveniles remained in the Delta and were salvaged at the state and federal fish protection facilities during April–June. The average number of longfin smelt salvaged per year is about 20,000 but can vary from zero to more than 100,000 (Table 4.5-6), reflecting climatic conditions. Given the high salvage rates of YOY juveniles in some years, many longfin smelt larvae also are likely entrained, especially during February, March, and April. Survival of salvaged fish is unknown.

Green Sturgeon

Green sturgeon (*Acipenser medirostris*) is a large, long-lived anadromous fish species living in the Sacramento River, the Bay-Delta and nearby ocean waters. Two DPSs for sturgeon have been designated: the northern and southern DPSs; the Eel River is the delineation point for the two groups. The southern DPS was listed by NMFS as Threatened under ESA in 2006 and is limited to the single spawning group in the Sacramento River (Adams et al. 2007). Green sturgeon are less common in the Delta than white sturgeon and probably have always been uncommon in the Central Valley (Moyle 2002).

Life History

Green sturgeon are anadromous, spawning in fresh water in the Central Valley and returning to San Francisco Bay and nearshore marine waters to feed and mature. Adult sturgeon have been reported as far upstream as Red Bluff on the Sacramento River (Moyle 2002). Spawning occurs in the spring in deep, fast water. Females produce 60–140,000 eggs that are broadcast and fertilized over cobble substrate (Moyle 2002). Juveniles migrate to sea after 1 year spending time in estuarine waters. Adults are largely marine and migrate considerable distances along the Pacific Coast. Adults sexually mature after 13 to 20 years and then spawn every 2–5 years (Adams et al. 2007).

Factors Affecting Abundance

The primary threat to the southern green sturgeon DPS is the reduction of total spawning area to a single area of the Sacramento River (Adams et al. 2007). Access to historical spawning areas probably has been lost because of dams, including Keswick and Shasta on the upper Sacramento and Oroville Dam on the Feather River. Other threats are additional migration barriers, insufficient flow, increased water temperatures, entrainment in water diversions, nonnative forage species, competitors, predators, poaching, pesticides and heavy metals, and local harvest (Biological Review Team 2005). Young sturgeon survival probably is affected by entrainment in diversions, toxics, and prey availability. Salvage of green sturgeon at the SWP and CVP fish facilities is sporadic and exceeded 100 individuals per year in only 11 of the years from 1980 to 2007 (Table 4.5-6). Flows upstream of the Delta have more effect than Delta outflow on sturgeon spawning success.

Other Fish Species

Although many other fish species reside in the Bay-Delta estuary, potential effects of Project operations are not assessed for most of these species individually because their responses to potential changes in habitat conditions caused by Project operations are likely to be similar to those of one or more of the species life stages discussed above. Assessment of Project impacts on these other species therefore is encompassed by the discussion of potential effects on the species listed above. Fish entrainment analyses are included for white catfish (*Ameiurus catus*) because it is abundant and therefore ecologically important.

Significant numbers of resident fish are entrained by water diversions, but the actual entrainment impact on populations cannot be easily determined because information on overall population size, screening efficiency (except for a few species), and indirect entrainment losses (e.g., predation caused by delays during migration) is generally unavailable. Based on movement patterns, habitat affinities, and abundance, open-water pelagic fish (e.g., threadfin shad) are probably most susceptible to entrainment in diversions, followed by bottom-feeding catfish and minnows. Species such as sunfish have the lowest susceptibility to entrainment because of their relatively small home ranges and associations with cover.

The number of Bay fish species greatly exceeds the number of species in the Delta. Biological responses of estuarine and marine species to Delta outflow conditions are highly variable (California Department of Fish and Game 1992d; Herrgesell et al. 1983). Some populations remain stable regardless of outflow conditions, particularly species having wide salinity and temperature ranges and a broad range of food requirements (e.g., gobies). Some marine species (e.g., anchovies [*Engraulis mordax*]) may become locally more abundant if salinity increases in response to decreased Delta outflow. Higher Delta outflow may directly or indirectly alter the distribution of estuarine species, affecting intraspecific and interspecific competition (Stevens and Miller 1983; Kimmerer 2002b). Higher outflow may increase recruitment of marine species into the Bay by increasing landward gravitational flows (two-layered circulation), which improves access to rearing habitat for marine-spawning species like starry flounder.

Invertebrate Species

In the conclusion to his 2002 study of the mechanisms linking the abundance of San Francisco estuary fish and invertebrate[8] populations to flow, Kimmerer (2002a) states the following:

> Although mechanisms behind the abundance flow relationships in higher trophic levels cannot be deduced from correlative analyses, these mechanisms are unlikely to arise from effects occurring at the base of the food web…For freshwater flow to influence fish and shrimp through the food web would

[8] An invertebrate is an animal without a vertebral column (backbone); prominent examples in the Bay-Delta include bay shrimp and several common zooplankton species.

> require first that lower trophic levels have positive responses to flow, and that these responses propagate up the food web. Neither of these mechanisms is supported by the results presented here. Taxa in lower trophic levels either did not respond to flow, or they responded inconsistently by season, or with different slopes up to versus after 1987. Most taxa at higher trophic levels, which feed mainly on copepods and mysids during early life, had positive relationships to flow that did not change in slope after 1987, although several changed in intercept, 2 negatively and 1 positively. The large change noted for delta smelt apparently occurred well before the step change at the base of the food web. Thus, the flow response at higher trophic levels was largely uncoupled from variability in lower trophic levels."

A significant negative correlation was found between X2 and abundance/survival of longfin smelt, Sacramento splittail, American shad, striped bass, starry flounder, and bay shrimp—that is to say, the data indicated that abundance/survival indices for these species increased as Delta outflow increased and X2 decreased. The relationship between X2 and the abundance of Pacific herring and delta smelt was not significant. Significantly, there was little relationship between X2 and the abundance of species in lower trophic orders (including invertebrates such as mysid shrimp and other zooplankton), although the abundance of these species frequently declined after establishment of the *Corbula* clam in 1987. Only the zooplankton *Eurytemora affinis* demonstrated a significant effect and this only after 1987.

Kimmerer's analysis suggests that X2 affects most fish not by a bottom-up food chain relationship, but by physical phenomena linked to X2[9]. The lack of response to X2 of lower trophic levels (i.e., invertebrates) supports the conclusion that the proximate mechanisms for most X2-fish relationships are physical phenomena associated with X2. However, Kimmerer et al.'s (2009) update of the previous abundance-X2 analyses and a more explicit examination of changes in habitat size (salinity) did little to support the abundance–habitat quantity hypothesis. Only two fish species (striped bass and American shad) of eight examined showed evidence of habitat quantity increasing and concurrent increases in abundance or survival.

Environmental Commitments

Previous Environmental Commitments

The 2001 FEIR and 2001 FEIS contained a number of environmental commitments to avoid and mitigate potential effects of the Project based upon the FOC. The FOC included a variety of measures related to diversion, discharge, and other aspects of the Project that are detailed in Appendix B of the 2000 RDEIR/EIS. The main features of these fish protection measures are summarized in Chapter 2, "Project Description," and Chapter 3, "Project Operations."

[9] To be specific, Kimmerer (2002a, 50-51) said, "There is evidence of bottom-up effects in the pelagic food web propagating from the decline in phytoplankton through rotifers, copepods and mysids, and into starry flounder and longfin smelt, but apparently leaving other fish and shrimp unaffected."

Current Environmental Commitments

Many of the fish protection measures agreed to in the previous FOC have been assumed to apply for the Place of Use EIR. The Project will obtain revised BOs from DFG, USFWS, and NMFS. Four of the provisions in the FOC are now included as environmental commitments.

Implementation of a Temperature Assessment Program

This environmental commitment is the same as the 1997 FOC except that the temperature measurements are specified to be weekly averages to account for daily variations in temperature. The Project will implement a temperature program to minimize or avoid adverse impacts of Project discharges, as set forth below:

a) The Project will not discharge reservoir water for export if the weekly average temperature differential between the discharge and the adjacent channel temperature is greater than or equal to 20°F.

b) If the natural receiving water temperature of the adjacent channel is greater than or equal to a weekly average of 55°F and less than 66°F, Project discharges will not increase the channel temperature by more than a weekly average of 4°F.

c) If the natural receiving water temperature of the adjacent channel is greater than or equal to a weekly average of 66°F and less than 77°F, Project discharges for export will not cause an increase of more than a weekly average of 2°F.

d) If the natural receiving water temperature of the adjacent channel is greater than or equal to a weekly average of 77°F, Project discharges for export will not cause an increase of more than a weekly average of 1°F.

e) The Project will develop temperature monitoring and implementation plans to ensure that the Project does not adversely affect the channel temperature levels as described above. The monitoring plan will include reservoir and channel temperature monitoring. The monitoring and implementation plan will be completed after the Project is permitted, but at least 90 days prior to Project operations. The plans will be submitted to the responsible agencies for approval with the concurrence of the resource agencies.

Implementation of Dissolved Oxygen Standards

This environmental commitment is identical to the FOC. The Project will implement a DO monitoring program to avoid and minimize adverse impacts of Project discharges for export, as set forth below:

a) The Project will not discharge reservoir water for export if the discharge DO level is less than 6.0 mg/l without authorization from the resource agencies and notice to the responsible agencies.

b) The Project will not discharge reservoir water for export if the discharge would cause channel water DO levels to fall below 5.0 mg/l.

c) The Project will develop DO monitoring and implementation plans to ensure that the Project does not adversely affect the channel DO levels as described above. The monitoring plan will include reservoir and channel DO monitoring. The monitoring and implementation plans will be completed after the Project is permitted, but at least 90 days prior to Project operations. The plans will be submitted to the responsible agencies for approval with the concurrence of the resource agencies.

Implementation of Diversion and Discharge Reductions during Smelt Presence

During January–March, the Project will obtain the most recent information on larval and early-juvenile longfin and delta smelt distribution from the DFG larval smelt and 20-mm surveys. The larval smelt survey (initiated in January 2009) begins in the second week of January and runs every second week until the second week in March. The 20-mm survey begins in mid-March and samples a variety of sites fortnightly until mid-July. Presence of larval smelt in the vicinity of the Project Reservoir Islands will trigger monitoring of Project diversion sites for evidence of larval smelt. Monitoring will be required only for the Reservoir Island(s) near which larval smelt have been collected. The triggers for monitoring of diversion sites are:

- Webb Tract: presence of at least one larval smelt at survey stations 809, 812, 815, or 901;
- Bacon Island: presence of at least one larval smelt at survey stations 902, 914, 915, or 918.

Diversion sites will be monitored daily during diversion periods. Should larval smelt be detected, the diversion rate will be immediately reduced by 50%. Smelt presence is defined as a 2-day running average in excess of one (1) delta or longfin smelt per day at the sampled reservoir diversion station. If the 2-day running average of smelt presence is below one smelt per day, diversions will be increased by 10% per day to 100% after 5 days. Daily monitoring will continue until the subsequent larval smelt survey's data are available. If these data indicate that larval smelt are no longer present in the vicinity of the Reservoir Island(s) then diversion monitoring will cease. Monitoring will recommence if subsequent DFG smelt larval surveys once again reveal smelt presence at the stations noted above. Monitoring will not be required at a diversion station if the total diversion rate at the station is less than 50 cfs (e.g., during topping-off).

Weekly monitoring reports will be transmitted by fax and daily reports by email to the fishery agencies as follows:

- USFWS, Sacramento Fish and Wildlife Office
- NMFS, Protected Resources and Habitat Conservation Division

- CDFG, Habitat Conservation Division (Central Valley–Bay Delta Branch)

Monitoring samples (preserved fish) will be retained for a minimum of one year after collection. Agency biologists and law enforcement personnel will have 24-hour access to fish monitoring personnel, fish samples, and daily fish capture data. A QA/QC protocol, acceptable to the fishery agencies, will be developed and provided to the fishery agencies as part of the final monitoring program plan. The QA/QC protocol will include, but is not limited to, measures to ensure correct identification of larval and juvenile fishes.

During July, the Project will obtain the most recent information on fish salvage at the SWP and CVP fish facilities. If juvenile longfin or delta smelt are present in salvage collections, the discharge for export rate will immediately be reduced by 50%. Smelt presence is defined as a two-day running average in excess of one (1) delta or longfin smelt per day at either fish salvage facility. Discharges will be increased to 100% if monitoring data indicate that the two-day running average of smelt presence is below one smelt per day.

The Project will establish a Monitoring Technical Advisory Committee (MTAC) to advise and resolve monitoring issues that may develop over the life of the Project. The MTAC will be made up of voluntary participants from a variety of agencies, including, but not limited to, invitees from the State Water Board, the Corps, USFWS, NMFS, DFG, DWR, Reclamation, USEPA, and the Project. The Project may convene the MTAC to evaluate and recommend adjustments to the monitoring program.

Initially, the Project will work directly with DFG to resolve daily technical monitoring issues but may convene the MTAC to act in a technical capacity to provide review and address any technical inadequacies or disagreements that may occur. The committee also may provide advisory review on issues of waiver occurring during implementation of the monitoring program. Any modifications to the monitoring program must be made with the approval of the responsible agencies and concurrence of the resource agencies who will continue to retain final approval or disapproval of any monitoring changes.

Funding and Implementation of an Accidental Spill Prevention Program and Boat Wake Reduction Measure

The Project will charge each boat slip owner or lessee $150 per year for each net additional berth beyond pre-Project conditions added to any of the four Project islands. These funds will be in January 2010 dollars and will be adjusted annually for inflation. The funds will be used by the Project to develop and implement a spill prevention program including signage and maintenance of clean-up supplies on boat docks. The funds will also be used to post speed-limits to reduce boat-wake-caused erosion. The spill prevention program will be ready for implementation prior to completion of docks.

Note that mitigation measures are discussed below in the section entitled Impacts and Mitigation Measures.

Environmental Effects

Methods

The primary fishery-related effects of Project operations would be changes in Delta water flows and increased entrainment of fish. Project operations will change flows in three ways: (1) Project diversions will reduce Delta outflows and San Joaquin River flows downstream of the Reservoir Islands, (2) Export of discharged Project water from the south Delta (by SWP pumping) will increase reverse OMR flows between the Bacon Island and Webb Tract discharge locations and the SWP and CVP intakes, and (3) Project releases in the fall months will beneficially increase the Delta outflow by increasing San Joaquin River flow downstream of Webb Tract and Bacon Island. Flow changes could affect Delta water quality; shift the position of the salinity gradient; or alter local habitat conditions. Project operations would increase entrainment of fish and invertebrates by Project diversions and by increasing SWP pumping to export water discharged from Project Reservoir Islands. These basic effects on fish habitat and fish entrainment were previously assessed, but are being re-evaluated with the revised operations modeling and updated fish abundance and fish density (i.e., number of fish per volume of water) information.

Construction impacts on fish habitat have been assessed previously and would not change based on the recent changes in Delta information and regulations. Potential changes in water quality (primarily temperature and DO) due to discharge of Project water were also previously analyzed and these effects would not change. Effects on fish from predation that might be increased by water-side recreational facilities also were assessed previously and would not change.

Simulation of Project Operations

Assessment of Project effects on Delta fish species and their associated habitats involves predicting fish and habitat responses to changes in Delta conditions that could result from Project operations. Project diversions, water storage, discharges for export pumping, and releases for Delta outflow with the associated changes in channel flows, outflow, and exports were simulated for Project operations under a range of hydrologic conditions (see Chapter 3, “Project Operations”). The baseline conditions are assumed to be recent operations as allowed under D-1641. This allowed full Project operations to be simulated without estimating potential restrictions caused by the OMR flow restrictions in the recent USFWS and NMFS biological opinions for OCAP. The fishery impacts were evaluated for these assumed full Project operations; possible Project limitations for OMR flow restrictions would reduce the impacts from the full Project operations. Furthermore, these simulated Project operations cannot reflect all of the fish protection measures that are part of the FOC, which include potential reductions in Project diversions and discharges that would be triggered by water temperature and DO standards and by the presence of delta smelt and longfin smelt in the vicinity of the Project diversions. Therefore, the results of these Project simulations, in combination with information on fish behavior and habitat needs, provided the basis for the fishery impact analysis, which estimated potential worst-case effects of Project operations on estuarine habitat conditions and fish entrainment at the Project fish-screened diversions and at the south Delta export facilities.

The monthly model for simulation of Project operations is fully described in Chapter 3, "Project Operations," and in Appendix A. The existing conditions and Project modeling was based on CALSIM results for existing Delta flow conditions as simulated for a repeat of the 1922–2003 runoff sequence with D-1641 objectives. The results from this modeling of existing conditions and Project operations are described in Chapter 3, "Project Operations." The Project modeling made three main assumptions:

- diversions of water for storage during the months of December to March;
- discharges of stored water for export by the SWP during the months of July through November; and
- occasional releases of stored water into the Delta during September–November for salinity control and estuarine habitat benefits.

Only Alternative 2 has been modeled because simulation of Alternative 2 encompasses the impacts of Alternative 1. Alternative 3 was modeled in the 2001 FEIR and 2001 FEIS, but is not simulated in this Place of Use EIR because the impacts would be consistent with the 2001 FEIR and 2001 FEIS conclusions and because Alternative 3 would be inconsistent with the FOC and the existing BOs.

The simulation of the Project operations was performed with a monthly model developed by MBK Engineers to evaluate potential Project operations that would not change CVP and SWP Delta operations nor interfere with the existing D-1641 objectives. This model provided results that were similar to the DeltaSOS modeling used for the 1995 DEIR/EIS and the 2000 RDEIR/EIS. However, the MBK model included accounting for the designated place(s) of use for the Project exported water and simulated the interim storage in groundwater banks when the designated place(s) of use already had full water deliveries.

Fish impacts caused by Project operations were estimated for the 1980–2003 period by comparing the simulated monthly results for conditions with the simulated monthly results for Project operations. This simulation period began in 1980 because historical salvage data (upon which entrainment analyses of juvenile and adult fish was based) did not identify all species consistently before this time. The period ended in 2003 because CALSIM runs only extend to this year. This baseline period includes a full range of flow conditions and corresponding fish salvage patterns.

The monthly results for the 1980–2003 period (24 water years, October to September) with the annual total (taf) can be referenced in Chapter 3, "Project Operations." The following Delta flow variables were used for the fish assessment:

- Table 3-18 gives the monthly total Delta inflow (cfs)
- Table 3-19 gives the monthly combined CVP and SWP exports (cfs) for the existing conditions (no Project operations)
- Table 3-20 gives the monthly Delta outflow (cfs) for the existing conditions (no Project operations)
- Table 3-21 gives the monthly Project diversions to storge (cfs)
- Table 3-22 gives the monthly Project discharges for export (cfs)
- Table 3-23 gives the monthly Project releases for Delta outflow(cfs)
- Table 3-24 gives the end-of-month X2 Location (km) for the existing conditions (no Project operations)
- Table 3-25 gives the end-of-month X2 Location (km) with Project operations
- Table 3-26 gives the change in the end-of-month X2 Location (km) with Project operations

Indirect effects were assessed by evaluating the entire life history effects to the species.

It is difficult to determine the existing conditions for the Delta fishery resources (fish abundance and habitat conditions) that should be used for the Project impact assessment. Historical records (1980–2008) of CVP and SWP salvage are used for the quantitative assessment of entrainment impacts, although many species are exhibiting long-term trends over time. The basic assumption is that the Project effects on a fish species will be similar for whatever total abundance of fish may occur each year. The impacts on the seasonal abundance (i.e., migration or distribution within the Delta) of each fish species was evaluated, using these monthly Delta flows and Project operations. Future Delta conditions are unknown but may include relaxation of VAMP pumping restrictions, construction of an isolated conveyance facility to transport water from the Sacramento River under or around the Delta, and further export pumping restrictions; such changes are unlikely to change substantially the impacts of the Project operations. The fish impacts described in this section were evaluated only for the D-1641 existing conditions to ensure that worst-case fisheries impacts are evaluated. OCAP remedy actions and additional reductions in CVP and SWP exports caused by the reverse OMR flow restrictions in December–June would reduce the overall impact of the proposed Project and entrainment by the export facilities.

Analytical Approach and Impact Mechanisms

Framework for Fish Impact Assessment

The analytical framework and calculations for assessing fishery resource impacts caused by the Project are similar to those used in the 2001 FEIR and 2001 FEIS and the preceding draft documents.

The framework evaluates the Delta conditions that are important for relevant life stages of each fish species being evaluated. Where possible, impacts are evaluated as the estimates of the percentage of a whole population that is affected. The baseline conditions are compared with the flow and habitat conditions with the Project operating for a range of baseline Delta inflows; however, because the simulated Project operations cannot reflect all of the fish protection measures that are part of the FOC, fisheries impacts are considered to be worst case for the Project. Implementation of the FOC will substantially avoid these impacts. The periods used in each analysis differed according to input data and other considerations—these are detailed below. For most analyses, a 1980–2003 baseline period was adopted. This period was used because it is generally representative of the full range of Delta hydrology simulated with the IDSM model (1922–2003) and also corresponds to the period of most reliable fish salvage density (fish/taf) collected at the SWP and CVP fish facilities. Potential effects of the Project operations on fish habitat and survival, as well as entrainment and predation losses are considered using appropriate fish surveys and export fish salvage data to characterize the existing conditions.

IDSM was used to simulate monthly Project operations, based on baseline CALSIM simulations of Delta inflows and CVP and SWP exports, as well as agricultural and municipal diversions corresponding to the 1922–2003 hydrologic record, as regulated by D-1641objectives (See Chapter 3, "Project Operations"). Simulation results for Project diversions, discharges for export, and resulting changes in Delta channel flows and Delta outflow were used to determine the worst-case effects of Project operations on fish habitat conditions and individual species entrainment or mortality. The Project operations were simulated with all Project diversions occurring in the December–March period during periods with outflow greater than 11,400 cfs (X2 downstream of Chipps Island), and all Project discharges for export occurring in July–November. The methods used to assess effects on fishery resources include: entrainment effects (eggs, larvae, juveniles, and adults during Project diversions and following discharge to export); salmonid migration mortality effects; changes in estuarine habitat area; outflow-linked changes in fish habitat area, survival and population abundance; upstream movement of smelt species caused by Project diversions; and entrainment loss of zooplankton.

Agricultural diversions in the Delta Lowlands (340,000 acres) were used to characterize existing effects of agricultural diversions on entrainment of screenable-sized fish. The existing diversions to the four Project islands (17,000 acres) were assumed to be 5% of this total, based on acreage. The agricultural diversions in the Delta Uplands (142,000 acres) were not included in the baseline entrainment calculations. It was assumed that the annual pattern of agricultural diversions in the Delta Lowlands had the same seasonality as the DW agricultural diversions.

There is no change to the methods used in the 2001 FEIR and 2001 FEIS and preceding draft documents to assess the effects of construction activities on fishery resources; the results and conclusions remain valid and are detailed below. The impact assessment identified the locations and type of fish habitat that could be affected by construction activities, including additional levee improvements (e.g., riprapping) and construction of intake and discharge structures, fish screens, and boat docks.

Also unchanged is the impact assessment of water quality impacts on fish from Reservoir Island discharge of organic materials and toxins; DO content and temperature of discharged water (particularly with regard to salmonids); and from increases in boating activities (e.g., gasoline and oil spills).

The major emphasis of the Place of Use EIR evaluation is the operational worst-case impacts on fish and habitat. The general methods are similar to those used in the 2001 FEIR and 2001 FEIS. However, because the Project operations are slightly different and because the recent fish salvage data and fish survey abundance data are updated from that used for the 2001 FEIR and 2001 FEIS, the calculation procedures are described here.

Methods for Assessing Losses of Fish Eggs and Larvae by Entrainment

The distribution of early life stages (eggs, larvae, and juveniles) of many fish species, including striped bass and delta and longfin smelt, is affected by Delta flow patterns and diversions. Many other factors also affect the distribution of larvae and juveniles in the estuary, including the distribution and timing of spawning, larval growth, and the response of fish to various environmental conditions (e.g., salinity, temperature, and prey distribution). These other factors are less well described than water movement based on Delta flows and flow splits between channels. Therefore, entrainment analyses often assume that eggs and larvae behave as passive particles and that water movement represents egg and larval movement (e.g., Kimmerer and Nobriga 2008). Losses of fish eggs and larvae to the Project would include entrainment at the reservoir and Habitat Island diversions, as well as losses because of SWP export of Project water discharges.

In the 2001 FEIR and 2001 FEIS and preceding draft documents, the fish transport model DeltaMOVE was used to simulate an entrainment index for evaluating the effects of water project operations on entrainment loss in the Delta. The present study adopted a similar approach. Kimmerer and Nobriga (2008) simulated movement of eggs and larvae in the Delta using the DSM2 particle tracking model to determine the fate of particles approximately 1 month after release from various Delta locations. They examined a large number of different export and inflow scenarios and determined that the proportion of particles lost to entrainment by the SWP and CVP pumps is well predicted by the export to inflow ratio (E/I), i.e., the ratio of water exported from the Delta by the CVP and SWP to water flowing into the Delta. High exports and low inflows (i.e., high E/I ratio) give greater losses of particles (simulated eggs/larvae) over a given time period than a lower E/I ratio. A month is enough time for particles to reach the exports for most Delta flow conditions. Particles originating in a region quite susceptible to entrainment at the SWP and CVP pumps (e.g., the south or central Delta) will be lost in greater numbers than particles originating in a region relatively unaffected by the pumps (e.g., the confluence of the Sacramento and San Joaquin Rivers).

Sigmoidal (i.e., logistic) relationships between the E/I ratio and the percentage of particles lost to entrainment over 30 days at various Delta locations were plotted by Kimmerer and Nobriga (2008). The relationships were used to estimate entrainment loss of striped bass and delta and longfin smelt larvae. The E/I ratio in each month was calculated for the baseline exports and for baseline plus Project operations (including reduced agricultural diversions), and the corresponding monthly particle loss percentages were calculated. Appendix B details the assumed monthly and geographic distributions applied to each species, which were largely the same as those used in the 2001 FEIS and preceding draft documents. The assumptions of the egg and larval entrainment analysis were as follows:

- diversions to the Project Reservoir Islands occur in December–March;
- discharges for export occur in July–November;
- each species spawns according to a fixed pattern in each year, both spatially and seasonally, i.e., the species were assumed to spawn in the same places at the same times each year—the results of the analysis are dependent on this assumption;
- entrainment of eggs and larvae to the Project islands can be estimated using relationships similar to the E/I curves developed for the SWP/CVP export facilities by Kimmer and Nobriga (2008);
- intake screening offers no protection to eggs and larvae;
- eggs and larvae behave as passive particles and move with water flows;
- diversions to the agricultural and Habitat Islands are the same (quantity and timing) in all years.

The Project entrainment effects, as a fraction of the existing conditions entrainment, indicate the direction and magnitude of potential change in entrainment loss relative to existing conditions. The entrainment impact should not be construed as the actual level of entrainment that would occur. Simulated monthly conditions, a fixed spawning distribution, and the assumed transport characteristics of a life stage cannot accurately and fully characterize the complex conditions and variable time periods that affect the entrainment process. Additionally, the reduction in egg and larval fish entrainment that would occur with implementation of FOC fish protection measures during Project diversions and discharges could not be modeled; therefore, projected impacts on fish eggs and larvae must be considered as the worst case.

Methods for Assessing Entrainment Loss of Juvenile and Adult Fish

Entrainment loss includes the total number of fish diverted onto the Project islands. Also included in this estimate are fish impinged on Project fish screens and eaten by predators exploiting habitats created by the intake facilities. Entrainment loss also includes fish entrainment at the SWP fish facilities as a result of pumping water discharged from the Project Reservoir Islands.

The intakes on all Project island siphons would have state-of-the-art positive barrier fish screens. Fish screen operations and design have been developed in consultation with DFG and NMFS. For juvenile fish longer than 20 mm and adult fish, the fish screens are assumed to nearly eliminate entrainment losses. Nobriga et al. (2004) found that a screened Delta intake on Sherman Island entrained less than 1% of the fish entrained at a nearby unscreened intake; delta smelt were not entrained at all by the screened intake, although numbers at the unscreened intake were relatively low. A Project screen efficiency of 95% for juvenile and adult fish was assumed in this analysis, which would account for mortality of fish by impingement as well as from potential increased predation near the intakes or boat docks. A 95% screen efficiency was assumed in the NMFS 2009 OCAP BO for the CCWD Old River and Alternative Intake Project diversions.

Historical (1980–2008) CVP and SWP salvage records (California Department of Fish Game 2009a) were used to estimate monthly densities of fish in the Delta that are large enough to be screened at the Project. Fish density (fish/taf exported at SWP and CVP) in each month was examined for each species of interest. The density of fish that would have approached the SWP and CVP intakes or the Project intakes was estimated by multiplying the salvage data by values to reflect presalvage losses due to fish passing through the fish facilities' louvers and losses due to predation in Clifton Court Forebay. The monthly fish densities were used in conjunction with simulated monthly diversions to determine potential entrainment loss under the baseline and with the Project operations (i.e., screened diversions to Project Reservoir Islands from December to March, export of Project water using available SWP pumping capacity from July to November, and seasonal diversions and screened diversions to the Habitat Islands).

In summary, the entrainment analysis of juvenile and adult fish assumed:

- diversions to the Project Reservoir Islands occur in December–March;
- discharges for export occur in July–November;
- density of fish in the Delta can be estimated from historic salvage data by applying appropriate corrections for presalvage losses (see next bullet);
- presalvage losses could be accounted for by multiplying the SWP salvage density by 5.3 (reflecting prescreen loss of around 80% due to louver

efficiency and predation losses; National Marine Fisheries Service 2009: 352) and by multiplying the CVP salvage density by 2.5 (reflecting prescreen losses of approximately 60%)—for green sturgeon, predation loss was assumed to be minimal (5% instead of 75% at SWP and 15% at CVP), with resulting multipliers of 1.4 for SWP data and 2.2 for CVP data based mostly on louver inefficiency;

- the density of fish is the same in each year and differs by month according to fixed seasonal patterns;
- any reduction in fish density between the Project and the south Delta facilities caused by the discharge of "fish-free" water from Project storage is not accounted for, which ensures a conservative analysis of impacts;
- the volume of water diverted or exported is directly related to the loss of fish: Loss of fish is calculated as fish density (fish/taf) multiplied by intake flow (taf), with corrections for screening efficiency (95% for screened Project islands), intake size (see next bullet), and postsalvage loss (2% during collection, holding, trucking and release and 10% by predation; all smelt were assumed to die during salvage and pre-/post-salvage predation on green sturgeon was assumed to result in a 1% loss);
- density of fish being drawn to the Project intakes (Reservoir Islands) is 50% of the density drawn to the export facilities because the Project intakes consist of an array of smaller intakes that are less likely to draw as many fish towards them; the density approaching the relatively small agricultural and Habitat Island diversions is 10% of that drawn to the export facilities—these assumptions are based on limited existing information, so comparative analyses also were conducted using values for the reservoir intakes of 50% and 100% and for the agricultural/Habitat Island intakes of 10%, 50%, and 100%;
- delta smelt adults occur from December to March and 25% of fish in April salvaged are adults—delta smelt in the remainder of the year are juveniles;
- Chinook salmon race (run) can be determined from length in a given month using the key established for the Delta (Greene 2004).
- diversions to the agricultural and Habitat Islands are the same (quantity and timing) in all years;
- baseline losses to Delta lowland agricultural diversions are 20 times greater than losses estimated for existing DW agricultural diversions—this assumption is based on the relative size of the irrigated acreages (DW is 5% of the total lowland irrigated acreage) and that other irrigation in the Delta follows the same annual pattern of diversion as the existing DW agriculture.

The predicted Project entrainment indicates the direction and magnitude of potential change in entrainment loss relative to existing conditions. The predicted entrainment impact should not be construed as the actual level of entrainment that would occur. Additionally, because the simulated Project operations cannot reflect all of the fish protection measures that are part of the FOC, fishery impacts are considered to be worst-case. Implementation of the FOC will largely avoid these impacts.

Methods for Assessing Effects of Old and Middle River Flows on Delta Smelt Loss

The USWFS (2008a) OCAP BO for delta smelt prescribed measures to reduce losses of delta smelt adults and larvae/juveniles from December to June due to SWP/CVP pumping in the south Delta (see section above on “2008 Operations Criteria and Plan Delta Smelt Biological Opinion (U.S. Fish and Wildlife Service)”). The measures are based, in large part, on reductions in pumping which are intended to lessen the upstream (reverse) flow in OMR. The Project cannot change the measured OMR flows in December to June because the Project diversions are downstream of the measurement gage (Figure 4.5-1). It is acknowledged that the Project diversions would have some effect on OMR flows downstream of the measurement gauges; how this effect could translate to delta smelt is unclear. The previous section described methods to analyze adult delta smelt entrainment loss during diversions that would be attributable to losses at the screened Project intakes (which are assumed to be 95% effective). Losses of juveniles were assumed to occur mostly during export of discharged Project water. The fish assessment methods will result in worst-case impacts because reductions in fish entrainment that would occur with implementation of FOC fish protection measures during Project diversions and discharges cannot be modeled. Implementation of the FOC will largely avoid these impacts.

It is unknown whether diversions of water to the Project’s Reservoir Islands could make delta smelt adults and larvae/juveniles more susceptible to entrainment at the south Delta pumping facilities by drawing some fish into the central Delta. To examine this potential effect, it was assumed that diversions to the Reservoir Islands could be equivalent to south Delta export pumping. Thus, for example, with OMR flows of -5,000 cfs and Project diversions of 2,000 cfs, the effective OMR flows would be -7,000 cfs. The effects of the decreased OMR flows on delta smelt were assessed using two equations described in the USFWS (2008a) OCAP BO. The first equation describes the percentage of adult delta smelt lost at the SWP/CVP facilities in December–March as a function of average OMR flows (U.S. Fish and Wildlife Service 2008a: 212). The second equation describes the proportion of larval-juvenile delta smelt lost at the south Delta export facilities in March–June as a function of average OMR flows and average X2 (U.S. Fish and Wildlife Service 2008a: 220). These equations were first used to estimate percentage losses of delta smelt under baseline conditions with only SWP and CVP exports considered (1980–2003). The increase in loss due to the additional Project diversions was then compared to baseline losses.

In summary, the assumptions of this analysis include:

- diversions to the Reservoir Islands occur in December–March;
- Project diversions to the Reservoir Islands on Webb Tract and Bacon Island increase the reverse OMR flows by the same amount of flow that is diverted and therefore increase the percentage of adult and juvenile delta smelt that is lost to entrainment at the south Delta export facilities;

- loss of adult delta smelt to entrainment at the south Delta export facilities is influenced by OMR flows from December to March and can be estimated from an equation in the USFWS (2008a) OCAP BO; and
- loss of larval-juvenile delta smelt to entrainment at the south Delta export facilities is influenced by OMR flows from March to June and can be estimated from an equation in the USFWS (2008a) OCAP BO.

Methods for Assessing Through-Delta Migration Mortality of Juvenile Sacramento River and Mokelumne River Salmonids

Outmigrating Central Valley salmonid smolts must pass through the Delta. Endangered Sacramento River winter-run Chinook salmon and Threatened Central Valley spring-run Chinook salmon currently spawn only within the Sacramento River watershed (Moyle et al. 2008); Threatened Central Valley steelhead originate mostly from the Sacramento River watershed because the San Joaquin watershed populations are diminished to very low abundance (McEwan 2001). Chinook salmon populations in the San Joaquin River watershed are also very low in abundance, with escapement of natural-origin spawning fall-run Chinook only around 5% of that in the Sacramento River watershed in 2008 (Anadromous Fish Restoration Program 2009). Salmonids entering the Delta from the Sacramento River may migrate through the river's mainstem or through smaller channels to the west (i.e., Sutter and Steamboat Sloughs). Other migrating salmonids may enter the central Delta through two main routes, the DCC and Georgiana Slough. The proportion of salmonids entering the central Delta depends on the position of the DCC gates (open or closed) and the amount of flow in the Sacramento River. NMFS (2009: 631) describes an average of about 45% of Sacramento River flow being diverted into the central Delta through the DCC and Georgiana Slough, with 25% being diverted in November and December. Smolts entering the central Delta have reduced probability of surviving passage through the Delta compared to smolts remaining in the mainstem or entering Steamboat and Sutter Sloughs. Brandes and McLain (2001) summarized coded wire–tag studies that showed survival to Chipps Island (just downstream of the Delta) for fish passing through the central Delta (having been released in Georgiana Slough) was around half that of fish released on the mainstem Sacramento River (at Ryde) at low export levels, declining to around 15% at high export levels (~10,000 cfs). Lower survival may have been partly a result of the greater distance (37% farther than the mainstem route [White 1998 as cited by Brandes and McLain 2001]) and longer travel time but could also have been attributable to greater residence time caused by lower river flows and high levels of export (Brandes and McLain 2001; National Marine Fisheries Service 2009). Residence time could be increased by altered hydrodynamics providing false directional cues to outmigration, for example. A greater residence time in the central Delta may expose fish to an increased threat of predation or poorer water quality compared to the mainstem Sacramento River (National Marine Fisheries Service 2009).

The analysis of through-Delta migration mortality of juvenile Sacramento River salmonids is similar to the approach in the 2001 FEIR and 2001 FEIS and preceding draft documents to assess the possible effects of the Project on outmigrating salmonids. The main assumptions of the analysis are:

- Diversions to the Reservoir Islands occur in December–March;
- Discharges for export occur in July–November;
- Brandes and McLain's (2001) findings can be applied to steelhead and winter-run and spring-run Chinook salmon (their observations were for fall-run and late-fall-run Chinook salmon);
- The DCC gates are closed from January to June;
- If the DCC gates are closed, the flow of water into the Central Delta is represented by 0.133(Sacramento River flow at Hood, cfs) + 829;
- If the DCC gates are open, the flow of water into the Central Delta is represented by 0.293(Sacramento River flow at Hood, cfs) + 2090;
- The percentage of juveniles leaving the Sacramento River and entering the central Delta is equivalent to the percentage of Sacramento River flow entering the central Delta;
- 90% of juveniles entering the Delta and remaining in the Sacramento River (or passing through Steamboat and Sutter Sloughs) would survive to Chipps Island (i.e., 10% mortality)—this survival rate is at the high end of recent estimates based on acoustic tagging (e.g., Perry and Skalski 2008, as cited by National Marine Fisheries Service 2009);
- 45% of juveniles entering the Delta and subsequently moving into the central Delta through the DCC or Georgiana Slough would survive to Chipps Island at zero exports (i.e., a minimum of 55% mortality would always occur because of the path through the Delta being longer and more hazardous because of higher predator numbers and poorer water quality);
- Additional mortality of juveniles passing through the central Delta would be directly proportional to the amount of exports, up to a maximum of 100% mortality (at exports of 15,000 cfs);
- Project diversions to storage are treated similarly to increased levels of south Delta export, except that the associated mortality of Project diversions is reduced by 50% (due to the intakes being smaller and screened, as well as being closer to the salmonids' migration path through the Delta and so being less likely to divert fish away from that path)—comparative analyses assuming values of 100% and 25% also were conducted to examine the effect of changing this value;
- Project discharges to export are treated similarly to increased levels of south Delta export, without accounting for the reduction in fish density between the Project and the south Delta facilities caused by the discharge of fish-free water from Project storage;
- For each salmonid species (i.e., steelhead and winter-run, spring-run, fall-run, and late-fall-run Chinook salmon), the percentage of the total number of

juveniles entering the Delta in each month is the same as the values used in the analysis of fish entrainment.

Baseline mortality (percentage of all smolts entering the Delta) was calculated for the baseline SWP/CVP exports for 1980–2003. The additional mortality percentage attributable to the Project diversions and exports then was calculated and compared to the baseline value. The main impact period on migrating juvenile salmonids is during Project diversions (December–March) because the assumed discharge-for-export period (July–November) does not coincide with the main periods that juvenile salmonids traverse the Delta. Likewise, the relatively small agricultural and habitat diversions associated with the Project occur primarily in the summer and were excluded from the analysis.

This analysis focuses on juvenile salmonids originating in the Sacramento River watershed because these represent the great majority or all of individuals, particularly of listed species such as winter-run and spring-run Chinook salmon and steelhead. It is acknowledged that Project effects on juvenile salmonids originating from populations in the San Joaquin watershed (i.e., Mokelumne River southwards) would probably be greater as a proportion of each of the whole population, but would numerically be low compared to the losses associated with the Sacramento River watershed. As an indication of the level of mortality for fall-run Chinook salmon and steelhead juveniles originating in the Mokelumne River, the results of the Sacramento River model were applied. This was achieved by using the equation,

% mortality of Mokelumne fish = % mortality of Sacramento fish due to Project × (100/% of Sacramento fish entering the central Delta)

The Project mortality percentage should not be construed as the actual level of mortality that would occur because simulated monthly conditions cannot accurately and fully characterize the complex conditions and variable time periods that affect survival during migration through the Delta. The mortality estimate provides a basis for evaluating the effects of the Project operations on the survival of outmigrating salmonid smolts.

Methods for Assessing Changes in Estuarine Habitat Area

Changes in estuarine habitat area between baseline conditions and with the Project operations were assessed using the same methods as those described in the 1995 DEIR/EIS and 2000 RDEIR/EIS. Salinity is an important habitat factor, and estuarine habitat is often defined in terms of a salinity range (Hieb and Baxter 1993). All estuarine species are assumed to have optimal salinity ranges, and different life stages within a species often vary in their salinity preferences. Species year-class production may be determined partly by the amount of rearing habitat available within the optimal salinity range (Unger 1994), although this is still under investigation (Kimmerer et al. 2009).

Rearing habitat area, based on the estimated optimal salinity range, was calculated for striped bass and delta and longfin smelt. The optimal salinity range was based on the locations of 10^{th} and 90^{th} percentiles of fish catch from survey data: 0.1–2.5 ppt for juvenile striped bass, 0.3–1.8 ppt for juvenile delta smelt, and 1.1–18.5 ppt for juvenile longfin smelt (Unger 1994).

The Bay-Delta estuary has a complex shape, and the area of optimal salinity habitat varies greatly with the salinity gradient position (i.e., X2). The geographical locations of the upstream and downstream limits of the optimal salinity habitat are computed from monthly average Delta outflow and the optimal salinity range of the species (Appendix B). The salinity gradient is assumed to maintain a logistic shape, with a salinity of 2 ppt at the X2 position and a salinity of 33 ppt at the Golden Gate Bridge. The surface area at 1-km segments from the Golden Gate to 100 km upstream was estimated from nautical charts. It was assumed that there was no functional habitat above km 100. Total area of optimal salinity habitat was computed for each month through addition of all areas contained between the upstream and downstream limits of the optimal salinity range.

The annual optimal salinity habitat area was the weighted sum of all juvenile rearing months. Weighting was based on the monthly mean relative abundance of larvae and early juveniles. Thus, if larvae are present only in April and May, if the area of optimal salinity habitat in April and May is 50 km^2 and 100 km^2, respectively, and if the proportion of larvae present in April and May is 30% and 70%, respectively, the weighted area would be $(50 \times 0.3) + (100 \times 0.7) = 15 + 70 = 85$ km^2. Further details of these calculations of optimal salinity habitat are included in Appendix B. A baseline period of 1980–2003 was used for this analysis to maintain consistency with the available CVP/SWP entrainment data.

The assumptions of this analysis were:

- diversions to the Reservoir Islands occur in December–March;
- discharges for export occur in July–November;
- there is no functional habitat for delta smelt, longfin smelt, or striped bass above km 100 of the Sacramento River;
- the monthly weightings of relative abundance of the larval fish remain the same in all years;
- monthly minimum and maximum isohaline positions can be reasonably predicted from X2 position (see Appendix B for calculation details).

Methods for Assessing Changes in Fish Population Abundance and Survival Caused by Shifts in X2

The mechanisms underlying the general link between X2 and fish abundance or survival are not clear. Nevertheless, a number of statistically significant X2-abundance relationships have been documented, most recently by Kimmerer et al. (2009). The X2-abundance equations provided by Kimmerer et al. (2009) were incorporated into an analysis of Project effects on X2 position and the associated fish abundance.

First, X2 location was calculated for the baseline condition. Predicted abundance indices of longfin smelt and American shad (based on FMWT surveys), and survival indices of striped bass (based on summer townet surveys) were calculated for the baseline X2 locations. The process was repeated for the X2 position under simulated Project conditions to assess the predicted change in abundance or survival indices from baseline attributable to the Project. Details of the analysis are given in Appendix B.

As noted in the OCAP delta smelt BO (2008), indices of juvenile delta smelt abundance from summer townet surveys are positively related to FMWT indices in the previous year, from 1987 onward. Prediction of juvenile abundance from adult abundance is greatly improved when the average X2 location from September to December is included in the regression. The possible effects of the Project on the abundance of juvenile delta smelt, as represented by the summer townet index (California Department of Fish and Game 2009d), were assessed by using historical FMWT indices from 1987 to 2003 and predicted end-of-month X2 locations for August to December.

Assuming the abundance and survival indices are representative of the whole populations involved, this analysis calculates the effects of the Project on entire fish populations. The regression relationships used in the analyses are based on data with an appreciable degree of variability, so that differences between baseline conditions and Project alternatives are typically much closer to each other than to the actual observed values.

The assumptions of this analysis were:

- Diversions to the Project Reservoir Islands occur in December–March;
- Discharges for export occur in July–November;
- Occasional releases of Project water for Delta outflow occur in September–November;
- The average position of X2 for a period in a species' early life determines abundance or survival later in life;
- Relationships between X2 and abundance index or survival developed by Kimmerer et al. (2009) are valid for use with average end-of-month X2 values during the early life stages of a species;
- For delta smelt, the abundance index of juveniles in the summer townet survey can be predicted from the previous year's fall midwater trawl abundance index and average fall X2 position;
- Changes in abundance index are representative of changes in the overall population's absolute abundance.

Methods for Assessing Upstream Movement of Adult Smelt from January to May

Both delta and longfin smelt migrate upstream to spawn in the December to March period. Project diversions from December to March have the potential to stimulate a migration farther upstream than normal if the smelt are following a flow-based cue such as X2 position. Although entrainment of adult smelt at the Project diversions will be relatively low because the Project diversions will be screened, movement of adults farther upstream than normal potentially would increase the proportion of the population susceptible to entrainment by the SWP/CVP export facilities. A general pattern of increased smelt entrainment at the SWP fish collection facility during drier years was noted by Sommer et al. (1997). Monthly smelt density data from a series of DFG spring kodiak trawl survey stations (California Department of Fish Game 2009a) along an estuarine transect from Carquinez Strait to the Delta were evaluated to determine the fraction of the adult smelt populations located upstream of the confluence of the Sacramento and San Joaquin Rivers. The percentage of the population upstream of the confluence was taken as an indicator of the susceptibility of these individuals to entrainment. The percentage upstream of the confluence was compared to estimated X2 position for evidence of X2 position influencing upstream distribution. Full details of the analysis are given in Appendix B.

Methods for Assessing Entrainment Loss of Zooplankton from June to September

The 2008 OCAP delta smelt BO noted that the entrainment loss of the zooplankter *Pseudodiaptomus forbesi* during the June–September period of the juvenile-subadult phase of delta smelt could be important in terms of food limitation. The Project proposes to discharge water from the Reservoir Islands for export during July to November. The potential impact of the July–November export of Project water on entrainment of *P. forbesi* was examined using June–September IEP zooplankton monitoring data from 1989 to 2003. Average monthly densities of *P. forbesi* in several regions of the Delta and below the Sacramento–San Joaquin confluence were extrapolated to total numbers using volume estimates for each region provided by Miller (2005). The percentage loss of *P. forbesi* in each month and region then was calculated based on the E/I ratio and sigmoidal entrainment loss relationships described above. The overall effect on the zooplankton production (i.e., abundance) was assessed by combining the results from all regions.

The zooplankton loss calculation was performed for simulated baseline conditions, and the results were compared with the results obtained from the simulated Project operations. As with the fish egg/larval analysis, it was assumed that changes in E/I ratio attributable to the Project operations would affect the percentage loss of zooplankton in a manner similar to SWP/CVP exports. The analysis assumed:

- discharges for export occur in July–November (although only the July–September period is important for *P. forbesi*);

- *Pseudodiaptomus forbesi* is the principal prey item of juvenile delta smelt and is most susceptible to entrainment from June to September;
- absolute abundance of *P. forbesi* in a region can be estimated by multiplying density data (zooplankton per unit volume) by the volume of the region;
- zooplankton are passive and cannot avoid entrainment—losses are proportional to the volume of water diverted and density of zooplankton in that water;
- entrainment of zooplankton at the SWP export facility can be estimated using relationships similar to the E/I curves developed by Kimmerer and Nobriga (2008);
- zooplankton at Chipps Island, Suisan Bay, and Suisun Marsh are not susceptible to entrainment by the Project diversions or the south Delta export facilities.

Although future zooplankton abundances may be different, the changes in the zooplankton loss index with the Project indicate the direction and magnitude of potential changes in zooplankton loss relative to the simulated baseline conditions for this recent 15-year period. The entrainment index should not be construed as the actual level of entrainment that would occur but an indication of loss based on flow diversions and assumptions of loss rates.

Significance Criteria

The fishery resource impact analysis considered several criteria for determining the significance of impacts related to this resource. The analysis took into account both relevant criteria contained in Appendix G of the State CEQA Guidelines (Association of Environmental Professionals 2009) and Project-specific criteria developed by the lead agency to address potential impacts unique to the Project's location and elements.

Populations of fish and other aquatic organisms may be reduced because of increased mortality and changes in habitat availability and suitability that affect survival, growth, migration, and reproduction. In general, impacts on fish populations are significant when Project operations cause or contribute to substantial short- or long-term reductions in abundance and distribution. Based on Section 15065 and Appendix G of the State CEQA Guidelines, an effect is found to be significant if it:

- substantially reduces the number or restricts the range of an Endangered, Rare, or Threatened species;
- threatens to eliminate an animal community;
- interfere substantially with the movement of any native resident or migratory fish;
- causes a fish population to drop below self-sustaining levels;
- substantially reduces fish habitat; or

- has considerable cumulative effects when viewed with past, current, and reasonably foreseeable future projects.

In this impact assessment, impacts were considered significant if it was determined that existing conditions would be worsened by Project operations and facilities, resulting in a substantial reduction in population abundance, movement, and distribution. The definition of a *substantial* reduction varies with each species, depending on the ability of the population to maintain or exceed current production levels through mechanisms that compensate for reduced abundance of earlier life stages. Many fish populations are resilient in the face of mortality caused by human activities and can sustain high levels of exploitation. For listed species, a precautionary approach was adopted in which even small impacts were regarded as significant.

Impacts and Mitigation Measures

Organization of the Impacts and Mitigation Measures

In the reporting of the analysis of impacts and mitigation measures the main features of the Project alternatives are described. Following this, several impacts are summarized for which results and mitigation measures are essentially the same as noted in the 2001 FEIR and 2001 FEIS and preceding draft documents: Impact FISH-1 (Alteration of Habitat through Construction of Project Facilities), Impact FISH-2 (Increase in Organic Materials and Toxics and Decrease in Dissolved Oxygen of Delta Water because of Project Discharges), Impact FISH-3 (Temperature-Related Impacts on Chinook Salmon and Other Species), and Impact FISH-4 (Potential Increase in Accidental Spills of Fuel and Other Materials).

The main results of the various impact analyses are then presented (with supporting documentation and discussion in Appendix B). Rather than describing mitigation for each of the impact mechanisms separately, the various impacts on each species are integrated to ascertain the overall impacts of the Project on each fish species and describe appropriate mitigation measures. A discussion of the differences in impacts between the Proposed Project and Alternatives 1 and 2 is then included.

Proposed Project (Alternative 2)

The Proposed Project (Alternative 2 with BOs, FOC, and other environmental commitments incorporated) involves diversion of water to Bacon Island and Webb Tract (Reservoir Islands) during the months of December–March and management of Bouldin Island and Holland Tract (Habitat Islands) primarily for wetlands and wildlife habitat (with relatively small diversions in most months). Existing agricultural diversions would be changed to irrigate crops that support wildlife and provide water for ponds and wetland management. Discharges from Bacon Island and Webb Tract for export at the SWP facility are assumed to occur in the July-to-November period. More details on the assumed operations and the monthly results from the modeling for 1980–2003 are given in Chapter 3, "Project Operations."

These assumed diversion and discharge-for-export periods represent the vast majority of opportunities for Project operations and are intended to minimize effects on sensitive aquatic species. Other opportunities for diversion and discharge may occur in specific years, but are not common enough to be reliably modeled.

The current analysis incorporates most elements of the FOC and previous Project BOs with some minor changes and provides an updated assessment of potential fish and estuary habitat effects given the new information that is available regarding fish resources.

Construction-Related Impacts

Intake facilities, fish screens (for new and existing diversions), discharge facilities, and boat docks would be constructed as part of Alternative 2. Boat docks would be constructed in conjunction with each of the discharge and diversion facilities. Additionally, boat docks associated with recreation facilities would be constructed at other locations on the Project reservoir and Habitat Islands. Piles would be driven to hold the floating docks in place. Dredging is not anticipated and exterior levee improvements would be minor. Ongoing maintenance programs for the exterior levees, however, would continue (see Section 4.4, Flood Control and Levee Stability).

The intake and discharge facilities and boat docks would be situated on relatively steep, riprapped levee slopes. Dredging of levee slopes and channels is not proposed. The proposed location of the facilities is not in what is believed to be preferred spawning or rearing habitat of delta smelt and Sacramento splittail (i.e., shallow vegetated habitat).

Pilings and boat docks constructed on existing riprap add structure and increase habitat diversity. Some species (e.g., some species of sunfish) would benefit from increased habitat diversity. Predation may increase on other species (e.g., delta smelt) (see discussion under Species Impacts).

Additional discussion of Project facilities and predation is provided below.

Impact FISH-1: Alteration of Habitat through Construction of Project Facilities

Construction of intake facilities and fish screens, discharge facilities, and boat docks on the Project islands could adversely change spawning and rearing habitat used by Delta fish species, resulting in habitat loss. Temporary localized increases in turbidity would be minimized through BMPs. Construction of project facilities may increase underwater sound pressure due to pile driving and other percussive activities, causing direct mortality or avoidance. Although specific spawning habitat parameters have not been defined for delta smelt and

Sacramento splittail, shallow vegetated habitat is believed to be important for their spawning success (U.S. Fish and Wildlife Service 1995). Shallow vegetated habitat is also important to the spawning and rearing success of many other Delta fish species. Historic and ongoing federal, state, and local agency and private activities (e.g., dredging, placement of riprap, levee construction) have destroyed substantial areas of shallow vegetated habitat in the Delta, and recent downward trends in the population abundance of delta smelt and Sacramento splittail may indicate the need to preserve the remaining habitat. If Project intake sites or boat docks were located in or near shallow vegetated habitat, spawning habitat for delta smelt, Sacramento splittail, and other Delta resident species could be lost or altered. The habitat area lost would be small relative to the total area of similar habitat in the Delta, and such loss would have minimal effects on fish populations. However, loss of habitat could have a significant adverse effect on *localized* reproduction of delta smelt, Sacramento splittail, and resident species. Given the reduced abundance of delta smelt and other species, this could constitute a substantial reduction in habitat or range. Therefore, this impact is considered significant. Implementation of Mitigation Measures FISH-MM-1, REC-MM-1, FISH-MM-2, FISH-MM-3 and FISH-MM-4 would reduce Impact FISH-1 to a less-than-significant level. The replacement of lost habitat at a ratio of 3:1 (see below) would fully mitigate any habitat losses.

Mitigation Measure FISH-MM-1: Conservation of Shallow-Water Vegetated Habitat

The Project facilities will be designed to minimize impacts to shallow-water vegetated habitat. The Project will conserve such habitat affected by construction of Project facilities at a ratio of 3:1. The acreage affected will be determined based on the final construction footprint acreage and surveys of the affected area. The Project will compensate for the affected shallow-water vegetated habitat by placement of a conservation easement on tidal habitat at the Chipps Island site owned by the Project applicant prior to construction.

Mitigation Measure REC-MM-1: Reduce the Size or Number of Recreation Facilities

The Project will reduce the total number or size of recreation facilities proposed by removing from Bacon Island and Webb Tract all 22 facilities proposed for construction, and reducing the number or size of proposed facilities on Bouldin Island and Holland Tract by 70%. This would reduce considerably the alteration of habitat during construction of Project facilities.

Mitigation Measure FISH-MM-2: Site Project Facilities to Avoid Existing Shallow-Water Vegetated Habitat

Project facilities will be sited at locations that avoid existing shallow-water vegetated habitat. Surveys of vegetation in shallow-water habitat will be undertaken by qualified botanists to determine appropriate locations to minimize impacts.

Mitigation Measure FISH-MM-3: Limit Waterside Construction to Less-Sensitive Time Periods

Waterside construction of Project facilities will be restricted to the July–October period. This will minimize exposure of sensitive species such as delta smelt, longfin smelt, Chinook salmon and steelhead to the possible negative effects of construction activities.

Mitigation Measure FISH-MM-4: Implement Best Management Practices for Waterside Construction
Construction activities for the Project facilities will have BMPs implemented to minimize habitat alteration. A stormwater pollution prevention plan will be developed for use during construction, following guidelines provided by the California Stormwater Quality Association (2003). BMPs will be documented and adhered to and will be based on guidelines provided in the California Stormwater BMP Handbook for Construction (California Stormwater Quality Association 2003). The following elements will be covered by the BMPs:

- erosion control,
- sediment control,
- wind erosion control,
- tracking control,
- non-stormwater management,
- waste management and materials pollution control.

In addition, underwater sound pressure change impacts from pile driving and related activities will be reduced by employing appropriate technology to avoid sound threshold exceedance. Vibration hammers or percussive hammers with bubble curtains may be used during in-water work.

Operations-Related Impacts

This section addresses potential water quality effects on fish associated with proposed discharges of stored water from the Reservoir Islands (Webb Tract and Bacon Island) and boat-related spills at docks on the Project islands. Effects of Project operations on seawater intrusion (i.e., the location of X2) are discussed below under Effects on Delta Outflow.

Water Quality

Impact FISH-2: Increase in Organic Materials and Toxics and Decrease in Dissolved Oxygen of Delta Water because of Project Discharges

Water discharged from the Reservoir Islands is not expected to contain materials toxic to aquatic organisms. Pesticides, currently a component of Delta agricultural discharge, would be applied at reduced levels on the reservoir and Habitat Islands. Soluble toxic materials are not known to be present in the soil or water on the Reservoir Islands. The water discharged from the Reservoir Islands would not contain toxic materials. The water discharged may have elevated levels of DOC but reduced quantities of particulate organic carbon (because of settling). Based on the water quality analysis contained in Section 4.2, Water Quality, discharge of such additional material is not expected to have significant adverse biological effects in the Delta and could increase availability of food for Delta fishes. Section 4.2 contains a detailed analysis of the potential effects of the Project on Delta water quality. When filled, the reservoirs would be relatively shallow (generally less than 20 feet deep), and water would be well mixed. It is assumed that DO levels in the reservoirs would be similar to those in the Delta channels. Algal blooms on the Reservoir Islands, however, may cause periodic differences between DO levels on the Reservoir Islands and in the Delta channels. Should this occur and the water be discharged, this impact may substantially reduce the available habitat for fish and other aquatic species. However, with implementation of the Environmental Commitments, discharge will be prohibited from reducing DO levels in the receiving channel by more than 1 mg/l (see Section 4.2, Water Quality). The FOC terms also include Project operating restrictions that preclude significant effects of the Project on DO levels and avoid a substantial reduction in habitat for fish and other aquatic species. The impact is expected to be less than significant with the implementation of DO standards as an environmental commitment (see Environmental Commitments, above).

Mitigation
No mitigation is required.

Impact FISH-3: Temperature-Related Impacts on Chinook Salmon and Other Species

Factors controlling the effect of Project discharges on Delta channel water temperature include initial channel water temperature, temperature of the stored water on the Reservoir Islands at the time of discharge, volume of the discharge, volume of the receiving channel, flow and mixing in the receiving channel, and meteorological conditions. Delta channel water temperature depends primarily on meteorological conditions except during high river inflow periods. If the temperature on the Project islands is substantially greater than water temperature in the adjacent Delta channels, Project discharges could increase channel water temperature. Increased channel water temperature could affect survival, growth, reproduction, and movement of aquatic organisms.

The 1995 DEIR/EIS concluded that, as a result of meteorological conditions, water temperature on the Reservoir Islands may be greater than water temperature in the adjacent Delta channels. It also concluded that the discharge of stored Project water could increase channel water temperature and adversely affect the survival rates of juvenile Chinook salmon. If the altered channel water temperature exceeds 60°F (Kjelson et al. 1989b), Chinook salmon survival could be significantly reduced. Temperatures greater than 60°F also may adversely affect growth. Releases of Project water are assumed to occur in July–November (for export) and September–November (for outflow). The proportion of the juvenile population of all runs migrating during these periods varies but is typically very low. The proportion of the juvenile Chinook salmon population exposed to Project discharges likely would be much less because most juvenile Chinook salmon do not migrate along the OMR pathway (U.S. Fish and Wildlife Service 1987). Adult migration may be reduced at temperatures of 65–70°F (Boles 1988 as cited by National Marine Fisheries Service 2009: 77; McCullough 1999 as cited by Lindley et al. 2004: 4). Some of the releases during the July–

November period would go to export. Migrations at this time consist primarily of spring-run and fall-run Chinook salmon and steelhead (Williams 2006). The September–November discharge-for-outflow period overlaps primarily with the upstream migrations of fall-run Chinook salmon and steelhead. This impact could substantially restrict the range of salmonids migrating through the Delta, both as juveniles and adults, and could significantly reduce the abundance of juvenile Chinook salmon if the water temperature of discharged water is not monitored and controlled. The impact is less than significant with the implementation of a temperature assessment and regulation program as an environmental commitment (see Environmental Commitments, above).

Mitigation
No mitigation is required.

Impact FISH-4: Potential Increase in Accidental Spills of Fuel and Other Materials and Boat Wake Erosion

The introduction of Project boat docks is expected to increase boat-related activities in the Delta. The boat docks would concentrate effects of minor fuel and lubricant spills from individual boat engines and other boat-related discharge at the dock locations. Fueling stations are not proposed as part of the boat docks. The relatively strong tidal currents in the channels surrounding the Project habitat and Reservoir Islands would disperse spills quickly. Boat docks located adjacent to spawning and early rearing areas of Sacramento splittail, delta smelt, and resident species could have localized adverse impacts. Accidental spills of fuel and other materials related to recreational boat use would be concentrated at boat dock locations. Such spills could occur adjacent to spawning and early rearing areas of Sacramento splittail, delta smelt, and other Delta species. Though spills are random, and are not an occurrence of normal Project operations, they are reasonably foreseeable as an outcome of the Project.

Increased boat traffic because of the boat docks would increase boat wake erosion also resulting in localized effects. Given the reduced abundance of delta smelt and other species even small, localized effects could constitute a substantial reduction in habitat or range of these species. This impact would be less than significant with the funding and implementation of an accidental spill prevention program and boat wake reduction measure, as detailed as an environmental commitment (see Environmental Commitments, above).

Mitigation
No mitigation is required.

Delta Flow and Project Operations Impacts

The following sections provide an overview of potential losses of fish eggs and larvae by entrainment, potential losses of juvenile and adult fish, potential through-Delta migration mortality of salmonids originating in the Sacramento river watershed, potential changes in estuarine habitat area, potential changes in fish population abundance and survival caused by shifts in X2, potential changes in upstream movement of adult smelt from January to May, and potential entrainment loss of zooplankton from June to September. Following this overview, species-specific impacts are described evaluating all life-history stages collectively for each species.

Losses of Fish Eggs and Larvae by Entrainment

Of the simulated 1billion eggs or larvae produced annually under the 1980–2003 baseline simulation, the annual average percentage loss to the south Delta export facilities was 6.1% for longfin smelt larvae, 7.6% for delta smelt larvae, and 4.8% of striped bass eggs (Table 4.5-7). Baseline losses to Delta agricultural diversions were not estimated quantitatively because the model upon which the estimates of entrainment was based did not include most agricultural diversions. Based on the relative size of the irrigated acreages of Project islands agriculture and other Delta lowlands agriculture, the baseline lowland agricultural losses would probably be an order of magnitude greater than those of the Project. Project diversions (December–March) were estimated to give average annual losses of 0.4% of longfin smelt larvae, 0.3% of delta smelt larvae, and no striped bass eggs (because the diversion period was before the assumed spawning period of striped bass). These projected losses must be qualified as worst-case because reduction in egg and larval smelt entrainment would be expected with implementation of fish protection measures provided in the Project's FOC. Additionally, the relative effect of such small losses of the egg and larval life stages is exponentially less than similar magnitude effects would be on older life stages in terms of population-level responses.

There would be no additional impact of the Project discharge of water for south Delta export because no eggs or larvae of the three species were assumed to occur during July–November. Reduction of agricultural diversions under the Project gave net benefits (reductions in entrainment of larvae) of 0.5–1.7% of the baseline SWP/CVP entrainment loss. Overall, the Project gave a net average annual benefit (i.e., reduced loss due to reductions in Delta Wetlands agricultural diversions) of 0.1% reduced entrainment loss of striped bass eggs, with a range over all years from 0.0% to 0.2%. The average annual net impact on longfin smelt larvae was a 0.4% loss of all larvae, with a range over all years from a 1.5% loss to a 0.1% reduced loss (i.e., reduction of agricultural diversions under the Project more than offset Reservoir Island diversions in some years). For delta smelt larvae, the average annual net impact was a loss of 0.2% of all larvae, with a range over all years from 2.3% of all larvae lost to a reduction in annual loss of 0.2% (Table 4.5-7). Detailed results are presented in Appendix B.

Table. 4.5-7. Average Annual Egg and Larval Entrainment Loss Attributable to the Project in Relation to the Baseline, Based on Simulated Conditions (1,000,000,000 Eggs or Larvae Released per Year) from 1980 to 2003

	Simulated Baseline CVP/SWP Entrainment[1]		Project Diversion Entrainment Impact[2]			Project Export Entrainment Impact[3]		Baseline Delta Wetlands Agricultural Diversion	Project Habitat Diversion	Project Benefit from Reduced Agricultural Diversions[6]		Net Project Impact	
	Loss	% of All Eggs/ Larvae	Loss	% of CVP/ SWP	% of All Eggs/ Larvae	Loss	% of All Eggs/ Larvae	Loss [4]	Loss [5]	Avoided Loss	% of CVP/ SWP Loss	% of CVP/ SWP Loss	% of All Eggs/ Larvae
Longfin smelt (larvae)	60,594,236	6.1%	4,082,540	6.9%	0.4%	0	0.0%	576,761	196,854	379,907	0.5%	6.4%	0.4%
Delta smelt (larvae)	76,369,550	7.6%	2,515,689	2.9%	0.3%	0	0.0%	1,045,637	218,344	827,292	1.0%	1.9%	0.2%
Striped bass (eggs)	48,186,950	4.8%	0	0.0%	0.0%	0	0.0%	1,075,219	202,738	872,481	1.7%	-1.7%	-0.1%

1 Assumes 1,000,000,000 eggs or larvae of each species were released annually at various locations (Appendix B).
2 Assumes diversions from December to March.
3 Assumes discharge for exports by SWP from July to November.
4 Assumes similar pattern of agricultural diversions each year.
5 Assumes similar pattern of habitat diversions each year.
6 Benefit is calculated as reduction in agricultural diversion entrainment loss minus increase in habitat diversion entrainment loss.

Loss of Juvenile and Adult Fish

Under the baseline 1980–2003 conditions, the average annual entrainment loss of juvenile and adult fish at the SWP and CVP export facilities ranged from about 240 green sturgeon to more than 20 million striped bass (Table 4.5-8). The annual entrainment loss to baseline agricultural diversions in the Delta lowlands ranged from 17 green sturgeon to over 1.5 million striped bass. The average annual entrainment loss to the Project Reservoir Islands ranged from 0 delta smelt juveniles and green sturgeon to almost 5,000 threadfin shad; in general, the percentage of fish directly lost to Project diversions was a very small percentage of fish lost due to the baseline exports, ranging from 0.0% for most species to 0.2% for winter-run and late-fall-run Chinook salmon and delta smelt adults (Table 4.5-9). The number of fish entrained during export of Project water by the SWP facility ranged from 0 (winter-run and spring-run Chinook salmon and delta smelt adults) to almost 470,000 (striped bass). The Project discharges are estimated to increase entrainment loss during July–November exports by about 3–4.5% for a number of species (striped bass, white catfish, American shad, threadfin shad, and green sturgeon) and by 0.0–0.6% for all salmonids, longfin smelt, and delta smelt adults.

Existing unscreened agricultural diversions on the islands were estimated to entrain an average of over 100,000 fish per year, including over 560 juvenile delta smelt (Table 4.5-9). These levels of entrainment exceeded the entrainment attributable to Habitat Island diversions under the Project by two orders of magnitude. The net impacts of the Project were assessed by summing the loss of fish at the Project diversions (reservoir and Habitat Islands) and the loss of fish due to exports of Reservoir Island water by SWP and CVP; from this total was subtracted the reduced fish loss due to the reduction of unscreened agricultural diversions. The final result was expressed as both a percentage of the baseline loss at the south Delta export facilities and a total number of fish. This suggests that the Project would have a net impact (i.e., an annual average loss of fish) on most species, ranging from an average annual loss of 5 green sturgeon (2.6% of the baseline SWP/CVP loss) to a loss of over 390,000 striped bass (2.5% of the baseline SWP/CVP loss). The net impact of the Project was generally low for listed salmonids: the average annual loss was 28 steelhead and 89 winter-run Chinook salmon; there was actually a net benefit of the Project to spring-run Chinook salmon because the migration season largely avoids the periods of Project storage diversions and discharges to export, so that the reduction and screening of existing agricultural diversions outweighs the small loss due to diversions and discharges. The loss of juvenile and adult delta smelt comprised annual averages of 50 and almost 2,000 individuals, respectively, or 0.1% and 1.1% of the baseline SWP/CVP mortality.

The annual ranges of net entrainment impacts are detailed in Appendix B and are summarized here (Table 4.5-9). The minimum net entrainment impact on all species was actually a reduced loss compared to the loss that occurred due to existing unscreened Delta Wetlands agricultural diversions. This ranged from one less entrained green sturgeon (-0.4% of baseline SWP/CVP entrainment losses) to almost 75,000 less entrained striped bass (-0.5% of baseline SWP/CVP losses). The maximum annual entrainment loss ranged from 19 green sturgeon (15.7% of baseline SWP/CVP loss) to over 1.8 million striped bass (around 19% of baseline SWP/CVP loss). The maximum loss for several listed salmonids was estimated to be 0.5% or less of the baseline SWP/CVP loss (i.e., winter-run and spring-run Chinook salmon, and steelhead). Maximum losses for delta smelt were 0.3% of baseline SWP/CVP losses for adults and 0.7% for juveniles; maximum losses of longfin smelt were also 0.7% of baseline SWP/CVP losses. Cumulative percentage plots presented in Figures 4.5-2 to 4.5-11 provide further information on the proportion of years with given levels of fish benefit or loss for various listed and special-status fish species.

The analysis to illustrate the effects of changing the small-intake correction factor demonstrated that the largest impact of the Project was when the density of fish approaching the Delta Wetlands diversions was not corrected (i.e., 100% correction) and the density of fish drawn to the agricultural/habitat diversions was 10% of that drawn to exports. However, for species that were more susceptible to entrainment during discharge to export (July–November), which included most species except for the salmonids and adult delta smelt, there was generally little difference between this scenario and the one adopted in the analysis (i.e., Delta Wetlands diversion small-intake correction of 50% and agricultural/habitat small-intake correction of 10%). This was because changes in the draw of fish to the Delta Wetlands diversions did little to change the loss of these species as they were much less abundant during the December–March diversion period. The least impact occurred when the agricultural diversions were assumed to have the same correction factor (100%) as the Reservoir Island diversions because the benefit of reducing and screening the Delta Wetlands agricultural intakes was maximized relative to DW diversions for storage and discharges for export (Table 4.5-10).

Note that the entrainment attributable to export of discharged water from the Project islands is likely to be a worst-case estimate because the Project is making available a quantity of fish-free water that has been stored until July–November. In theory, this fish-free water should not greatly increase the entrainment of fish, except possibly for those fish between the Project islands and the export facilities in the south Delta. The analysis did not attempt to adjust for this potential effect and conservatively assumed that entrainment would occur at rates similar to those observed historically.

Table 4.5-8. Average Annual Entrainment Loss of Juvenile and Adult Fish Attributable to the Project Compared to the Baseline, Based on Simulated Conditions from 1980 to 2003

			Project Diversion Impact[3]		Project Export Impact[4]		Baseline DW Agricultural Diversion	Project Habitat Diversion	Project Benefit from Reduced and Screened Agricultural Diversions[7]		Net Project Impact	
	Baseline CVP/SWP Loss[1]	Baseline Delta Lowland Agriculture Loss[2]	Loss	% of Baseline SWP/CVP	Loss	% of Baseline SWP/CVP	Loss[5]	Loss[6]	Avoided Loss	% of SWP/CVP	Loss	% of SWP/CVP
Chinook salmon (fall-run)	291,019	10,571	74	0.0%	311	0.1%	529	6	523	0.2%	-138	0.0%
Chinook salmon (late fall–run)	20,190	202	52	0.2%	79	0.4%	10	0	10	0.1%	121	0.6%
Chinook salmon (winter-run)	60,420	633	120	0.2%	0	0.0%	32	1	31	0.1%	89	0.1%
Chinook salmon (spring-run)	130,901	852	26	0.0%	0	0.0%	43	0	42	0.0%	-16	0.0%
Steelhead	23,178	202	32	0.1%	6	0.0%	10	0	10	0.0%	28	0.1%
Striped bass	20,639,124	1,556,731	2,354	0.0%	466,038	2.9%	77,837	879	76,958	0.4%	391,435	2.5%
White catfish	1,570,376	77,919	585	0.0%	54,509	4.0%	3,896	50	3,846	0.3%	51,247	3.7%
American shad	3,768,712	151,216	2,763	0.1%	129,383	3.8%	7,561	115	7,446	0.2%	124,699	3.7%
Threadfin shad	9,728,832	448,606	4,798	0.0%	402,914	4.6%	22,430	313	22,117	0.2%	385,595	4.4%
Sacramento splittail	1,698,805	131,056	114	0.0%	19,826	1.5%	6,553	72	6,481	0.4%	13,460	1.1%
Longfin smelt	134,017	2,279	10	0.0%	195	0.2%	114	1	113	0.1%	92	0.1%
Delta smelt (adults)[a]	33,571	256	62	0.2%	0	0.0%	13	0	13	0.0%	50	0.1%
Delta smelt (juveniles)[b]	261,643	11,279	0	0.0%	2,528	1.3%	564	2	562	0.3%	1,966	1.1%
Green sturgeon	242	17	0	0.1%	6	2.9%	1	0	1	0.4%	5	2.6%

			Project Diversion Impact[3]		Project Export Impact[4]		Baseline DW Agricultural Diversion	Project Habitat Diversion	Project Benefit from Reduced and Screened Agricultural Diversions[7]		Net Project Impact	
	Baseline CVP/SWP Loss[1]	Baseline Delta Lowland Agriculture Loss[2]	Loss	% of Baseline SWP/CVP	Loss	% of Baseline SWP/CVP	Loss[5]	Loss[6]	Avoided Loss	% of SWP/CVP	Loss	% of SWP/CVP

[1] Based on average of monthly fish densities at salvage (fish/taf) extrapolated to account for pre- and postsalvage losses and multiplied by export flows.

[2] Assumes baseline loss is 20 times that of the Delta Wetlands Agricultural diversion loss (based on Delta Wetlands being 5% of irrigated Delta acreage).

[3] Assumes diversions from December to March, 50% small-intake correction, and 95% screening efficiency.

[4] Increased loss of fish assuming SWP and CVP export of all discharged Project water from July to November.

[5] Assumes similar pattern of agricultural diversions each year, and10% small-intake correction.

[6] Assumes 95% screening efficiency, 10% small-intake correction, and similar pattern of habitat diversions each year.

[7] Calculated as entrainment loss to existing Delta Wetlands agricultural diversions minus entrainment loss to Project wetland habitat diversions.

[a] All delta smelt entrained from December to March and 25% entrained in April were assumed to be adults.

[b] All delta smelt entrained from May to November and 75% entrained in April were assumed to be juveniles.

Table 4.5-9. Comparison of Minimum, Average, and Maximum Net Entrainment Losses Attributable to the Project

	Minimum		Average		Maximum	
	Loss	% of SWP/CVP	Loss	% of SWP/CVP	Loss	% of SWP/CVP
Chinook salmon (fall-run)	-502	-0.3%	-138	0.0%	1,039	0.3%
Chinook salmon (late fall–run)	-10	-0.1%	121	0.6%	894	4.5%
Chinook salmon (winter-run)	-31	-0.1%	89	0.1%	392	0.5%
Chinook salmon (spring-run)	-42	-0.1%	-16	0.0%	204	0.3%
Steelhead	-8	-0.1%	28	0.1%	110	0.5%
Striped bass	-74,672	-0.5%	391,435	2.5%	1,837,003	18.9%
White catfish	-3,316	-0.2%	51,247	3.7%	158,799	16.8%
American shad	-4,090	-0.1%	124,699	3.7%	377,103	17.0%
Threadfin shad	-15,988	-0.2%	385,595	4.4%	1,184,302	18.9%
Sacramento splittail	-6,456	-0.6%	13,460	1.1%	78,532	9.6%
Longfin smelt	-105	-0.2%	92	0.1%	440	0.7%
Delta smelt (adults)a	-13	-0.1%	50	0.1%	92	0.3%
Delta smelt (juveniles)b	-562	-0.3%	1,966	1.1%	8,458	8.3%
Green sturgeon	-1	-0.4%	5	2.6%	19	15.7%

Table 4.5-10. Comparison of Net Average Annual Entrainment Losses Attributable to the Project with Different Values of the Small-Intake Correction (100% Assumes No Correction)

	Reservoir Diversion Correction: 50%; Agricultural/Habitat Diversion Correction: 10%		Reservoir Diversion Correction: 100%; Agricultural/Habitat Diversion Correction: 50%		Reservoir Diversion Correction: 100%; Agricultural/Habitat Diversion Correction: 10%		Reservoir Diversion Correction: 50%; Agricultural/Habitat Diversion Correction: 50%		Reservoir Diversion Correction: 100%; Agricultural/Habitat Diversion Correction: 100%	
	Loss	% of SWP/CVP	Loss	% of SWP/CVP	Loss	% of SWP/CVP	Loss	% of SWP/CVP	Loss	% of SWP/CVP
Chinook salmon (fall-run)	-138	0.0%	-2,155	-0.9%	-63	0.0%	-2,229	-0.9%	-4,770	-1.9%
Chinook salmon (late fall–run)	121	0.6%	134	0.6%	173	0.8%	82	0.3%	86	0.3%
Chinook salmon (winter-run)	89	0.1%	85	0.1%	209	0.4%	-35	-0.1%	-70	-0.2%
Chinook salmon (spring-run)	-16	0.0%	-160	-0.1%	9	0.0%	-185	-0.2%	-371	-0.3%
Steelhead	28	0.1%	20	0.1%	60	0.3%	-12	-0.1%	-29	-0.2%
Striped bass	391,435	2.5%	85,958	0.9%	393,789	2.5%	83,604	0.9%	-298,831	-1.2%
White catfish	51,247	3.7%	36,447	2.7%	51,832	3.8%	35,863	2.7%	17,216	1.4%
American shad	124,699	3.7%	97,678	2.9%	127,462	3.8%	94,915	2.9%	60,448	1.9%
Threadfin shad	385,595	4.4%	301,926	3.5%	390,394	4.5%	297,128	3.5%	191,342	2.3%
Sacramento splittail	13,460	1.1%	-12,349	-0.6%	13,574	1.1%	-12,463	-0.6%	-44,752	-2.8%
Longfin smelt	92	0.1%	-350	-0.3%	101	0.1%	-360	-0.3%	-915	-0.9%
Delta smelt (adults)	50	0.1%	61	0.2%	112	0.3%	-1	0.0%	-2	0.0%
Delta smelt (juveniles)	1,966	1.1%	-282	0.1%	1,966	1.1%	-282	0.1%	-3,093	-1.2%
Green sturgeon	5	2.6%	2	1.2%	6	2.7%	2	1.2%	-2	-0.6%

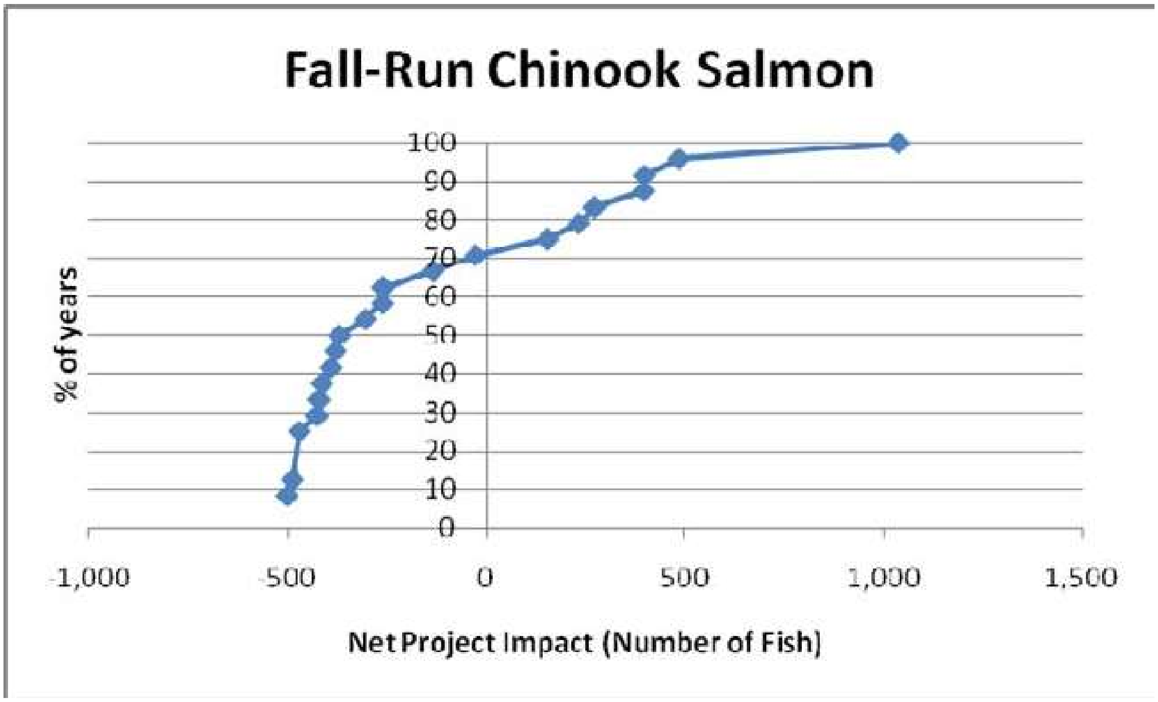

Figure 4.5-2. Fall-Run Chinook Salmon Net Project Impact (Number of Juvenile and Adult Fish Lost) Attributable to Entrainment, Expressed As Cumulative Percentage of Years

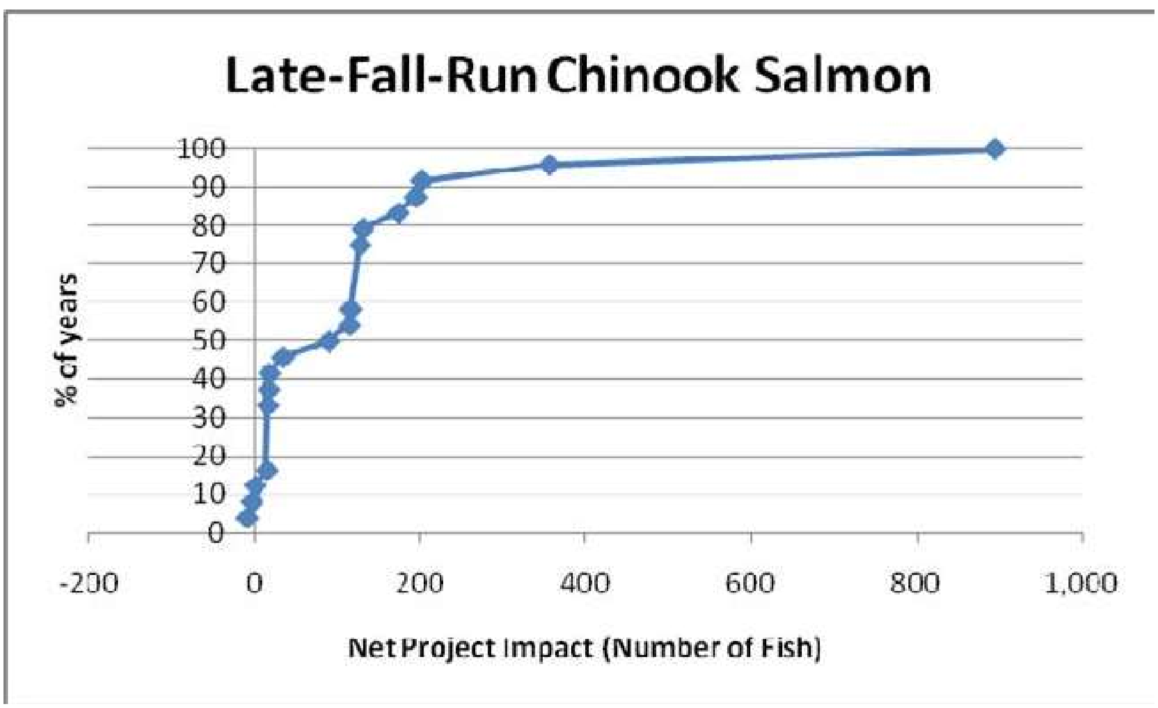

Figure 4.5-3. Late-Fall-Run Chinook Salmon Net Project Impact (Number of Juvenile and Adult Fish Lost) Attributable to Entrainment, Expressed As Cumulative Percentage of Years

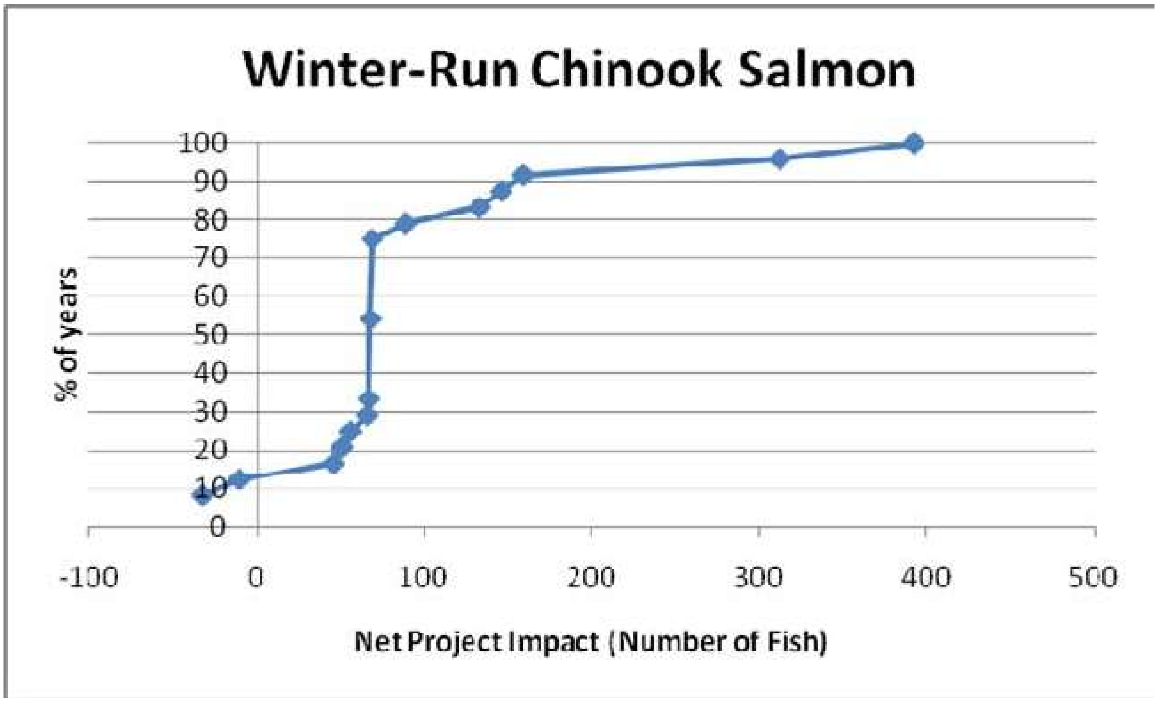

Figure 4.5-4. Winter-Run Chinook Salmon Net Project Impact (Number of Juvenile and Adult Fish Lost) Attributable to Entrainment, Expressed as Cumulative Percentage of Years

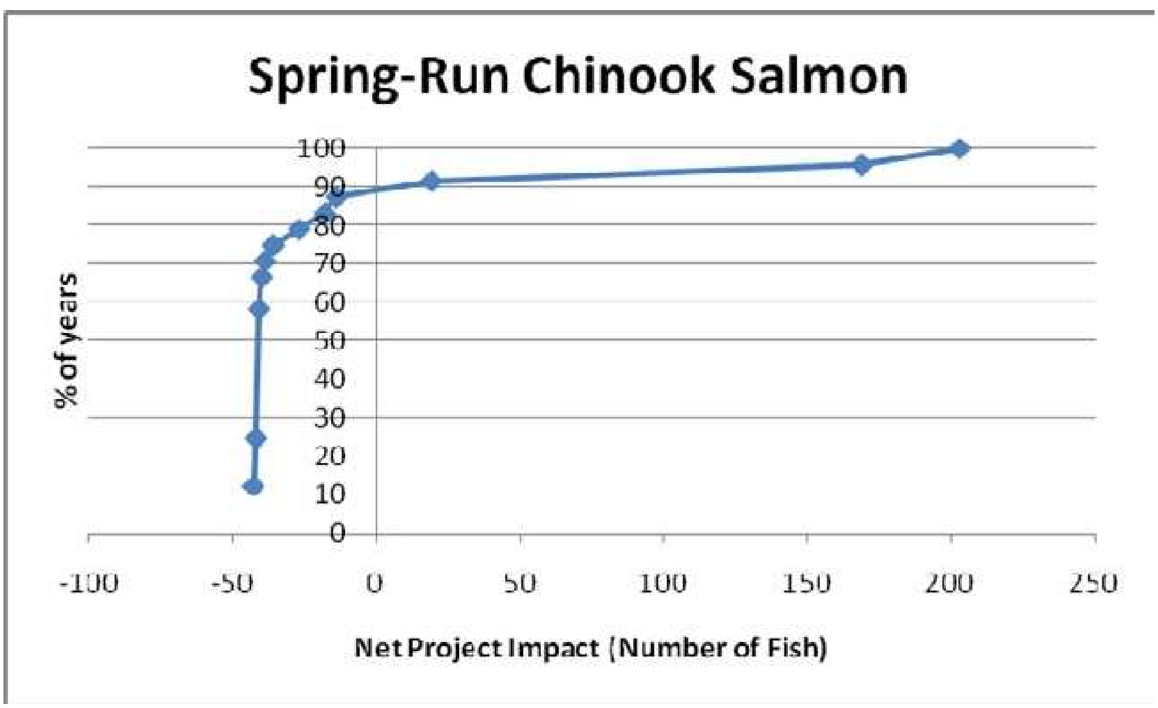

Figure 4.5-5. Spring-Run Chinook Salmon Net Project Impact (Number of Juvenile and Adult Fish Lost) Attributable to Entrainment, Expressed as Cumulative Percentage of Years

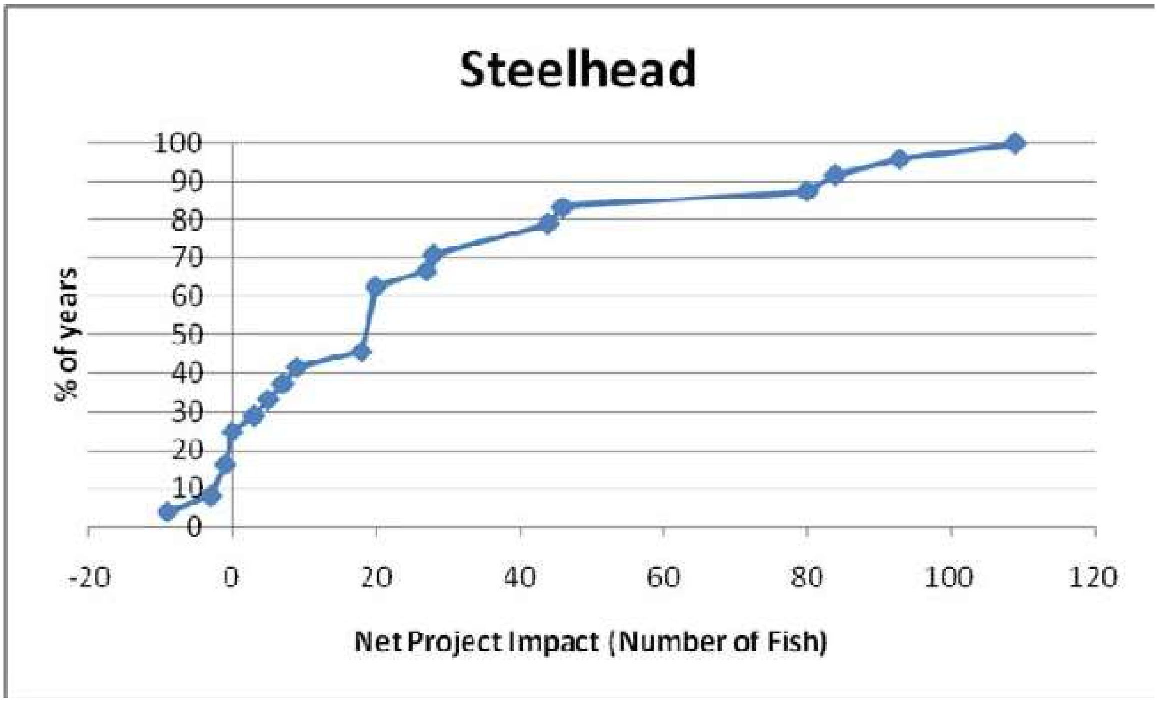

Figure 4.5-6. Steelhead Net Project Impact (Number of Juvenile and Adult Fish Lost) Attributable to Entrainment, Expressed as Cumulative Percentage of Years

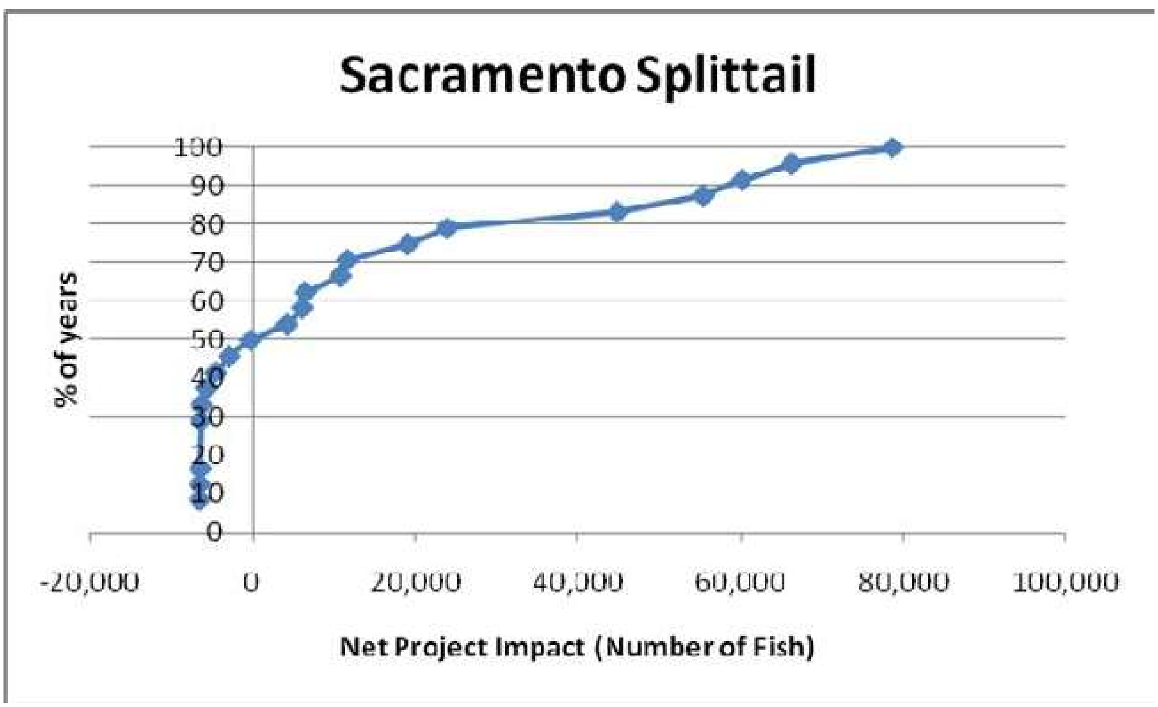

Figure 4.5-7. Sacramento Splittail Net Project Impact (Number of Juvenile and Adult Fish Lost) Attributable to Entrainment, Expressed as Cumulative Percentage of Years

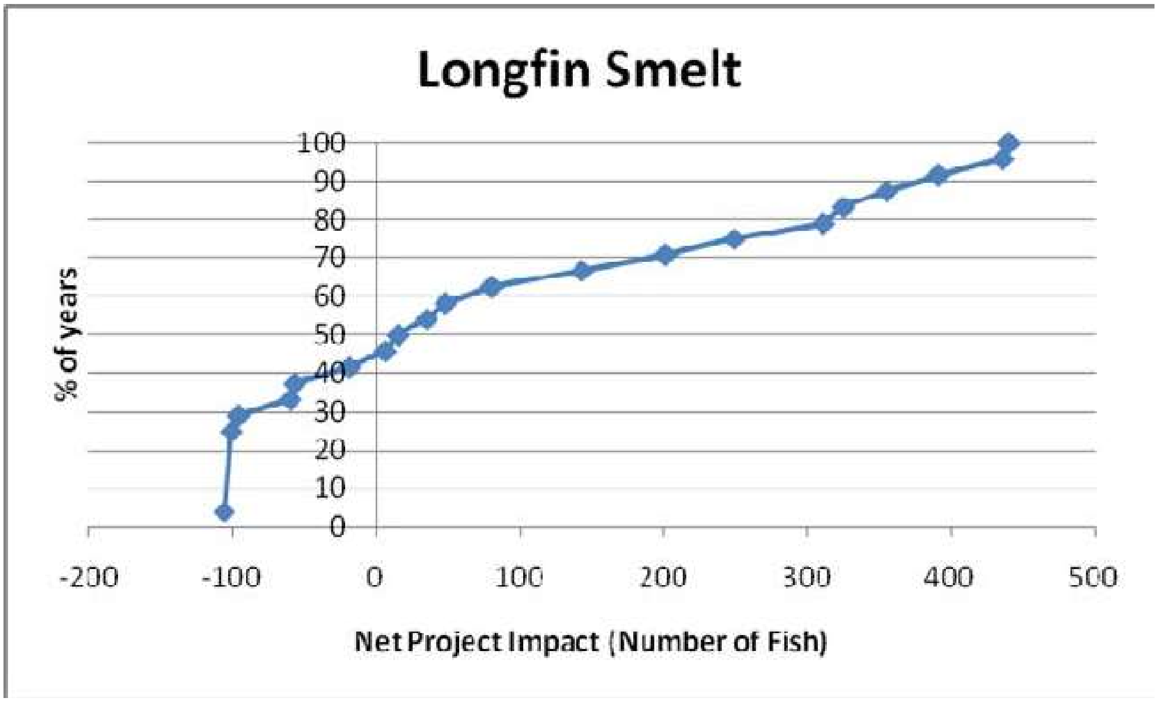

Figure 4.5-8. Longfin Smelt Net Project Impact (Number of Juvenile and Adult Fish Lost) Attributable to Entrainment, Expressed as Cumulative Percentage of Years

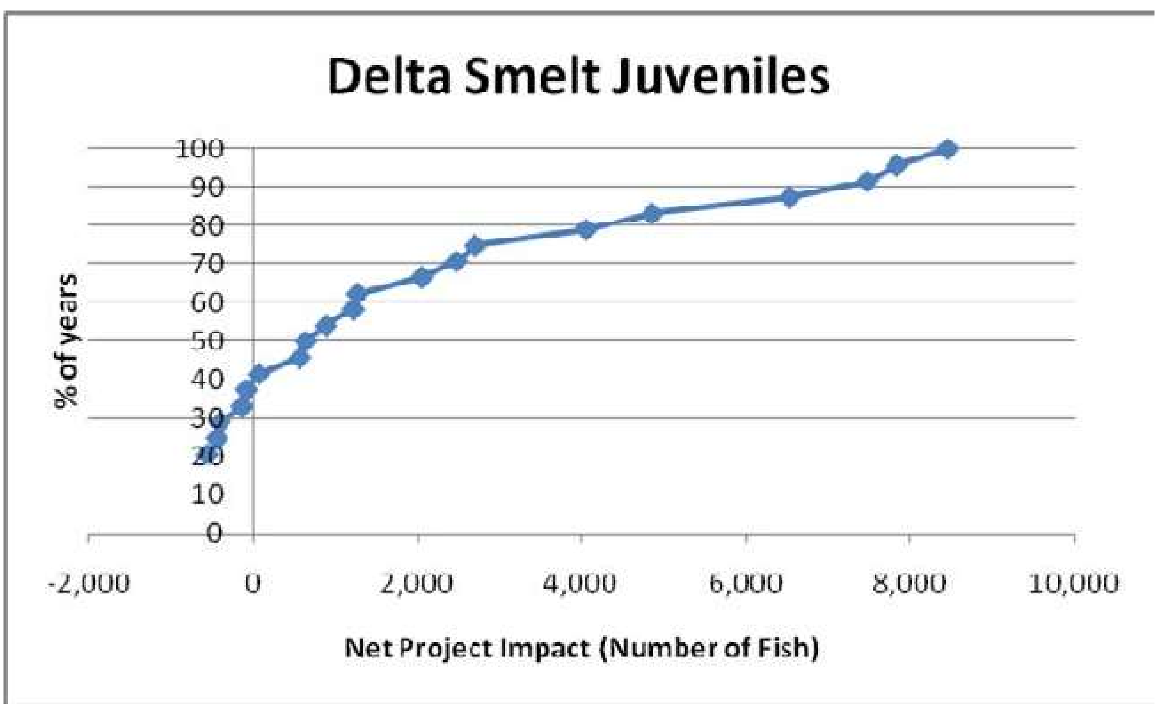

Figure 4.5-9. Delta Smelt Juvenile Net Project Impact (Number of Juvenile Fish Lost) Attributable to Entrainment, Expressed as Cumulative Percentage of Years

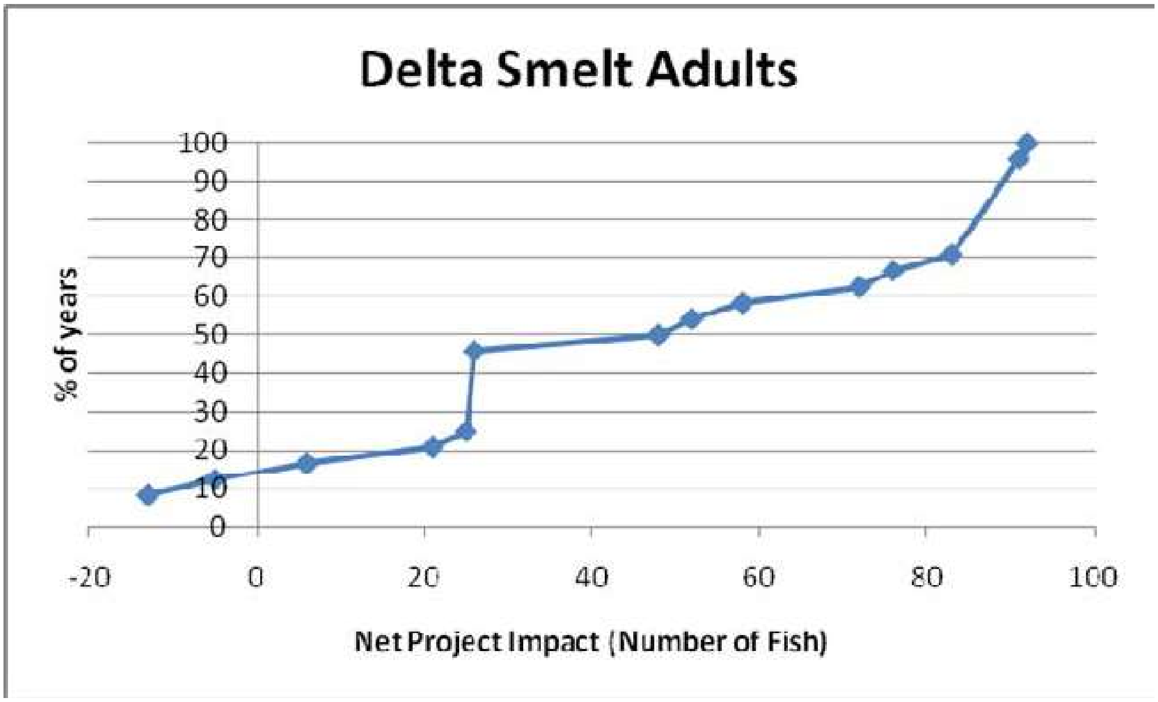

Figure 4.5-10. Delta Smelt Adult Net Project Impact (Number of Adult Fish Lost) Attributable to Entrainment, Expressed as Cumulative Percentage of Years

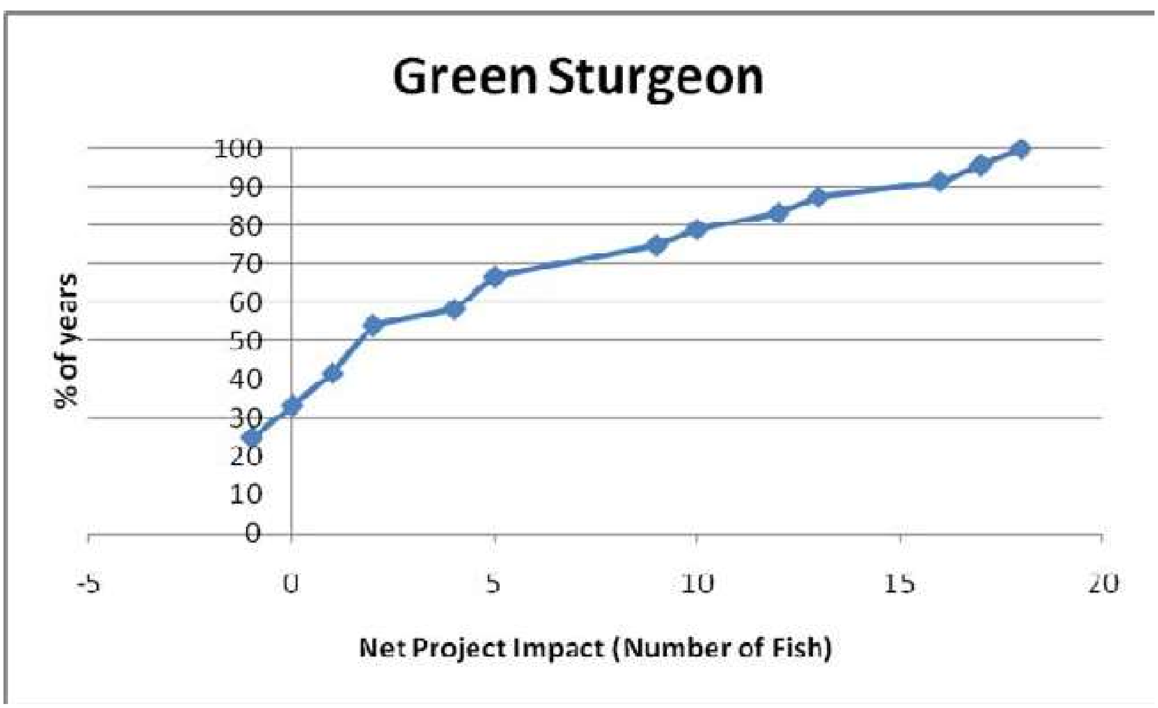

Figure 4.5-11. Green Sturgeon Net Project Impact (Number of Juvenile and Adult Fish Lost) Attributable to Entrainment, Expressed as Cumulative Percentage of Years

Effects of Old and Middle River Flows on Delta Smelt Loss
Baseline December–March losses of delta smelt adults to entrainment at the SWP/CVP export facilities from 1980 to 2003 averaged 10.7% of the population (range: 0–14.8%) (Figure 4.5-12). Additional losses due to Project diversions decreasing OMR flows averaged 0.70% of the population (range: 0–0.93%) (Figure 4.5-12).

Baseline March–June losses of delta smelt larvae/juveniles to entrainment at the SWP/CVP export facilities from 1980 to 2003 averaged 17.4% of the population (range: 0–27.0%) (Figure 4.5-13). Additional losses due to Project diversions decreasing OMR flows averaged 0.24% of the population (range: 0–1.99%) (Figure 4.5-13).

As detailed in Appendix B, this analysis assumed that Project diversions would increase X2, decrease OMR flows, and hence draw more fish into an area of susceptibility to entrainment, leading to increased losses of delta smelt at the SWP/CVP export facilities; it was assumed that the additional entrainment would be the same as if the export facilities had increased exports by the same flows as were diverted to the Project islands. Note that the previous analysis described in "Loss of Juvenile and Adult Fish" focused both on entrainment losses during diversions through the Project's screened intakes and also on entrainment losses at the SWP/export facilities during export of water discharged from the Project's reservoir islands.

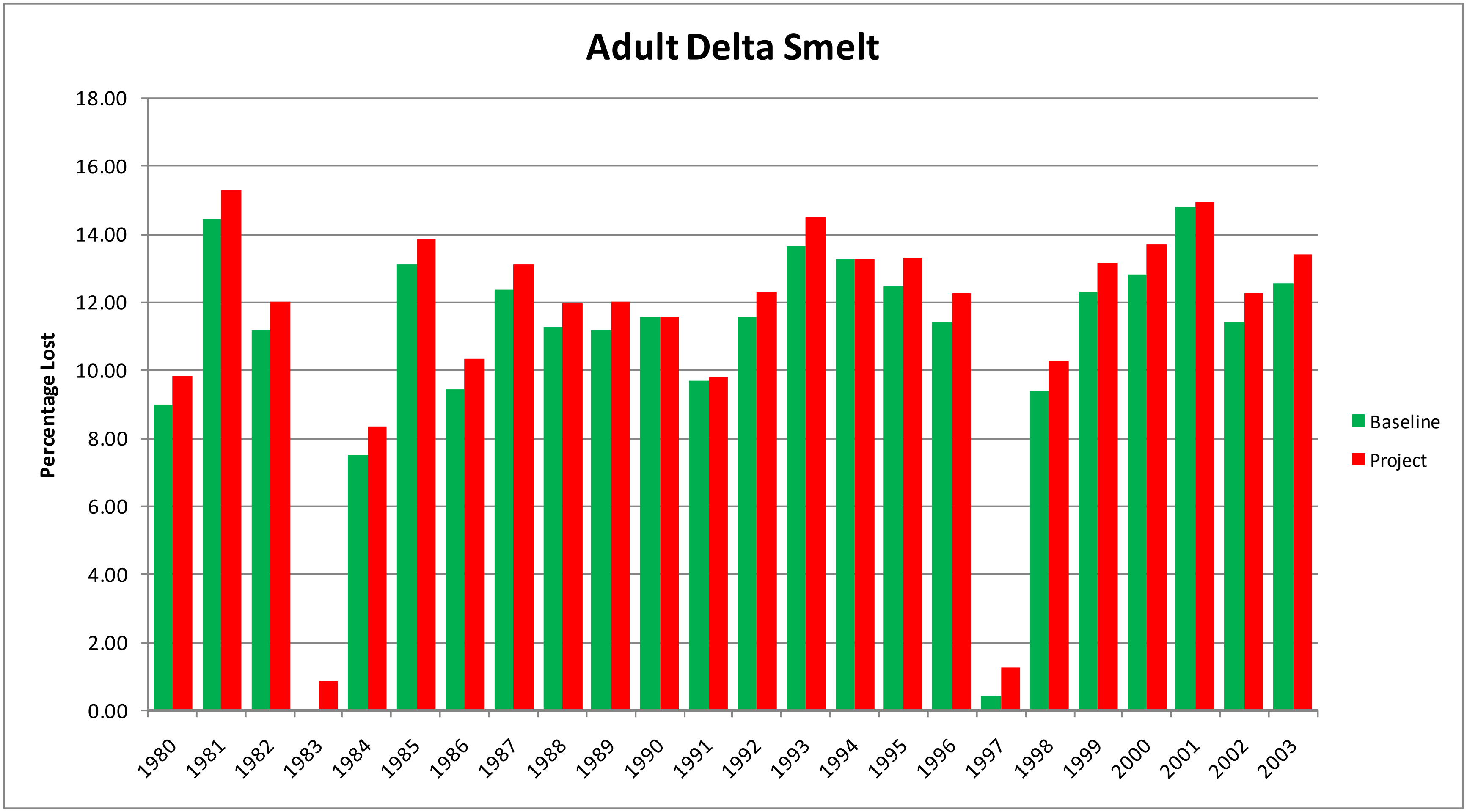

Figure 4.5-12. Percentage of Adult Delta Smelt Lost to Entrainment at the SWP/CVP Export Facilities, Based on a Predictive Equation Described by USFWS (2008a: 212)

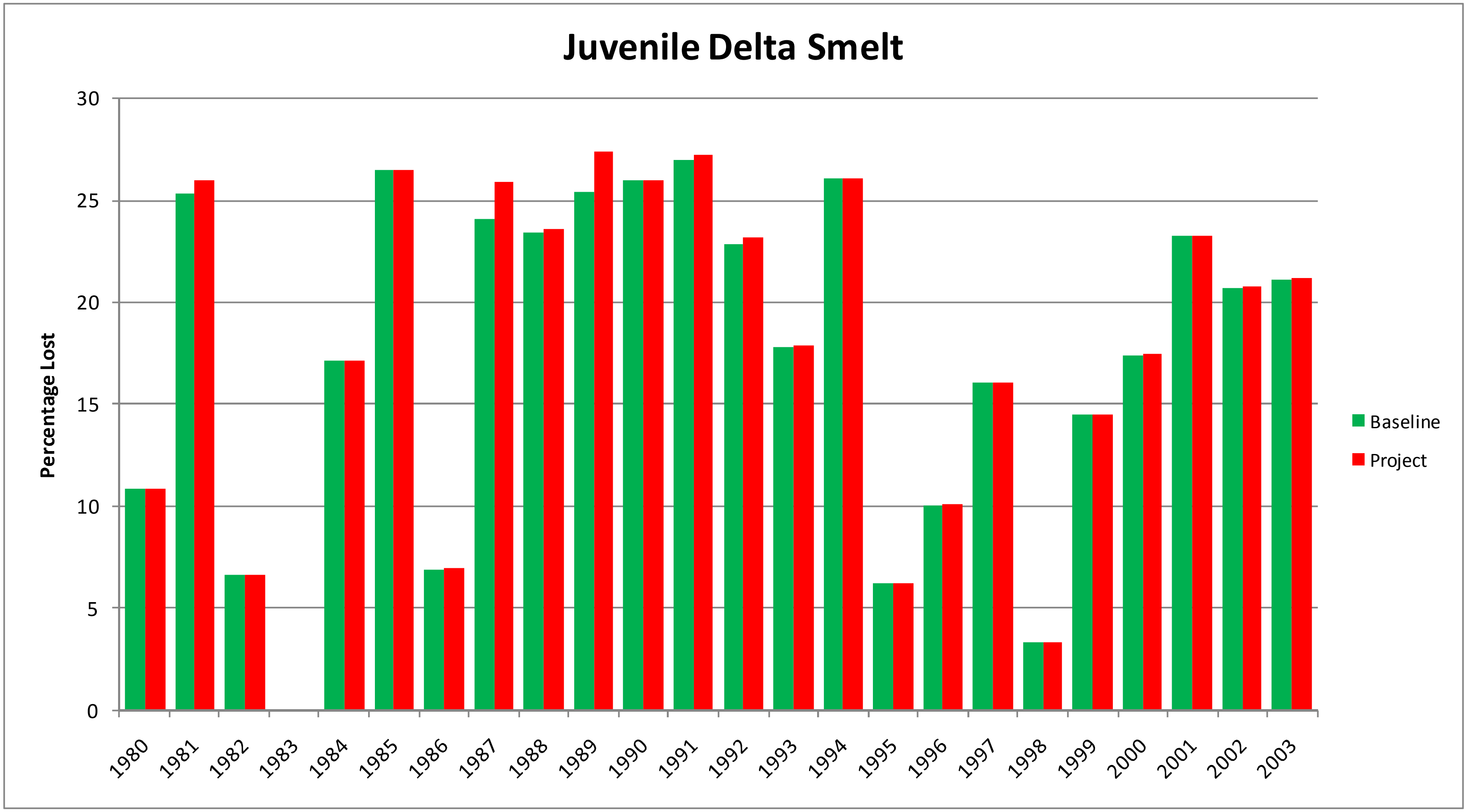

Figure 4.5-13. Percentage of Larval-Juvenile Delta Smelt Lost to Entrainment at the SWP/CVP Export Facilities, Based on a Predictive Equation Described by USFWS (2008a: 220)

Through-Delta Migration Mortality of Juvenile Sacramento River and Mokelumne River Salmonids

An average of 19.3% of Sacramento River fall-run Chinook salmon juveniles entered the central Delta and baseline mortality due to exports, predation, or water quality amounted to nearly 14% of the total juveniles entering the Delta from Sacramento River (Table 4.5-11). The additional loss attributable to the Project was very low, at around 0.01% of the total fish. This was due to the main fall-run outmigration period coinciding with no Project diversions (i.e., April and May). Over 35% of late-fall-run Chinook salmon were estimated to enter the central Delta, resulting in relatively high baseline mortality (~28.5%) and mortality attributable to the Project of 0.23 %. Winter-run Chinook salmon had a somewhat lower average mortality attributable to Project operations than late-fall-run (0.12%), whereas spring-run had very low mortality attributable to the Project (0.01%). This latter result was again because the main spring-run outmigration occurred after Project diversions had ceased.

Sacramento River-origin steelhead were intermediate in mortality estimates compared to the various runs of Chinook: an average of 18% entered the central Delta and almost 14% were lost to baseline mortality, with an additional 0.07% being lost to the effects of the Project (Table 4.5-11).

The minimum annual mortality was 0.00% for all juvenile salmonids and maximum annual mortality ranged from 0.05% in fall-run Chinook salmon to 0.99% in late-fall-run Chinook salmon (Table 4.5-12).

The results of the analysis to address the uncertainty in the correction factor used in the migration mortality assessment suggested that reducing the effects of the Project to 25% of the SWP/CVP impact (per unit volume diverted) would halve the impact compared to the 50% correction factor value. Assuming a similar effect of Project diversions on exports (i.e., a value of 100%, or no correction for Project impacts), the losses attributable to the Project generally doubled (Table 4.5-13).

The results for the Mokelumne River-origin fall-run Chinook salmon and steelhead indicated several times higher percentage losses due to the Project than for Sacramento River–origin fish. This was due to all individuals within the populations having to pass through the central Delta. The average percentage loss for fall-run Chinook salmon was 0.09% (range: 0.02% to 0.38%) and for steelhead the average loss was 0.41% (range: 0.00% to 1.32%).

Table 4.5-11. Average Annual Mortality Losses of Juvenile Sacramento River Salmonids Migrating through the Delta under Simulated Baseline and Project Conditions

	Whole-Population Estimates			Baseline % Loss (CVP/SWP + Predation/Water Quality Losses in Central Delta)	Project % Loss
	Total Loss	Sacramento River Loss (assumed)	% Entering Central Delta		
Chinook salmon (fall-run)	23.9%	10.0%	19.3%	13.9%	0.02%
Chinook salmon (late fall–run)	38.7%	10.0%	35.2%	28.5%	0.23%
Chinook salmon (winter-run)	25.3%	10.0%	19.0%	15.2%	0.12%
Chinook salmon (spring-run)	22.9%	10.0%	18.2%	12.9%	0.01%
Steelhead	23.9%	10.0%	18.0%	13.8%	0.07%

Table 4.5-12. Comparison of Average, Minimum, and Maximum Sacramento River Salmonid Migration Mortality Losses Attributable to the Project

	% Loss		
	Minimum	Average	Maximum
Chinook salmon (fall-run)	0.00%	0.02%	0.08%
Chinook salmon (late fall–run)	0.00%	0.23%	0.99%
Chinook salmon (winter-run)	0.00%	0.12%	0.39%
Chinook salmon (spring-run)	0.00%	0.01%	0.07%
Steelhead	0.00%	0.07%	0.23%

Table 4.5-13. Comparison of Average Annual Salmonid Migration Mortality Losses Attributable to the Project with Variations in the Project Diversions Correction Factor (100% Assumes the Same Impact of Project Diversions as Exports)

	% Loss By Correction Factor		
	25%	50%	100%
Chinook salmon (fall-run)	0.01%	0.02%	0.03%
Chinook salmon (late fall–run)	0.14%	0.23%	0.42%
Chinook salmon (winter-run)	0.06%	0.12%	0.25%
Chinook salmon (spring-run)	0.00%	0.01%	0.02%
Steelhead	0.04%	0.07%	0.15%

Changes in Estuarine Habitat Area

The effects of Project diversions and SWP/CVP export of discharged Project Reservoir Island water were examined for longfin smelt, delta smelt, and striped bass. For the 1980–2003 period under the baseline, the average annual area of optimal salinity habitat ranged from 51.0 km^2 (delta smelt) to 159.9 km^2 (longfin smelt) (Table 4.5-14). Average annual impacts to optimal salinity habitat area attributable to the Project ranged from a gain (i.e., a benefit as opposed to an impact) of 0.04 km^2 (delta smelt) to a loss of 0.26 km^2 (longfin smelt). These reductions represented proportional decreases of -0.09–0.17 % compared to the baseline.

Over the baseline period, the minimum Project effects were beneficial increases in estuarine habitat area for longfin smelt (2.34 km^2 or 1.24 % of baseline) and delta smelt (0.90 km^2 or 1.90% of baseline). The minimum effect on striped bass was no change from baseline. The maximum impacts of the Project were decreases in optimal salinity habitat of 1.65 km^2 for striped bass (2.44% of baseline), 5.74% km^2 for longfin smelt (3.10% of baseline), and 0.79 km^2 for delta smelt (1.61% of baseline). For the two listed smelt species, the estimated Project effects were zero or beneficial in approximately 70% of years for longfin smelt (Figure 4.5-14) and in approximately 80% of years for delta smelt (Figure 4.5-15).

Table 4.5-14. Average Annual Reduction in Optimal Salinity Habitat Area Attributable to the Project in Relation to the Baseline, Based on Simulated Conditions from 1980 to 2003

		Area of Optimal Salinity Habitat			
	Optimal Salinity Range [1]	Baseline (km^2)	Project Alternative (km^2)	Project Impact (Reduced Area, km^2)	Project Impact (%)
Longfin smelt (larvae and early juveniles)[a]	1.1–18.5 ppt	159.89	159.63	0.26	0.17%
Delta smelt (larvae and early juveniles)[b]	0.3–1.8 ppt	50.99	51.03	-0.04	-0.09%
Striped bass (larvae)[c]	0.1–2.5 ppt	75.55	75.45	0.11	0.16%

[1]Based on the 10^{th} and 90^{th} percentiles of the salinity distribution.
[a] Estimated by Jones and Stokes Associates from 16 years of DFG's Egg and Larval Survey data (Unger 1994).
[b] Estimated by Jones and Stokes Associates from 2 years of DFG's Egg and Larval Survey data (Unger 1994).
[c] Estimated by DFG from IEP Delta Outflow/San Francisco Bay Study Program data (Unger 1994).

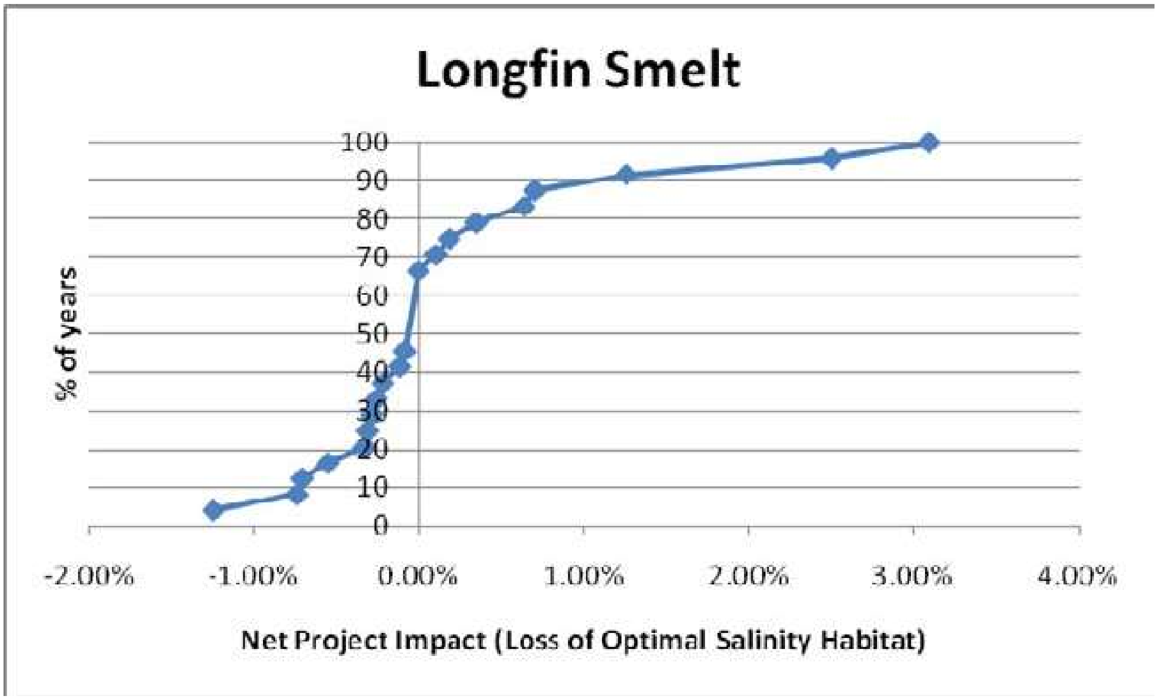

Figure 4.5-14. Longfin Smelt Net Project Impact (Percentage of Baseline) Attributable to Decrease in Optimal Salinity Habitat Area, Expressed as Cumulative Percentage of Years

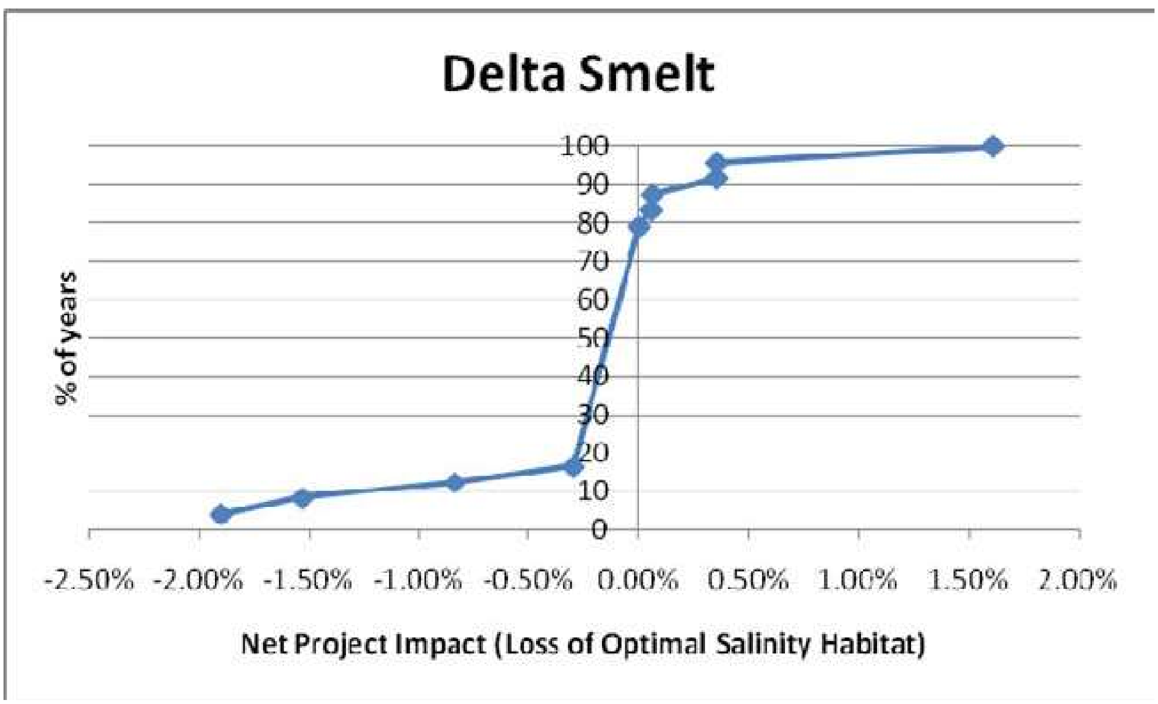

Figure 4.5-15. Delta Smelt Net Project Impact (Percentage of Baseline) Attributable to Decrease in Optimal Salinity Habitat Area, Expressed as Cumulative Percentage of Years

Changes in Fish Population Abundance and Survival Caused by Shifts in X2
The estimated FMWT index of longfin smelt under Project conditions was on average just over 1% (1.02%) lower than the baseline for the 1967–2003 period (Figure 4.5-16). The maximum reduction was 3.7% in 1981, a year in which the FMWT was moderately low. Four years had higher FMWT indices under Project operations (including a 1.1% increase in 1994) than the baseline.

The average 1967–2003 FMWT index of American shad was 0.25% lower under the Project than the baseline (Figure 4.5-17). The maximum reduction (1.2%) under the Project occurred in 1992, and four years exhibited increases in FMWT index under the Project (0.01–0.13%).

The survival index of striped bass under the Project was on average 0.12% lower than the baseline for the 1978–2003 period (Figure 4.5-18). The maximum reduction under the Project was in 1987 (0.96%). A very small increase in survival under the Project occurred in 1994 (0.04%).

For delta smelt, the predicted STN Index was estimated to increase by an average of almost 1.2% under the Project compared to the baseline conditions, when using the actual FMWT index values (Figure 4.5-19). This was due to the assumption of beneficial releases of water during the fall (September-November) of some years. The maximum increase was predicted to be 6.0% above baseline and the greatest decrease was 0.7% below baseline. Adopting annually constant FMWT index values of 23, 280, and 1,000 gave average predicted STN indices 6.1%, 2.0%, and 0.8% higher than baseline.

Changes in Upstream Movement of Adult Smelt from January to May
The percentage of delta smelt upstream of the confluence of the Sacramento and San Joaquin Rivers during the January–May Kodiak Trawl surveys was not related to the location of X2 (Figure 4.5-20). Sommer et al. (1997) found that, although delta smelt were salvaged more frequently in dry years (Sacramento Valley runoff index below 7.8), the difference in salvage was not statistically significant between wet and dry years (Mann-Whitney test, $P < 0.10$). USFWS (2008a: 212) noted that “there is wide, apparently random variation in the use of the Central and south Delta by spawning delta smelt.” The results of the analysis of potential effects of Project diversions on distribution of adult delta smelt support this statement.

No longfin smelt were observed upstream of the confluence during the spring Kodiak trawl survey for the subset of trawl stations used in the analysis. Therefore, a comparison of the potential flow-related effects of the Project to the baseline was not undertaken for this species.

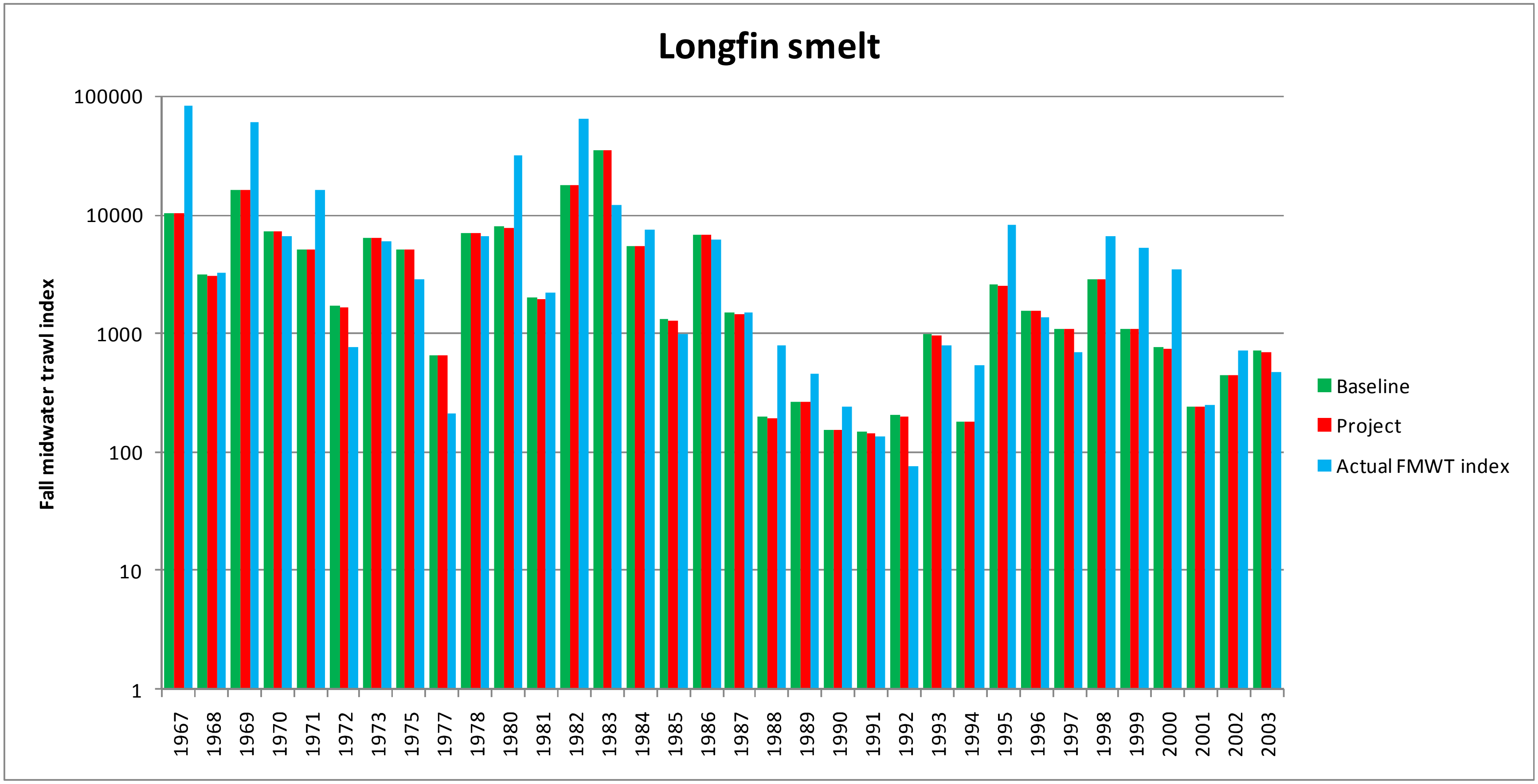

Figure 4.5-16. Fall Midwater Trawl (FMWT) Indices of Longfin Smelt under Baseline and the Project, as Estimated from a Regression of FMWT against X2 (Kimmerer et al. 2009)
Note logarithmic y axis scale.

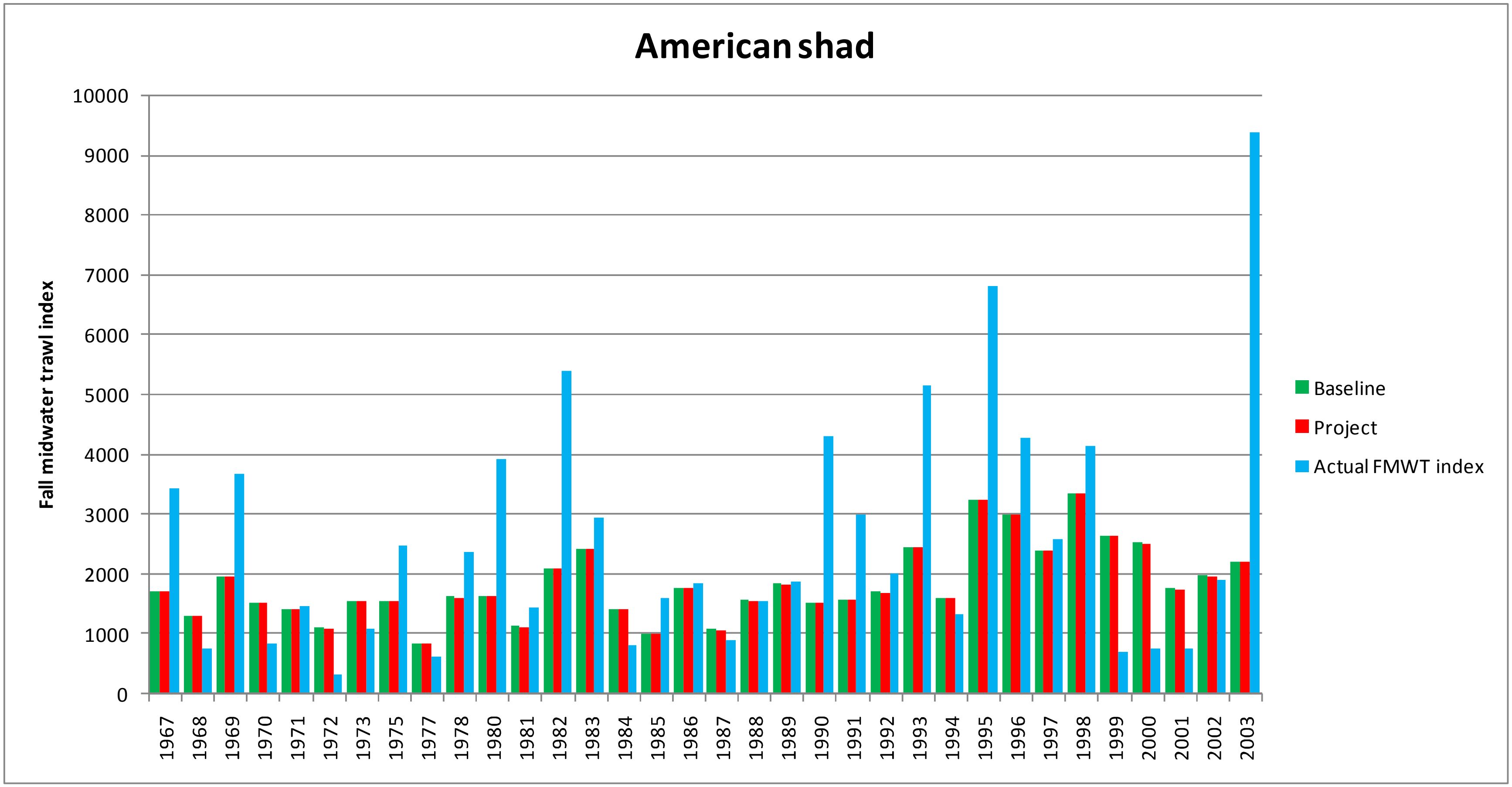

Figure 4.5-17. Fall Midwater Trawl (FMWT) Indices of American Shad under Baseline and the Project, as Estimated from a Regression of FMWT against X2 (Kimmerer et al. 2009)

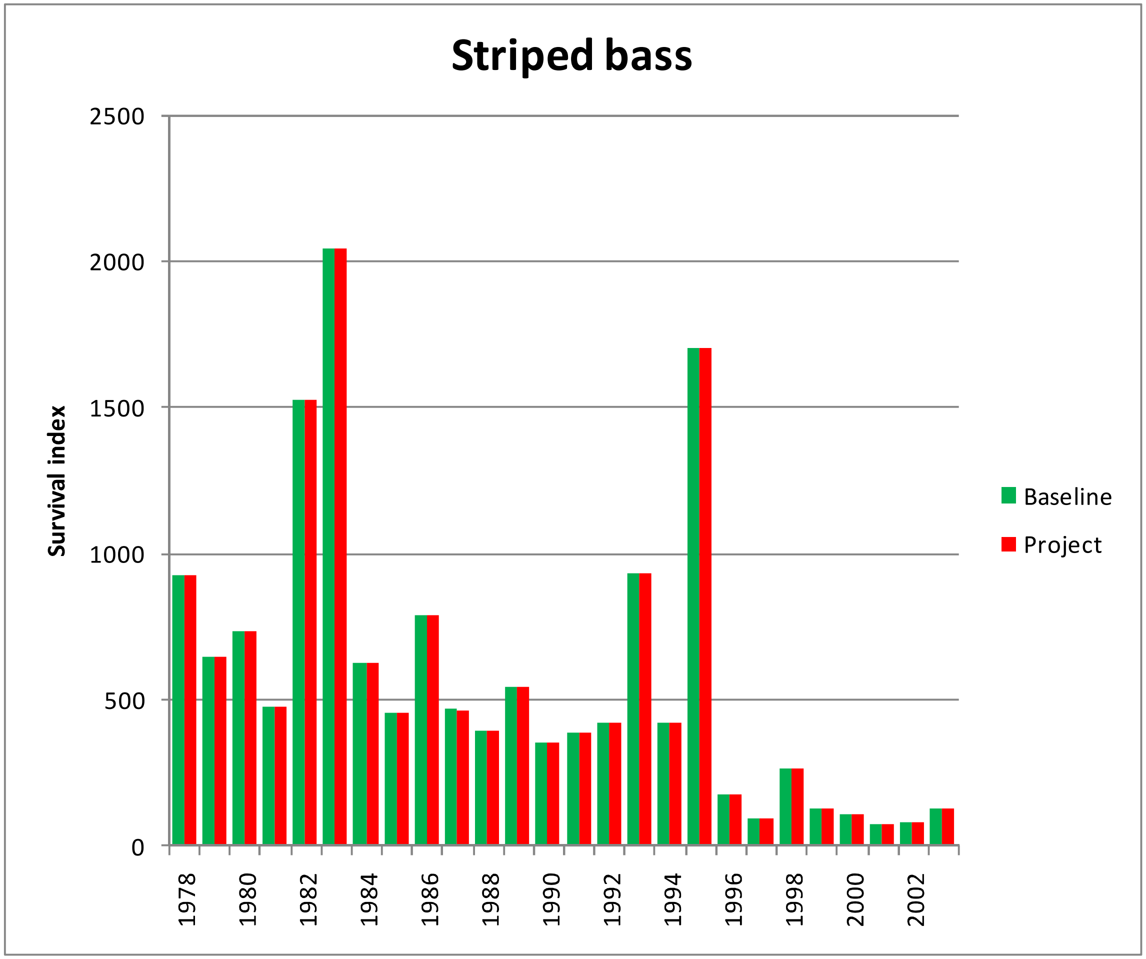

Figure 4.5-18. Survival Indices of Striped Bass under Baseline and the Project, as Estimated from a Regression of Survival Index against X2 (Kimmerer et al. 2009)

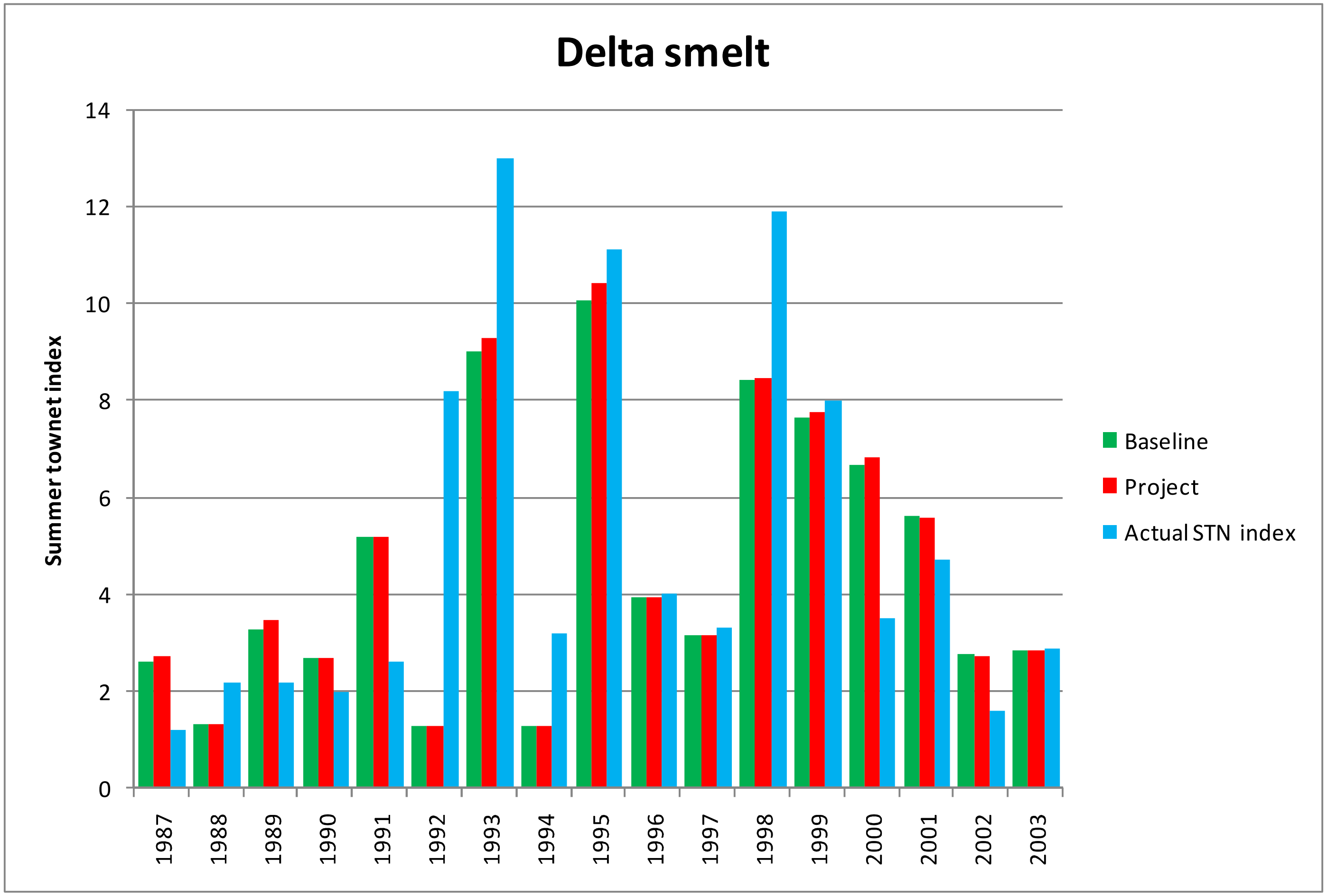

Figure 4.5-19. Summer Townet Indices of Delta Smelt under Baseline and the Project, as Estimated from a Regression of Summer Townet Index versus Fall Midwater Trawl Index and X2 Position

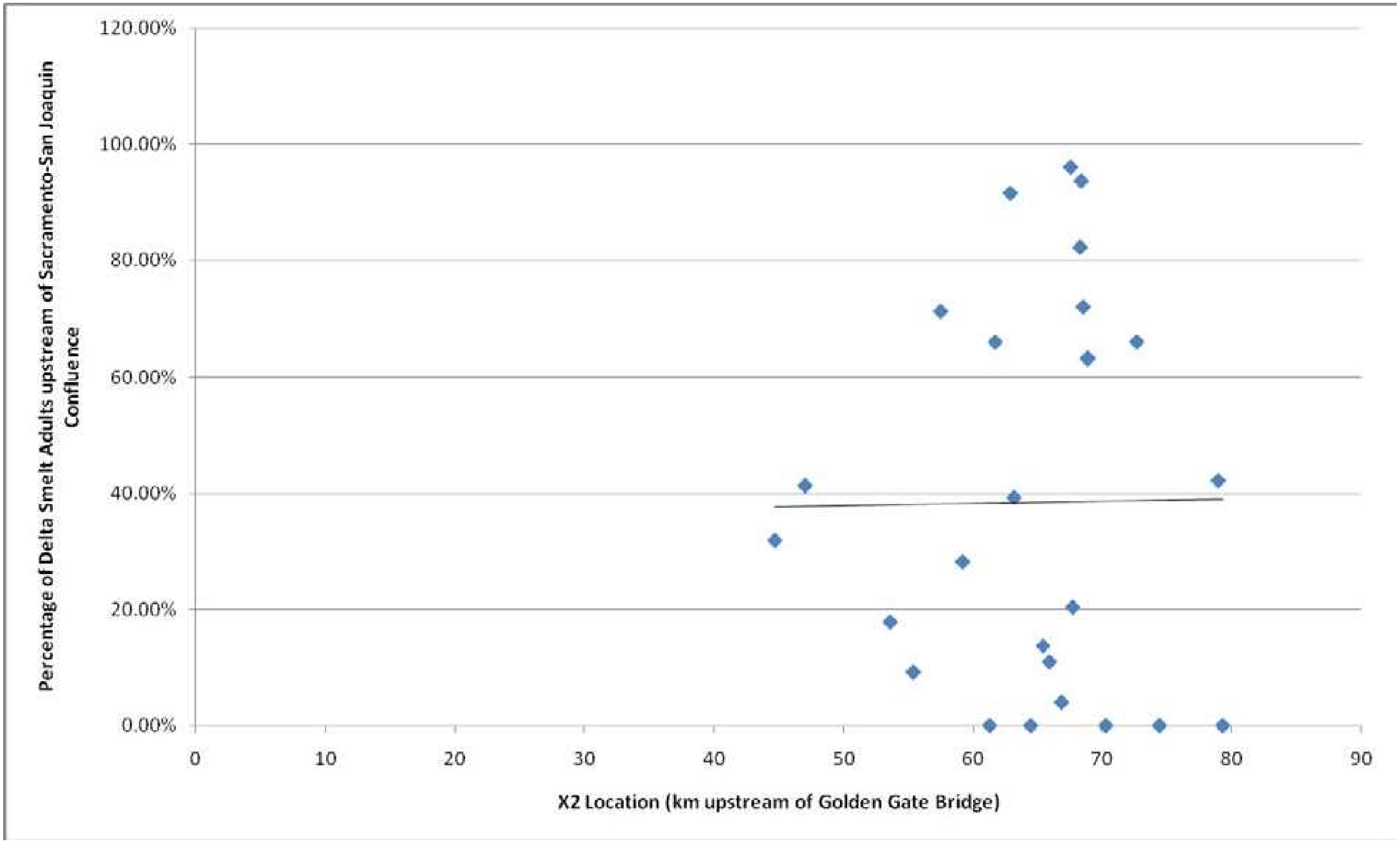

Figure 4.5-20. Percentage of Delta Smelt Adults along an Estuarine Transect from Carquinez Strait to the Delta That Were upstream of the Sacramento–San Joaquin Confluence
A trendline is shown to demonstrate the lack of a relationship. Values are monthly estimates based on extrapolations of total abundance from spring kodiak trawling (January to May, 2002 to 2007) and do not include regions beyond the main transect (Montezuma Slough, the Sacramento River, and Cache Slough).

Entrainment Loss of Zooplankton from June to September

The estimated baseline June–September cumulative abundance of *Pseudodiaptomus forbesi* in the regions for which zooplankton density data were available averaged from 4.7×10^{11} (470 billion) in the SE Delta to 2.2×10^{12} (2.2 trillion) in the Franks Tract region during 1989 to 2003 (Table 4.5-15). It was assumed (based on particle tracking results) that there would be no entrainment loss of *P. forbesi* inhabiting Suisun Bay, Suisun Marsh, and Chipps Island regions because of the distance from the exports and the Project. In regions for which entrainment losses were estimated, average baseline losses to CVP/SWP entrainment ranged from 23% (from the lower Sacramento River) to 99% (from the southeast Delta). The additional entrainment estimated to occur because of Project discharge of water for export by SWP was almost zero for *P. forbesi* from the southeast Delta (because baseline pumping already had caused nearly all of the losses possible given the assumed E/I-loss relationship). Estimates of total loss attributable to Project entrainment were greatest from Franks Tract (3.6%).

The average benefit of the Project in terms of reduced agricultural diversions ranged from 0.1% in the southeast Delta to 1.5% in Franks Tract. The net impact of the Project was greatest for the lower Sacramento River (an average of 2.2% loss to entrainment). There was a net benefit of the Project to the east-southeast Delta consisting of an average 0.1% decreased entrainment loss (primarily because of decreased agricultural diversions in June) (Table 4.5-15).

Combining the results for all regions for which zooplankton density data were available required removal of several months of data because not all regions were sampled throughout 1989–2003. Overall, from an average cumulative June–September population size of 8.4×10^{12} (8.4 trillion) *P. forbesi*, it was estimated that around 42% were lost to baseline SWP/CVP entrainment (Table 4.5-15). Additional SWP entrainment losses attributable to the Project discharges for export contributed a further 1.9% average loss to the zooplankton population, but reduction of agricultural diversions with the Project reduced the average net impact to 1.2% (Table 4.5-15). The maximum annual impact of the Project was a net loss of 6.1% of all *P. forbesi* and the minimum impact was a reduced loss (compared to the baseline) of 1.5%.

It is possible that zooplankton populations on the Project Reservoir Islands will increase in size following diversion onto the islands, as they will be in a relatively fish-free habitat with few predators. Thus, discharge of zooplankton-rich water may compensate for losses attributable to export of discharged water. The scenario analyzed above therefore excludes a potential benefit from the Project islands discharges.

Table 4.5-15. Average June–September *Pseudodiaptmous forbesi* Loss Attributable to the Project in Relation to the Baseline, based on Extrapolations of Observed Zooplankton Density Data from 1989 to 2003

	Cumulative Population size[1]	Baseline SWP/CVP Exports % Loss	Project Discharges for Export % Loss[2]	Baseline DW Agricultural Diversion % Loss[3]	Project Habitat Diversion % Loss[4]	Project Benefit from Reduced Agricultural Diversions (Reduced % Loss)[5]	Net Project Impact (% Loss)
Suisun Bay	506,177,232,624	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Suisun Marsh	882,595,467,199	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Chipps Island	530,523,864,861	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Lower Sacramento River	1,483,020,608,272	23.01%	3.00%	1.09%	0.31%	0.77%	2.23%
Lower San Joaquin River	1,262,742,998,170	27.44%	2.95%	1.33%	0.37%	0.96%	1.99%
Franks Tract	2,202,689,903,129	43.92%	3.59%	1.97%	0.51%	1.47%	2.13%
East-southeast Delta	1,483,020,608,272	95.12%	0.17%	0.80%	0.19%	0.61%	-0.44%
Southeast Delta	469,836,828,071	99.00%	0.00%	0.15%	0.04%	0.11%	-0.11%
All regions[6]	8,380,078,392,871	41.69%	1.93%	1.06%	0.28%	0.78%	1.15%

1 The cumulative population size is the sum of the extrapolated monthly abundance estimates from June to September.
2 Assumes discharge for exports by SWP from July to November.
3 Assumes similar pattern of agricultural diversions each year.
4 Assumes similar pattern of habitat diversions each year.
5 Benefit is calculated as reduction in agricultural diversion entrainment loss minus increase in habitat diversion entrainment loss.
6 A subset of months was used for the all-region summary because not all regions were sampled in all months.

Species Impacts—Chinook Salmon

Impact FISH-5: Effects of the Project on Juvenile Chinook Salmon

Outmigrating juvenile Chinook salmon are the main life stage of this species likely to be affected by the Project. The potential impacts include entrainment during diversions to the Project islands and, to a lesser extent, during discharges of Project water for export. Other impacts include possible exposure to reduced water quality during discharge of Project water. Discharge of water for export (July–November) or for outflow (i.e., beneficial use in October–November) could potentially affect fish due to the elevated temperature and reduced DO of reservoir water relative to the receiving Delta waters. Salmonids, in particular, are susceptible to elevated temperatures. However, water would be discharged at times of the year when the effects on salmonids would be minimal because the main migration period is from December to June. The greatest potential for negative effects of releases due to elevated water temperature is for late-fall-run Chinook salmon, of which the bulk of the population outmigrates in November and December. The environmental commitments implementing DO and temperature standards (detailed in Chapter 2) would lessen this impact to a less-than-significant level. The potential impact of increased temperature on adult Chinook salmon migrating upstream to spawn would also be less than significant with these environmental commitments.

The average entrainment loss to the Project diversions was estimated to range from 0.0% of the baseline SWP/CVP loss for spring-run Chinook salmon (which were present only at very low density during the December–March diversion period) to 0.2% of baseline for winter-run and late fall–run Chinook salmon (which are most abundant during the December–March diversion period). Reduction and screening of existing DW agricultural diversions offset the Project losses for fall-run and spring-run Chinook salmon, but not for winter-run or late fall-run Chinook salmon because the main migration periods of the former two species overlap the main diversion period to a lesser extent than those of the latter two species. Given that the installed screens will be constructed to delta smelt standards, which are above those required for salmonids (i.e., approach velocity is lower), it is probable that the screened intakes will entrain very few salmonids (National Marine Fisheries Service 2009).

The conservation easement included primarily as mitigation for delta and longfin smelt (see Mitigation Measure FISH-MM-2 above) would also provide benefits to other species. The importance of estuarine habitats for salmonids was not, until recently, examined in detail. Survival of juvenile Chinook salmon to adulthood is enhanced in watersheds that have a greater proportion of natural estuarine habitat (Magnusson and Hilborn 2003). Chipps Island is an estuarine area that is included in critical habitat designations for winter-run and spring-run Chinook salmon. Along with other areas in Suisun Bay/Marsh, seasonal restrictions on water diversions are implemented to protect these two species (and delta smelt). Perpetual conservation of 200 acres of Chipps Island will enhance salmonid survival. The position of Chipps Island, at a prominent location on the outmigration route, is likely to be of considerable importance to juvenile salmonids.

In addition, there is the potential for Project diversions to provide false outmigration cues to Chinook salmon juveniles traversing the Delta via the central Delta. Through direct entrainment and increased residence time within the central Delta (leading to a greater risk of predation, prolonged effects of poor water quality, and a greater possibility of entrainment at the south Delta pumps), the Project was estimated to result in average mortality of 0.12% of winter-run Chinook salmon juveniles and 0.01% of spring-run Chinook salmon. The losses may be relatively small in numeric terms, but NMFS (2009) notes that the loss of individuals that have successfully survived many earlier threats prior to entry to the Delta may represent a significant loss to the population in terms of genetically fitter individuals; this may represent a substantial reduction in abundance of Endangered winter-run Chinook salmon and Threatened spring-run Chinook salmon. Therefore, this impact is considered significant. Implementation of Mitigation Measures FISH-MM-1 (Conservation of Shallow-Water Vegetated Habitat), FISH-MM-5 (Implement a Fishery Improvement Mitigation Fund), and FISH-MM-6 (Establish a Shallow-Water Aquatic Habitat Conservation Easement) would reduce Impact FISH-5 but the impact would still be significant and unavoidable.

Mitigation Measure FISH-MM-5: Implement a Fishery Improvement Mitigation Fund

The Project applicant will implement a fishery improvement mitigation fund that will provide monetary compensation to support habitat enhancement and conservation of fish populations. Annual fund contributions will be based on the annual quantity of water diverted to the Project Reservoir Islands, the amount of this water exported, and Project effects. Previously, DFG and NMFS imposed permit terms that called for between $750–1,250/TAF for diversions during October through August and $2,250/TAF for export discharges. Revised permit terms may be established by USFWS, DFG, and NMFS. Initial funding will be provided prior to implementing the Project.

Use of the monies from the fund will be at the discretion of the resource agencies that will implement actions to improve habitat conditions and decrease mortality for species impacted by the Project; it is expected that money from the fund will be contributed to several of the following improvement actions:

- Augmentation of spawning and rearing habitat for salmonids in tributaries of the Central Valley. A good example is opportunities to provide funding toward the Battle Creek Salmon and Steelhead Restoration Project implemented by DWR, Reclamation, USFWS, DFG, and NMFS.
- Restoration of habitat within the Delta. There are opportunities to contribute funds to the Delta Pumping Plant Fish Protection Agreement (i.e., Four Pumps Agreement) which calls for cost-sharing and has successfully conducted restoration projects, installed screens and barriers, and increased enforcement in the Delta.
- Rearing and releasing additional fish. There is an opportunity to contribute to the UC Davis/USFWS Fish Conservation and Culture Facility that is currently rearing delta smelt as a safeguard against further declines in the

wild population but requires additional facilities to maintain sufficient family groups to maintain genetic diversity.

- Improving fish salvage operations. There is an opportunity to contribute to DWR and Reclamation's efforts to improve salvage techniques at the SWP and CVP fish facilities in accordance with the NMFS (2009) OCAP BO.

Mitigation Measure FISH-MM-6: Establish a Shallow-Water Aquatic Habitat Conservation Easement

Prior to construction, the Project will secure a perpetual conservation easement (easement) for 200 acres of shallow-water aquatic habitat on Chipps Island that are owned by the Project applicant but not currently protected by easement or covenant. The easement will fully protect in perpetuity the shallow-water aquatic habitat. A management plan for the easement area will be developed by the Project within the first year of Project operation for the habitat covered by the easement, and will be incorporated as an exhibit to the easement.

Additionally, the Project will demonstrate to the USFWS documentation that there is adequate financing for the perpetual management of the habitat protected by the conservation easement consistent with the management plan including that (1) adequate funds for the management of habitat in perpetuity protected by the conservation easement have been transferred to an appropriate third-party, and (2) the third party has accepted the funds and (3) such funds have been deposited in an interest-bearing account intended for the sole purpose of carrying out the purposes of this easement.

The easement (along with a title report for the easement area) and management plan will be approved by the USFWS prior to recordation. After approval, the easement and management plan will be recorded in the appropriate County Recorder's Office(s). A true copy of the recorded easement will be provided to the USFWS within 30 days after recordation.

The conservation easement will mitigate for potential losses of larval/early-juvenile smelt rearing habitat. For delta smelt, the average impact in terms of the loss of optimal salinity habitat was actually a very slight benefit of 0.04 km^2 increased area (9.9 acres per year). The maximum impact was a decrease of 0.79 km^2 (195 acres). This is approximately the size of the proposed conservation easement of 200 acres of habitat at Chipps Island.

Species Impacts—Steelhead

Impact FISH-6: Effects of the Project on Juvenile Steelhead

All the potential Project impacts identified for Chinook salmon would also affect steelhead: changes in water quality due to Project discharges; entrainment at Project diversions and, to a lesser extent, during export of discharged Project water; and increased Delta mortality because of altered hydrodynamics or false outmigration cues caused by Project diversions. Changes in water quality would be minimized by the environmental commitments detailed in Chapter 2.

The net entrainment loss was estimated to average 0.1% of the baseline loss attributable to SWP/CVP exports. Nobriga and Cadrett (2001) estimated that between 0.04% and 0.5% of all Central Valley steelhead smolts (wild and hatchery-origin) were salvaged at SWP and CVP fish facilities from 1997 to 2000. Assuming around four times as many fish were lost before salvage, this would give an upper limit of 2% of smolts lost. Estimates of the total number of steelhead smolts at that time ranged from 1.8 million in 1997–1998 to almost 2 million in 1998–1999. Assuming loss of steelhead to Project diversions or discharges for export is 0.1% of baseline SWP/CVP losses, 0.1% × 2% × 2 million = 40 steelhead smolts could have been lost to the Project diversions. This is close to the estimated 28 steelhead estimated to be lost during Project diversions and south Delta export of Project water. The proportion of the loss that is wild-origin individuals may be around 30% (Nobriga and Cadrett 2001).

The overall loss of steelhead smolts entering the Delta from the Sacramento River that might be attributable to Project operations (direct entrainment plus increased predation loss plus increased exposure to poor water quality plus increased probability of entrainment at SWP/CVP) was estimated at approximately 0.7%. This would represent around 14,000 smolts (hatchery- and wild-origin) based on the upper population estimate above.

Estuarine areas are also important critical habitat for steelhead (National Marine Fisheries Service 2009: 113); therefore the species would benefit from Mitigation Measure FISH-MM-6 (see above), which establishes a perpetual shallow-water conservation easement at Chipps Island.

As noted for Chinook salmon above, the loss may represent a significant loss to the population in terms of genetically fitter individuals that have survived passage to the Delta and may substantially reduce the abundance of this species. Therefore, this impact is considered significant. Implementation of the various environmental commitments detailed in Chapter 2 and Mitigation Measures FISH-MM-1 (Conservation of Shallow-Water Vegetated Habitat), FISH-MM-5 (Implement a Fishery Improvement Mitigation Fund), and FISH-MM-6 (Establish a Shallow-Water Aquatic Habitat Conservation Easement) would reduce the severity of Impact FISH-6 but the impact would remain significant and unavoidable.

Species Impacts—Delta Smelt

Impact FISH-7: Effects of the Project on Delta Smelt

Delta smelt are estuary-resident fish, inhabiting the Delta and other portions of the San Francisco Bay estuary throughout their lives. Several life stages thus potentially are affected by the Project (Table 4.5-16). Loss of habitat during construction could affect the number of eggs successfully spawned as described earlier. The effects of entrainment loss are marginally counteracted by the average gain in optimal salinity area, resulting in an average loss of 0.14% of all larvae. Assuming that 0.25% of larvae survive to adulthood (Bennett 2005), the loss of larvae could represent a loss of 0.00005% of the adult population.

During the juvenile phase, net entrainment loss under the Project averaged 1.2% of baseline SWP/CVP mortality and occurred during discharges for export. If Project diversions decrease OMR flows, then an average of 0.24% of juveniles may be entrained at the export facilities each year. Releases of water in September–November may increase the following summer's juvenile population by outflow- or salinity-related mechanisms correlated with decreased (downstream) X2 that benefit the older juvenile (subadult) population in the fall. The environmental commitments detailed in Chapter 2 will minimize the risk to juvenile delta smelt from releases of Project water in July–November (for export) or September-November (for outflow) that could have relatively high temperature or low DO.

Assuming that SWP/CVP exports cause the loss of 15% of the adult population annually (Kimmerer 2008), the Project may take an additional 0.1% × 15% = 0.015% of the adult population during diversions to the Reservoir Islands. In the worst-case scenario, the diversions to the Reservoir Islands could cause entrainment of adult delta smelt at the export facilities due to decreased OMR flows—this averaged 0.70% of the adult population in the analysis. Adding all "equivalent adult" losses suffered by the population at the various life-history stages, the estimated average annual loss attributable to the Project is around 0.72% of the adult population.

Spring Kodiak trawl data were extrapolated to calculate an average adult delta smelt population size from 2002 to 2008 of approximately 900,000 individuals, which is consistent with estimates presented by Kimmerer (2008: 21). The loss attributable to the Project may represent around 6,500 adult delta smelt. Given the long-term downward trend in abundance of delta smelt, the additive effects of the Project may substantially reduce the abundance of this listed species. Therefore, this impact is considered significant. Implementation of the environmental commitments detailed in Chapter 2 (water quality standards, spill prevention, reduction in boat wake erosion, and reductions in diversion/discharge during smelt presence) and Mitigation Measures FISH-MM-1 (Conservation of Shallow-Water Vegetated Habitat), REC-MM-1 (Reduce the Size or Number of Recreation Facilities), FISH-MM-2 (Site Project Facilities to Avoid Existing Shallow Water Vegetated Habitat), FISH-MM-3 (Limit Waterside Construction to Less Sensitive Time Periods), FISH-MM-4 (Implement Best Management Practices for Waterside Construction), FISH-MM-5 (Implement a Fishery Improvement Mitigation Fund), and FISH-MM-6 (Establish a Shallow-Water Aquatic Habitat Conservation Easement) would reduce this impact. However, because of the current low abundance of delta smelt and the uncertainty associated with the effectiveness of the mitigation proposed, this impact is considered significant and unavoidable.

Table 4.5-16. Summary of Project Impacts on Delta Smelt (Percentages Represent Averages over the Time Periods Included in Each Analysis)

Life stage	Analysis	Average Impact	Percentage Surviving to Adulthood [1]	Percentage of Adult Population
Eggs	Loss of spawning habitat (analysis from 1995 DEIR/EIS)	Qualitative—could occur if suitable habitat is lost	0.067%	–
Larvae	1. Entrainment loss during Project diversions	1. 0.2% loss	0.25%	1. 0.0005%
	2. Optimal salinity area	2. 0.09% gain		2. 0.00000225%
Juveniles	1. Entrainment loss during export of Project water	1. 1.2% loss (compared to baseline SWP/CVP)	1%	1. 0.0016% [2]
	2. Entrainment loss due to OMR flow effect	2. 0.24%		2. 0.0024%
	3. Zooplankton prey loss	3. 1.2% loss		3. 0.012%
	4. Population abundance-X2 analysis	4. 1.2% gain		4. 0.012%
Adults	1. Entrainment loss during Project diversions	1. 0.1% loss (compared to baseline SWP/CVP)	100%	1. 0.015% [3]
	2. Entrainment loss due to OMR flow effect	2. 0.70%		2. 0.70%
			Sum	0.72%

1 Values assumed from Bennett's (2005: 12) conceptual delta smelt life-history model.
2 Assumes that baseline annual SWP/CVP loss is 13% of total juveniles, the median of the values calculated by Kimmerer (2008).
3 Assumes that baseline annual SWP/CVP loss is 15% of total adults, the median of the values calculated by Kimmerer (2008).

Species Impacts—Longfin Smelt

Impact FISH-8: Effects of the Project on Longfin Smelt

Longfin smelt, as with delta smelt, may be affected by the Project at several stages of the life cycle. Increased entrainment loss of juveniles during export of discharged Project water was 0.2% of baseline SWP/CVP (accounting for reduced DW agricultural loss due to reductions and screening); loss of subadults during the Project diversions in December–March would be very low (0.0% of baseline SWP/CVP export loss, or 10 fish per year on average). It is unclear to what extent spawning habitat may be lost or what proportion of total spawning habitat could be affected by the Project. Applying a framework of estimating losses in terms of equivalent older life stages, in this case subadults (i.e., longfin smelt nearing the end of their first year of life), suggests that impacts on larvae because of entrainment loss and reduction of optimal salinity area could represent an average annual loss of 0.00075% of the subadult population (Table 4.5-17). The environmental commitments for water quality standards will minimize the risk to juvenile longfin smelt from releases of Project water in July-November (for export) or September–November (for outflow) that could have relatively high temperature or low DO.

The greatest potential impact on the longfin smelt population is estimated to be caused by diversions during January to June, which may result in an average decrease in subadult population abundance (indexed by the FMWT survey). Assuming the FMWT index represents overall population trends of longfin smelt in the region sampled by the FMWT, the Project on average would result in a reduction of the population's abundance by about 1%. Kimmerer et al. (2009) suggested that a portion of the correlation between X2 and longfin smelt could be explained by changes in habitat availability (e.g., the reduction in optimal salinity habitat area, as shown in this EIR), but that other factors such as larval retention may increase with decreasing X2 (i.e., increasing inflow). In isolation, a 1% reduction in population is not likely to be a significant reduction in abundance or to pose a threat to eliminate the species from the region. Nevertheless, the species' long-term abundance decline and apparent reduced survival following the 1987–94 drought (Rosenfield and Baxter 2007) mean that even a small decline in population could constitute a substantial reduction in the population's ability to sustain itself. The estimated population size of longfin smelt within the FMWT survey area averaged 1,330,000 from 1993 to 2007 (Water Agencies analysis provided to DFG 2009). The proportion of subadults (fish up to 1 year old) in the FMWT is about 90%, with the rest being mostly adults up to 2 years old (California Department of Fish and Game 2009c; Rosenfield and Baxter 2007). This estimate is based on volumetric extrapolations of catch per unit volume and does not include regions seaward of the FMWT survey area, which many longfin smelt inhabit. The average annual loss of longfin smelt subadults in the FMWT area attributable to the Project water diversions during the early-life period is estimated at around 1,300 fish. Given the species' recent decline, this may constitute a substantial reduction in abundance and is possibly caused by a significant reduction in favorable early-life habitat.

The average loss of optimal salinity habitat was 0.26 km^2 (64.2) acres per year. Mitigation Measure FISH-MM-6 (Establish a Shallow-Water Aquatic Habitat Conservation Easement), as described above, provides a perpetual conservation easement of 200 acres, which would mitigate for the loss of optimal salinity habitat in many years (although it should be noted that the maximum loss was 5.74 km^2 [around 1,400 acres]). This mitigation measure provides important habitat during the early life stages.

Implementation of the environmental commitments detailed in Chapter 2 (water quality standards, spill prevention, reduction in boat wake erosion, and reductions in diversion/discharge during smelt presence) and Mitigation Measures FISH-MM-1 (Conservation of Shallow-Water Vegetated Habitat), REC-MM-1 (Reduce the Size or Number of Recreation Facilities), FISH-MM-2 (Site Project Facilities to Avoid Existing Shallow Water Vegetated Habitat), FISH-MM-3 (Limit Waterside Construction to Less Sensitive Time Periods), FISH-MM-4 (Implement Best Management Practices for Waterside Construction), FISH-MM-5 (Implement a Fishery Improvement Mitigation Fund), and FISH-MM-6 (Establish a Shallow-Water Aquatic Habitat Conservation Easement) would reduce this impact. However, the uncertainty associated with the implementation of these mitigation measures means that the impact is significant and unavoidable.

Table 4.5-17. Summary of Project Impacts on Longfin Smelt

Life Stage	Analysis	Average Impact	Percentage Surviving to Subadulthood [1]	Percentage of Subadult Population
Eggs	Loss of spawning habitat (analysis from 1995 DEIR/EIS)	Qualitative—could occur if suitable habitat is lost	0.01%	
Larvae	1. Entrainment loss during Project diversions	1. 0.1% loss	0.25%	1. 0.00025%
	2. Optimal salinity area	2. 0.2% loss		2. 0.0005%
Juveniles	Entrainment loss during export of Project water	0.2% loss (compared to baseline SWP/CVP)	1%	0.0002% [2]
Subadults	1. Population abundance–X2 analysis	1. 1% loss	100%	1%
	2. Entrainment loss during Project diversions	2. 0.0% loss (compared to baseline SWP/CVP)		
			Sum	1%

[1]Values assumed from Bennett's (2005: 12) conceptual delta smelt life-history model, with fecundity changed to 10,000 eggs per female.

[2]Assumes 10% of the juvenile population is lost due to baseline entrainment at SWP/CVP.

Species Impacts—Green Sturgeon

Impact FISH-9: Effects of the Project on Green Sturgeon

NMFS (2009: 131) notes that good water quality is important for green sturgeon. Discharges of Project water could affect juvenile sturgeon and restrict their distribution, although the environmental commitments to maintain adequate water quality standards minimize this impact. Juvenile green sturgeon may be entrained at the SWP pumping facility during export of discharged Project water. The average annual net increase in loss was 2.6% of baseline SWP/CVP losses; this amounted to five green sturgeon based on the extrapolation of observed salvage density that was used to derive the density of green sturgeon in the Delta. Although the estimated average loss appears small and the maximum loss was estimated at 19, the declining population abundance may make even a small loss substantial and reduce the population towards levels that are no longer self-sustaining. The impact is considered significant and unavoidable. Mitigation Measure FISH-MM-5 (Implement a Fishery Improvement Mitigation Fund) would reduce the impact of the Project on green sturgeon without changing the significance conclusion.

Species Impacts—Sacramento Splittail

Impact FISH-10: Effects of the Project on Sacramento Splittail

Sacramento splittail may be affected by loss of spawning habitat during the construction phase of the Project and also by reduced water quality during Project discharges. The main impact of the Project on Sacramento splittail would be entrainment by the SWP export facility during export of discharged Project water from July to November, during which time abundance in the south Delta is high. There is a relatively small impact from diversions to the Project islands during December–March. Overall, the net impact would be a 1.1% increase in loss over the baseline loss attributable to the SWP/CVP export facility operations. The proportion of the overall population this represents is uncertain, but it is likely to be low. The species is able to increase greatly in number during favorable, high-outflow conditions; the relatively long life span, high reproductive output, and broad environmental tolerances make Sacramento splittail more resilient to anthropogenic alterations in the Delta than other endemic species such as delta smelt (Sommer et al. 1997). Sacramento splittail may be salvaged in vast numbers at the SWP/CVP fish facilities in years with high inflow because the increased inundation of floodplain habitat gives a greater habitat area for spawning, rearing, and growth. As noted by Sommer et al. (1997: 975), "the main factor affecting splittail entrainment… is year-class strength, typically greatest in wet years when the population is in a better position to accept some losses." Additional losses from the Project are not expected to substantially reduce the number or restrict the range of this species, or cause the population to drop below self-sustaining levels. Therefore, this impact is considered less than significant. Sacramento splittail will benefit from the environmental commitments detailed earlier in this chapter and also the various Project Mitigation Measures: FISH-MM-1 (Conservation of Shallow-Water Vegetated Habitat), REC-MM-1: Reduce the Size or Number of Recreation Facilities, FISH--MM-2 (Site Project Facilities to Avoid Existing Shallow Water Vegetated Habitat), FISH-MM-3 (Limit Waterside Construction to Less Sensitive Time Periods), FISH-MM-4 (Implement Best Management Practices for Waterside Construction), FISH-MM-5 (Implement a Fishery Improvement Mitigation Fund), and FISH-MM-6 (Establish a Shallow-Water Aquatic Habitat Conservation Easement).

Impacts on Other Species

Impact FISH-11: Effects of the Project on Other Aquatic Species

The Project may affect many common fish and invertebrate species inhabiting regions of the Delta and downstream that may be influenced by Project operations. Entrainment during Project diversions or discharges for export was estimated to increase losses by around 3.7–4.5% of baseline SWP/CVP salvage for three species analyzed in the juvenile and adult fish entrainment analysis (White catfish, American shad, and threadfin shad). Assuming that diversions to the Reservoir Islands occurs in December–March and that discharge for export occurs in July–November, loss of striped bass eggs would not occur during Project operations. The area of optimal salinity habitat decreased by an average of 0.11% for striped bass larvae. Losses of zooplankton, as analyzed for delta smelt, probably will affect other species.

The prominence and broad distribution of nonnative species such as striped bass, white catfish, American shad, and threadfin shad in the Delta mean that they may have appreciable numeric losses attributable to the Project. The losses likely represent only a small portion of the total populations and are unlikely to constitute a substantial reduction in abundance or range. For native species that may occasionally inhabit the Delta (e.g., starry flounder), localized impacts may occur, but the bulk of the population is likely to be far enough downstream that effects of Project operations are minimal. No substantial reduction in abundance, range, or habitat for any other species is anticipated. This impact is considered less than significant. The environmental commitments and mitigation measures adopted for other species will also benefit common fishes and invertebrates not detailed in the Species Impacts sections above.

Alternative 1

Alternative 1 would not differ from the Proposed Project (Alternative 2) in terms of construction impacts. For operational impacts, possible impacts from increased boating activity due to dock construction would remain the same under Alternative 1. The same amount of water would be diverted to the Reservoir Islands but less water would be discharged for export; this would result in lower entrainment impacts and flow-related changes in the Delta than Alternative 2. The water not exported would be released for outflow in the fall (September–November), increasing the water quality benefit compared to Alternative 2. Overall, the difference in impact between Alternative 1 and the Proposed Project (Alternative 2) varies by species because of seasonality and occurrence of species in regions that could be affected by the Project. This is summarized in Table 4.5-18.

Table 4.5-18. Comparison of the Relative Impact of Alternative 1 to Alternative 2 on Species of Concern

Species	Relative Impact of Alternative 1 in Comparison to Proposed Project (Alternative 2)	Notes
Chinook Salmon (Fall-Run)	Unchanged impacts: entrainment at Project diversions. Lower impacts: a minor decrease in SWP entrainment and migration mortality because of decreased exports of Project water.	Only 2% of the juveniles are assumed to outmigrate in July–November, so the reduction in impact would be minimal
Chinook Salmon (Late Fall–Run)	Unchanged impacts: entrainment at Project diversions. Lower impacts: a decrease in SWP entrainment and migration mortality because of decreased exports.	Over 30% of the juveniles are assumed to outmigrate in July–November, so the reduction in impact would be moderate
Chinook Salmon (Winter-Run)	Unchanged impacts: entrainment at Project diversions; migration mortality due to Project diversions.	No migration assumed to occur during July–November, therefore no change in relation to reduced discharge for export
Chinook Salmon (Spring-Run)	Unchanged impacts: entrainment at Project diversions; migration mortality due to Project diversions.	No migration assumed to occur during July–November, therefore no change in relation to reduced discharge for export

Steelhead	Unchanged impacts: entrainment at Project diversions. Lower impacts: a minor decrease in migration mortality due to Project diversions and entrainment mortality at SWP during export of Project water.	Only 1% of the juveniles are assumed to outmigrate in July–November, so the reduction in impact would be minimal
Sacramento Splittail	Unchanged impacts: entrainment at Project diversions. Lower impacts: a decrease in SWP entrainment because of decreased exports.	The main period of entrainment is May–June, but appreciable numbers are present in July–November
Longfin Smelt	Unchanged impacts: entrainment at Project diversions; area of estuarine rearing habitat; fall midwater trawl abundance due to X2 position in early life stages. Lower impacts: a minor decrease in SWP entrainment because of decreased exports of Project water.	The main period of entrainment is April–June, with only minor numbers present (~1% of annual total) in the export period (July–November).
Delta Smelt (Adults: December–April)	Unchanged impacts: entrainment at Project diversions; entrainment at export facilities due to OMR flows effects of Project diversions.	Adults do not occur during the July–November export period.
Delta Smelt (Larvae/Juveniles: February to December)	Unchanged impacts: larval entrainment at Project diversions; entrainment at export facilities due to OMR flows effects of Project diversions; area of estuarine rearing habitat. Lower impacts: decreased SWP entrainment because of decreased exports of Project water; increased summer abundance because of increased fall discharges providing more habitat for subadults; decreased summer entrainment of *Pseudodiaptomus forbesi*.	10% or less of juveniles would be entrained from July to November, so the entrainment impact is only slightly reduced.
Green Sturgeon	Lower impacts: a decrease in SWP entrainment because of decreased exports of Project water.	August was the main month of entrainment (0.4 fish/taf compared to 0.0–0.1 fish/taf in the rest of the year).

Alternative 3

Alternative 3 would not differ from the Proposed Project (Alternative 2) in terms of construction impacts. Compared to the Proposed Project, Alternative 3 would double diversions to the Reservoir Islands and double discharge of water for export and outflow; there would be no diversions for habitat. This would lead to substantially greater impacts than Alternative 2. In general, doubling the diversions and exports would result in approximate doubling of the impacts. In some cases the impacts may be somewhat more or less than doubled. Two quantitative examples are provided by reexamining the analyses of entrainment and assuming that under Alternative 3 Project diversions and discharges are doubled, with no Habitat Island diversions (Tables 4.5-19 and 4.5-20). Examples of larval entrainment of smelts show that the losses could be more or less than two times greater under Alternative 3 compared to Alternative 2, because of the nonlinear nature of the entrainment relationship (Table 4.5-19; see Appendix B). In all of the small fish entrainment examples, the increase in impact under

Alternative 3 is more than double that of Alternative 2 because the number of existing agricultural diversions that are reduced remains the same; this results in relatively less "offsetting" of the doubled entrainment loss impacts through screening of the agricultural diversions under Alternative 3. The impacts therefore are more than twice those of the Project (Table 4.5-19).

Table 4.5-19. Relative Entrainment Impacts of Alternative 2 (the Proposed Project) and Alternative 3 (Doubling of Diversions to the Reservoir Islands and Doubling of Discharges for Export) for Larval Delta Smelt and Longfin Smelt

	Proposed Project (Alternative 2)		Alternative 3	
	Number of Larvae	% of All Larvae	Number of Larvae	% of All Larvae
Longfin smelt	4,082,540	0.4%	9,660,515	1.0%
Delta smelt	2,515,689	0.2%	4,275,036	0.4%
Results are annual averages based on a 1980–2003 baseline period.				

Table 4.5-20. Relative Entrainment Impacts of Alternative 2 (the Proposed Project) and Alternative 3 (Doubling of Diversions to the Reservoir Islands and Doubling of Discharges for Export) for Juvenile and Adult Fish

	Proposed Project (Alternative 2)		Alternative 3	
	Number of Fish	% Change from Baseline SWP/CVP Loss	Number of Fish	% Change from Baseline SWP/CVP Loss
Chinook salmon (fall-run)	-138	0.0%	243	0.1%
Chinook salmon (late fall–run)	121	0.6%	252	1.2%
Chinook salmon (winter-run)	89	0.1%	210	0.4%
Chinook salmon (spring-run)	-16	0.0%	9	0.0%
Steelhead	28	0.1%	66	0.3%
Sacramento splittail	13,460	1.1%	33,330	2.6%
Longfin smelt	92	0.1%	295	0.3%
Delta smelt (adults)	50	0.1%	113	0.3%
Delta smelt (juveniles)	1971	1.1%	4,493	2.4%
Green sturgeon	5	2.6%	12	5.6%
Results are annual averages based on a 1980–2003 baseline period.				

The main increased benefit of Alternative 3 would be the doubled outflow to the Delta that would occur in the fall of some years. This was not examined quantitatively but would be expected to push X2 farther downstream and result in a larger population of juvenile delta smelt the following summer, according to the relationship between fall X2 position and trawl abundance indices presented in Appendix B. The nonlinear nature of the relationship means that the increase in abundance would not be twice that of the Project, which suggested an average increase of 1.2% (See section above on Changes in Fish Population Abundance and Survival Caused by Shifts in X2).

No-Project Alternative

Under the No-Project Alternative, the adverse effects of levee maintenance, discharge of agricultural drainage water, and unscreened agricultural diversions on the four Project islands would continue as represented by the baseline conditions, as would ongoing adverse effects of water diversions and facilities, including the south Delta export facilities and numerous agricultural diversions.

Ongoing actions under the ESA and CESA (for winter-run Chinook salmon, spring-run Chinook salmon, steelhead, delta smelt, longfin smelt, and green sturgeon) and an update of the Bay-Delta WQCP may address adverse effects under the No-Project Alternative. For example, the many measures outlined in the USFWS and NMFS OCAP BOs (Appendix B) aim to reduce the effects of the SWP and CVP facilities within and outside the Delta.

Section 4.6
Vegetation and Wetlands

Introduction

This section describes recent changes to the existing environmental conditions and regulatory setting of the Project area, summarizes the unchanged affected environment, and describes changed environmental effects related to vegetation and wetlands for the Project. This section contains a review and update of the 1995 DEIR/EIS vegetation and wetlands impact assessment, incorporated by reference in the 2001 FEIR. The vegetation and wetlands impacts of the Project were analyzed most recently in the 2001 FEIS, which also served as a basis for this analysis.

The 2001 FEIR and 2001 FEIS concluded that implementing Alternative 1 or 2 would result in losses of riparian and permanent pond habitats and of upland and agricultural habitats. Losses in acreages of these jurisdictional wetland habitat types on the Reservoir Islands would be offset by creation of similar vegetation types on the Habitat Islands as described in the Draft Habitat Management Plan (HMP); therefore, these losses were considered less than significant.

The HMP was developed to describe how the Habitat Islands will be managed to offset Project impacts on state-listed Threatened species, wintering waterfowl, and jurisdictional wetlands. Land management practices to benefit other wildlife species were also incorporated into the plan. The HMP was developed by DFG and Jones & Stokes, in consultation with the State Water Board and the Project applicant. Representatives from the California Waterfowl Association, Ducks Unlimited, and the Contra Costa County Fish and Wildlife Committee were also consulted to resolve technical issues. As outlined in the HMP, the HMP team designed island habitats, habitat juxtaposition, and habitat management criteria to achieve the following goal, which are listed and described below, in order of descending priority:

- **Compensation goals.** Compensate for Project impacts on species listed as Threatened or Endangered under the California Endangered Species Act; wintering waterfowl habitat; and jurisdictional wetlands, including riparian habitats. Compensation goals must be achieved to offset significant Project impacts.
- **Species goals.** Without compromising compensation goals, implement land management practices to provide the greatest benefit to upland wildlife species; enhance breeding habitat for waterfowl; roosting habitat for Greater

Sandhill Crane; nesting habitat for Swainson's hawk; and provide potential habitats for other special-status species. Species goals should be implemented to enhance overall wildlife values associated with compensation habitats.

- **Other important goals.** Implement best land management practices that do not detract from compensation and priority species goals to enhance habitat conditions for other important species or species groups; such as migratory shorebirds; nongame water birds; and species associated with riparian habitats.

Implementing the HMP under Alternative 1 or 2 would result in a beneficial increase in freshwater marsh and exotic marsh habitats and the beneficial cumulative impact of an increase in wetland and riparian habitats in the Delta.

Under Alternative 1, 2, or 3, construction of Project facilities (e.g., siphon and pump stations or recreation facilities) and levee improvements on sites occupied by special-status plants could result in the loss of special-status plants; this was considered a significant impact. Avoidance measures were recommended to reduce this impact to a less-than-significant level.

Under Alternative 3, the loss of jurisdictional wetlands on Reservoir Islands, including riparian, marsh, and pond habitats, were considered a significant impact. Although a limited amount of habitat would be created in the NBHA to partially offset this impact, the Project applicant would need to develop and implement an offsite mitigation plan to reduce this impact to a less-than-significant level.

Under the No- Project Alternative, impacts would result primarily from conversion of fallow, herbaceous upland, riparian, and wetland habitats to agricultural use. In contrast to implementing any of the Project alternatives, implementing the No-Project Alternative would decrease the diversity of vegetation types on the four Project islands. Implementing the No-Project Alternative would not result in direct disturbance of special-status plants from construction of facilities as described for the Project alternatives. However, as increasing land subsidence rates and flood risks become critical to levee stability over time, improvements to perimeter levees under the No-Project Alternative could adversely affect known populations of plants.

Summary of Impacts

Table 4.6-1 provides a summary and comparison of the impacts and mitigation measures for vegetation and wetlands from the 2001 FEIR, 2001 FEIS, and this Place of Use EIR.

Table 4.6-1. Comparison between Delta Wetlands Project 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures for Vegetation and Wetlands

2001 FEIS and 2001 FEIR Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
ALTERNATIVES 1 AND 2	
Impact G-1: Increase in Freshwater Marsh and Exotic Marsh Habitats (B) **Mitigation:** No mitigation is required.	**Impact VEG-1:** Increase in Freshwater Marsh and Exotic Marsh Habitats (B and LTS) **Mitigation:** No mitigation is required.
Impact G-2: Loss of Riparian and Permanent Pond Habitats (LTS) **Mitigation:** No mitigation is required.	**Impact VEG-2:** Loss of Riparian and Permanent Pond Habitats (LTS) **Mitigation:** No mitigation is required.
Impact G-3: Loss of Upland and Agricultural Habitats (LTS) **Mitigation:** No mitigation is required.	**Impact VEG-3:** Loss of Upland and Agricultural Habitats (LTS) **Mitigation:** No mitigation is required.
	Impact VEG-4: Consistency with Local Policies or Ordinances Protecting Biological Resources (NI) **Mitigation:** No mitigation is required.
	Impact VEG-5: Conflict with Provisions of an Adopted HCP/NCCP (NI) **Mitigation:** No mitigation is required.
	Impact VEG-6: Introduction and Spread of Invasive Plants (LTS) **Mitigation:** No mitigation is required.
Impact G-4: Loss of Special-Status Plants (LTS-M) **Mitigation Measure G-1:** Site Project Facilities to Avoid Special-Status Plant Populations **Mitigation Measure G-2:** Protect Special- Status Plant Populations from Construction and Recreational Activities **Mitigation Measure G-3:** Develop and Implement a Special-Status Plant Species Mitigation Plan	**Impact VEG-7:** Loss of Special-Status Plants (LTS-M) **Mitigation Measure VEG-MM-1:** Site Project Facilities to Avoid Special-Status Plant Populations **Mitigation Measure VEG-MM-2:** Protect Special-Status Plant Populations from Construction and Recreation Activities **Mitigation Measure VEG-MM-3:** Develop and Implement a Special-Status Plant Species Monitoring and Mitigation Plan
ALTERNATIVE 3	
Impact G-1: Increase in Freshwater Marsh and Exotic Marsh Habitats (B) **Mitigation:** No mitigation is required.	**Impact VEG-1:** Increase in Freshwater Marsh and Exotic Marsh Habitats (B and LTS) **Mitigation:** No mitigation is required.
Impact G-2: Loss of Riparian and Permanent Pond Habitats (LTS) **Mitigation:** No mitigation is required.	**Impact VEG-2:** Loss of Riparian and Permanent Pond Habitats (LTS) **Mitigation:** No mitigation is required.
Impact G-3: Loss of Upland and Agricultural Habitats (LTS) **Mitigation:** No mitigation is required.	**Impact VEG-3:** Loss of Upland and Agricultural Habitats (LTS) **Mitigation:** No mitigation is required.
	Impact VEG-4: Consistency with Local Policies or Ordinances Protecting Biological Resources (NI) **Mitigation:** No mitigation is required.
Impact G-5: Loss of Jurisdictional Wetlands on Reservoir Islands (LTS-M) **Mitigation Measure G-4:** Develop and Implement an Offsite Mitigation Plan	**Impact VEG-8:** Loss of Jurisdictional Wetlands on Reservoir Islands (LTS-M) **Mitigation Measure VEG-MM-4:** Develop and Implement an Off-Site Mitigation Plan

2001 FEIS and 2001 FEIR Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
Impact G-6: Loss of Special-Status Plants (LTS-M) **Mitigation Measure G-1:** Site Project Facilities to Avoid Special-Status Plant Populations **Mitigation Measure G-2:** Protect Special- Status Plant Populations from Construction and Recreational Activities **Mitigation Measure G-3:** Develop and Implement a Special-Status Plant Species Mitigation Plan	**Impact VEG-7:** Loss of Special-Status Plants (LTS-M) **Mitigation Measure VEG-MM-1:** Site Project Facilities to Avoid Special-Status Plant Populations **Mitigation Measure VEG-MM-2:** Protect Special-Status Plant Populations from Construction and Recreation Activities **Mitigation Measure VEG-MM-3:** Develop and Implement a Special-Status Plant Species Monitoring and Mitigation Plan

Note: SU = Significant and unavoidable; LTS = Less than significant; LTS-M = Less than significant with mitigation; B = Beneficial; NI = No impact.

Summary of Changes, New Circumstances, and New Information

There have been a variety of changes and new information, but this has not resulted in a substantial increase in the severity of previously identified effects on vegetation and wetlands. Specifically these changes include:

- An increase in the amount of emergent marsh habitat that is used as grazed land on Holland Tract due to temporary fallowing;
- New information on special-status plants in the Delta; and
- New information on invasive species and their control.

A new impact has been identified for invasive species and their control to ensure this resource topic is addressed during Project implementation. A substantial increase in the severity of impacts is not anticipated because an updated final HMP is still expected to mitigate Project effects.

Substantial Changes

Since the 2001 FEIR and 2001 FEIS were completed, there have been no substantial changes in the Project resulting in new significant effects or substantial increase in the severity of effects on vegetation and wetlands. The environmental setting remains nearly identical to the previous document though there has been an increase in the amount of emergent marsh habitat that is used as grazed land on Holland Tract due to temporary fallowing. This is described within this chapter.

New Circumstances

Since the 2001 FEIR and 2001 FEIS were completed, there have been no substantial new circumstances resulting in new significant effects or substantial increase in the severity of effects on vegetation and wetlands. The circumstances surrounding the Project are similar to the previous document, though there have been some regulatory changes, a new tree ordinance and the development of several nearby Habitat Conservation Plans.

New Information

Changes to the existing conditions have occurred since the 2001 FEIR and 2001 FEIS .While information in the 2001 FEIR and 2001 FEIS was current at that time, several changes in agricultural land use and corresponding vegetation conditions have occurred in the years since. Subsequent field survey efforts were completed in 2001, 2002, and 2008 for jurisdictional wetlands, special-status plants, and invasive species. The type and amounts of jurisdictional wetlands have been delineated and verified by the Corps on all the islands since the 2001 FEIR and 2001 FEIS.

Additionally, special-status plant occurrences have been identified on the water side of island levees, and on the interior of Webb Tract. The types and distribution of crops and distribution of wetlands on the islands have changed, with the largest change occurring on Holland Tract.

New information available since the 2001 FEIR and 2001 FEIS includes changes to the land use on Holland Tract and a subsequent increase in the amount of emergent marsh habitat that is used as grazed land; new information on special status plants in the Delta, and new information on invasive species and their control.

Affected Environment

This section discusses changes in the existing conditions or regulatory setting since the 2001 FEIR and 2001 FEIS and describes the vegetation and wetland resources on the four Project islands. This section is based on information gathered for the 1995 DEIR/EIS, the 2001 FEIR and 2001 FEIS, and supplemental survey efforts completed since 2001. Several changes in agricultural land use and vegetation conditions on the islands have occurred as a result of land management decisions (primarily decisions made in anticipation of Project implementation) since 2001. A detailed description of the methods used to identify baseline conditions and the results of vegetation and wetland studies were presented in the 2001 FEIR and 2001 FEIS in the "Vegetation and Wetlands" analysis, and Appendices G1–G5 of the 2001 FEIS. This section summarizes previous methods and provides a summary of updated methods, where relevant, for vegetation and wetland resources.

Sources of Information

Information regarding vegetation types (hereafter referred to as habitat types for the purposes of this section) on the Project islands was collected in 1988 using a combination of aerial photograph interpretation and verification of mapped habitat types during field surveys (see Chapter 3G and Table 3G-3 in the 2001 FEIS). Additional field surveys were completed by Jones & Stokes in 2001 and 2008, and updated habitat mapping was completed in 2008. Special-status plant populations on the Project islands were documented during botanical surveys conducted in April and August–September 1988 and in August 1994 (see Chapter 3G and Table 3G-2 in the 2001 FEIS). Additional surveys for special-status plants were completed in 2002 by DWR (California Department of Water Resources 2003). Information pertaining to wetlands on the Project islands initially was collected during the 1994 wetland delineation conducted by the Natural Resources Conservation Service (NRCS), Corps, EPA, and USFWS (see Chapter 3G and Appendix G5 in the 2001 FEIS) and later was updated by Jones & Stokes (Jones & Stokes 2001) and verified by the Corps in 2002. Jones & Stokes completed additional wetland mapping in 2008 using a combination of aerial photograph interpretation and field survey.

The key sources of data and information used to assess changes in the environmental setting following the publication of the 2001 FEIR and 2001 FEIS that pertain to vegetation and wetlands are listed below.

- A California Natural Diversity Database (CNDDB) records search for the Jersey Island, Bouldin Island, Birds Landing, Rio Vista, Isleton, Thornton, Antioch North, Antioch South, Terminous, Brentwood, Woodward Island, and Holt U.S. Geological Survey (USGS) 7.5-minute quadrangles (California Natural Diversity Database 2008).
- The California Native Plant Society (CNPS) 2008 online *Inventory of Rare and Endangered Plants of California* (California Native Plant Society 2008).
- A USFWS list (dated July 15, 2008) of Endangered, Threatened, and candidate plant species for the Jersey Island and Bouldin Island USGS 7.5-minute quadrangles and San Joaquin and Contra Costa Counties (U.S. Fish and Wildlife Service 2008).
- Preliminary Delineation of Waters of the United States for the Delta Wetlands Project (Jones & Stokes 2001: 27–30).
- U.S. Army Corps of Engineers Verification Letter 190109804 issuing a jurisdictional determination for the Delta Wetlands Project (U.S. Army Corps of Engineers 2002)
- The San Joaquin County Multi Species Habitat Conservation and Open Space Plan (SJMSCP) (San Joaquin Council of Governments 2000: 2-16–2-32).
- The Contra Costa County General Plan (Contra Costa County 2005: 8-12–8-16).

- The Sacramento/San Joaquin Delta Wildlife Habitat Protection & Restoration Plan (Madrone & Associates 1980: 8-23–8-31)
- Jones & Stokes file information.

Regulatory Setting

The following section describes the regulations affecting vegetation and wetlands relative to the Project.

Federal

Endangered Species Act

The federal Endangered Species Act (ESA) protects fish and wildlife species, and their habitats identified by the USFWS and NMFS as Threatened or Endangered. *Endangered* refers to species, subspecies, or distinct population segments that are in danger of extinction through all or a significant portion of their range; *Threatened* refers to species, subspecies, or distinct population segments are likely to become endangered in the near future. The ESA is administered by the USFWS and NMFS. In general, NMFS is responsible for protection of ESA-listed marine species and anadromous fishes, whereas other listed species are under USFWS jurisdiction.

Endangered Species Act Prohibitions (Section 9)

Section 9 of ESA prohibits the take of any fish or wildlife species listed under ESA as endangered. Take of Threatened species is also prohibited under Section 9, unless otherwise authorized by federal regulations. *Take*, as defined by ESA, means “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.” (Section 3 of the ESA; 16 USC Section 1532(19). *Harm* is defined by regulation as “any act that kills or injures the species, including significant habitat modification.” (50 CFR Sections 17.3; 222.102). In addition, Section 9 prohibits removing, digging up, cutting, and maliciously damaging or destroying federally listed plants on sites under federal jurisdiction. Section 9 does not prohibit take of federally listed plants on sites not under federal jurisdiction. If the Project may result in take prohibited by Section 9, this take would need to be authorized through ESA Sections 7 or 10 (providing for the issuance of “incidental take” permits).

For plants listed as endangered under the ESA, Section 9(a)(2) prohibits their import or export from the United States. Section 9(a)(2) also prohibits acts to remove, cut, dig up, damage, or destroy an endangered plant species in nonfederal areas in knowing violation of any state law or in the course of criminal trespass. Candidate species and species that are proposed, or under petition for listing, receive no protection under Section 9.

Endangered Species Act Consultation Process (Section 7)

Section 7 of the ESA mandates that all federal agencies consult with USFWS, and NMFS if they determine that a proposed project may affect a listed species or its habitat. The purpose of consultation with USFWS and NMFS is to ensure that the federal agencies' actions do not jeopardize the continued existence of a listed species or destroy or adversely modify critical habitat for listed species.

If a proposed project "may affect" a listed species or designated critical habitat, the lead agency is required to prepare a BA evaluating the nature and severity of the expected effect. The BA is prepared for the proposed action, and is submitted to USFWS and/or NMFS to initiate consultation. In response to a BA, USFWS and/or NMFS issues a BO, with a determination that the proposed action either:

- may jeopardize the continued existence of one or more listed species (jeopardy finding) or result in the destruction or adverse modification of critical habitat (adverse modification finding) or
- will not jeopardize the continued existence of any listed species (no jeopardy finding) or result in adverse modification of critical habitat (no adverse modification finding).

The BO issued by USFWS and/or NMFS may stipulate discretionary "reasonable and prudent" conservation measures. If the proposed action would not jeopardize a listed species, USFWS and/or NMFS may issue an incidental take statement to authorize the proposed activity and may include appropriate measures to offset the impacts of take.

Past Project ESA Compliance

In 1997, the USFWS and NMFS issued no-jeopardy BOs regarding effects of the Project on federally listed fish and wildlife species. No federally listed plants were addressed in the BO because none were present.

Clean Water Act

The CWA was enacted as an amendment to the federal Water Pollution Control Act of 1972, which outlined the basic structure for regulating discharges of pollutants to waters of the United States. The CWA serves as the primary federal law protecting the quality of the nation's surface waters, including lakes, rivers, and coastal wetlands.

The CWA empowers the EPA to set national water quality standards and effluent limitations and includes programs addressing both *point-source* and *nonpoint-source* pollution. Point-source pollution is pollution that originates or enters surface waters at a single, discrete location, such as an outfall structure or an excavation or construction site. Nonpoint-source pollution originates over a broader area and includes urban contaminants in stormwater runoff and sediment loading from upstream areas. The CWA operates on the principle that all discharges into the nation's waters are unlawful unless specifically authorized by a permit; permit review is the CWA's primary regulatory tool. The following sections provide details on specific sections of the CWA.

Permits for Fill Placement in Waters and Wetlands (Section 404)

CWA Section 404 regulates the discharge of dredged and fill materials into waters of the United States. *Waters of the United States* refers to oceans, bays, rivers, streams, lakes, ponds, and wetlands, including any or all of the following:

- areas within the ordinary high water mark of a stream, including nonperennial streams with a defined bed and bank and any stream channel that conveys natural runoff, even if it has been realigned; and
- seasonal and perennial wetlands, including coastal wetlands.

On January 9, 2001, the U.S. Supreme Court ruled in *Solid Waste Agency of Northern Cook County v. United States Army Corps of Engineers* (SWANCC) (121 S.CT. 675, 2001) that the Corps no longer has jurisdiction or regulates isolated wetlands (i.e., wetlands that have no hydrologic connection with waters of the United States).

Applicants must obtain a permit from the Corps for all discharges of dredged or fill material into waters of the United States, including adjacent wetlands, before proceeding with a proposed activity. The Corps may issue either an individual permit evaluated on a case-by-case basis or a general permit evaluated at a program level for a series of related activities.

Compliance with CWA Section 404 requires compliance with several other environmental laws and regulations. The Corps cannot issue an individual permit or verify the use of a general permit until the requirements of NEPA, the ESA, and the NHPA have been met. In addition, the Corps cannot issue or verify any permit until a water quality certification or a waiver of certification has been issued by the state pursuant to CWA Section 401.

Wetland Delineations on Agricultural Lands

In 1994, the Departments of Agriculture, Interior and Army and the EPA entered into a Memorandum of Agreement (MOA) to streamline the wetland delineation process on agricultural lands, to promote consistency between the CWA and the Food Security Act (FSA), and to provide predictability and simplification for U.S. Department of Agriculture (USDA) program participants. The 1994 MOA determined that the NRCS would be the lead agency for wetland delineations on agricultural lands and that delineations made by NRCS would be accepted for CWA purposes.

In January 2005, the NRCS and Corps withdrew from the 1994 MOA. It was replaced by the "Joint Guidance on Conducting Wetland Delineations for the Food Security Act of 1985 and Section 404 of the Clean Water Act," issued February 25, 2005 (2005 MOA). Under the 2005 MOA, NRCS is responsible for wetland determinations for participants in USDA programs, and the Corps is responsible for wetland determinations for CWA purposes, and both will inform landowners that their determinations are not necessarily valid for both purposes.

Permits for Stormwater Discharge (Section 402)

CWA Section 402 regulates construction-related stormwater discharges to surface waters through the National Pollutant Discharge Elimination System (NPDES) program, administered by EPA. In California, the State Water Board is authorized by EPA to oversee the NPDES program through the RWQCBs (see the related discussion under "Porter-Cologne Water Quality Control Act" below). The Project area is under the jurisdiction of the Central Valley RWQCB.

NPDES permits are required for projects that disturb more than 1 acre of land. The NPDES permitting process requires the applicant to file a public notice of intent (NOI) to discharge stormwater and to prepare and implement a stormwater pollution prevention plan (SWPPP). The SWPPP includes a site map and a description of proposed construction activities. In addition, it describes the best management practices (BMPs) that would be implemented to prevent soil erosion and discharge of other construction-related pollutants (e.g., petroleum products, solvents, paints, cement) that could contaminate nearby water resources. Permittees are required to conduct annual monitoring and reporting to ensure that BMPs are implemented correctly and effective in controlling the discharge of stormwater-related pollutants.

Water Quality Certification (Section 401)

Under CWA Section 401, applicants for a federal license or permit to conduct activities that may result in the discharge of a pollutant into waters of the United States must obtain certification from the state in which the discharge would originate or, if appropriate, from the interstate water pollution control agency with jurisdiction over affected waters at the point where the discharge would originate. Therefore, all projects that have a federal component and may affect state water quality (including projects that require federal agency approval, such as issuance of a Section 404 permit) must also comply with CWA Section 401.

Rivers and Harbors Act Section 10

Section 10 of the Rivers and Harbors Act of 1899 requires authorization from the Corps for the construction of any structure in or over any navigable waters of the United States. Tidal waterways in the Delta are considered navigable waters. The law applies to any dredging, excavation, filling, or any other modification of a navigable water of the United States, as well as to all structures, including bank protection (e.g., riprap) and mooring structures, such as those in a marina. Structures or work outside the limits defined for navigable waters of the United States require a Section 10 permit if the structure or work affects the course, location, or condition of the water body.

Executive Order 11990: Protection of Wetlands

EO 11990, signed May 24, 1977, directs all federal agencies to refrain from assisting in or giving financial support to projects that encroach on publicly or privately owned wetlands. It further requires that federal agencies support a policy to minimize the destruction, loss, or degradation of wetlands. Such a project (that encroaches on wetlands) may not be undertaken unless the agency has determined that: (1) there are no practicable alternatives to such construction, (2) the project includes all practicable measures to minimize harm to wetlands that would be affected by the project, and (3) the impact will be minor.

Executive Order 13112: Prevention and Control of Invasive Species

EO 13112, signed February 3, 1999, directs all federal agencies to prevent and control introduction of invasive species in a cost-effective and environmentally sound manner. The EO established the National Invasive Species Council (NICS), which is composed of federal agencies and departments and a supporting Invasive Species Advisory Committee (ISAC) composed of state, local, and private entities. The NISC and ISAC prepared a national invasive species management plan (National Invasive Species Council 2001) that recommends objectives and measures to implement the EO and to prevent the introduction and spread of invasive species. The EO requires consideration of invasive species in NEPA analyses, including their identification and distribution, their potential impacts, and measures to prevent or eradicate them.

State

California Endangered Species Act

The California Endangered Species Act (CESA) prohibits the take of Endangered and Threatened species; however, habitat destruction is not included in the state's definition of *take* (CA Fish & Game Code Section 86; 2080). Section 2090 of CESA requires state agencies to comply with endangered species protection and recovery and to promote conservation of these species. DFG administers CESA and authorizes take (except for species designated as fully protected) through a variety of sections in the CA Fish & Game Code. Section 2080 of the act prohibits the take of Endangered and Threatened species, except as otherwise provided under Fish and Game Code Sections 2080.1 (if the species is listed under both ESA and CESA and take authorization has already been provided through the ESA, DFG can write a consistency determination where it determines that the avoidance, minimization, and compensation measures are consistent with the provisions of CESA), 2081(b) (where DFG makes findings that, among other things, the impacts of take are minimized and fully mitigated and that the take would not lead to jeopardy) and 2835 (as part of a Natural Communities Conservation Planning Act (NCCPA), where it has been covered under an approved Natural Communities Conservation Plan). Unlike its Federal counterpart, CESA also applies the take prohibitions to species petitioned for listing (state candidates). DFG can adopt a federal biological opinion as a state biological opinion under California Fish and Game Code, Section 2095. In the case of rare plant species, CESA defers to the California Native Plant Protection Act of 1977 (discussed below).

Past Project California Endangered Species Act Compliance

DFG issued a no-jeopardy opinion in 1998 on Project effects on state-listed fish and wildlife species. No state listed plant species were included in the permit because none were present; however, the permit did include measures to survey for special-status plants and avoid, minimize and mitigate effects should they occur.

California Native Plant Protection Act

California Fish and Game Code Sections 1900–1913, also known as the California Native Plant Protection Act (CNPPA) prohibits importation of rare and endangered plants into California, take of rare and endangered plants, and sale of rare and endangered plants. The CESA defers to the CNPPA, which ensures that state-listed plant species are protected when state agencies are involved in projects subject to CEQA. In this case, plants listed as rare under the California Native Plant Protection Act are not protected under CESA but rather under CEQA.

California Fish and Game Code

Under the California Fish and Game Code, the DFG provides protection from take for a variety of species. The DFG also protects streams, water bodies, and riparian corridors through the Streambed Alteration Agreement process under Sections 1601 to 1606 of the California Fish and Game Code. The Fish and Game Code states that it is “unlawful to substantially divert or obstruct the natural flow or substantially change the bed, channel or bank of any river, stream or lake” without notifying the DFG, incorporating necessary mitigation, and obtaining a Streambed Alteration Agreement. DFG’s jurisdiction extends to the top of banks and often includes the outer edge of riparian vegetation canopy cover.

Porter-Cologne Water Quality Control Act

Water Code Section 13260 requires “any person discharging waste, or proposing to discharge waste, in any region that could affect the waters of the state to file a report of discharge (an application for waste discharge requirements).” Under the Porter-Cologne definition, the term *waters of the state* is defined as “any surface water or groundwater, including saline waters, within the boundaries of the state.” Although all waters of the United States that are within the borders of California are also waters of the state, the converse is not true (i.e., in California, waters of the United States represent a subset of waters of the state). Thus, California retains authority to regulate discharges of waste into any waters of the state, regardless of whether the Corps has concurrent jurisdiction under Section 404.

Local

Bacon and Bouldin islands are located within San Joaquin County and Webb and Holland Tracts are located in Contra Costa County. The local regulations established by San Joaquin and Contra Costa Counties that pertain to the islands that fall within their respective boundaries are described below.

San Joaquin County Multi-Species Habitat and Open Space Conservation Plan

The SJMSCP was adopted in 2001 and covers all of San Joaquin County (available: www.sjcog.org). Permit holders under the SJMSCP include the county; the cities of Escalon, Lodi, Manteca, Stockton, Lathrop, Ripon, and Tracy; the SJCOG; and others. The SJMSCP is designed to provide a regional approach to mitigating development impacts on the 97 listed and non-listed plant, fish, and wildlife species covered by the SJMSCP and compensating for the conversion of open space to non–open space uses. The plan provides compensation for habitat losses through collection of fees that are used to preserve habitats elsewhere. However, the Project is not a covered activity and is not subject to the SJMSCP.

San Joaquin County Tree Ordinance

San Joaquin County’s natural resources regulations contain provisions to preserve county tree resources (San Joaquin County 2008). The removal of a native oak, heritage oak tree, or historical tree requires an approved improvement plan application (Chapter 9-1505.3), which requires replacement of the tree subject to requirements described in Chapter 9-1505.4. These provisions do not cover horticultural or orchard trees proposed for removal. Native oaks are defined as valley oaks with stem diameters of 15.2–81.3 centimeters (6–32 inches) for single-trunk trees and a minimum combined trunk diameter of 20.3 centimeters (8 inches) for multi-trunk trees and interior live oaks or blue oaks with stem diameters of 10.2–81.3 centimeters (4–32 inches) for single-trunk trees and a minimum combined diameter of 15.2 centimeters (6 inches) for multi-trunk trees. Heritage oaks are defined as native oaks with a single-trunk diameter of 81.3 centimeters (32 inches) or more (all stem diameters are measured 1.4 meters [4.5 feet] above the average ground elevation of the tree). Historical trees are defined as any trees or groups of trees given special recognition by the San Joaquin County Planning Commission because of size, age, location, or history. The Project is subject to the ordinance.

East Contra Costa County Habitat Conservation Plan/Natural Community Conservation Plan

The East Contra Costa County Habitat Conservation Plan/Natural Community Conservation Plan (ECCCHCP/NCCP) was adopted in January 2008. Permit holders under the ECCCHCP/NCCP include the County; the cities of Brentwood, Clayton, Oakley, and Pittsburg; and Contra Costa County Flood Control and Water Conservation District and the East Bay Regional Park District. The ECCCHCP/NCCP is designed to provide a regional approach to mitigating housing, transportation, and growth impacts on the 28 covered species. The plan provides compensation for habitat losses through collection of fees that are used to preserve and restore habitats and natural communities in the County as well as a framework to pursue other conservation efforts in the County. It does not include Delta lands and therefore does not affect the Project.

Contra Costa General Plan

The policies of the Contra Costa County General Plan most relevant to vegetation and wetlands on the Project islands are summarized below (Contra Costa County 2005: 8-15–16).

- Significant trees and natural vegetation shall generally be preserved.
- Areas determined to contain significant ecological resources, particularly those containing endangered species, shall be maintained in their natural state and carefully regulated to the maximum legal extent.
- Any development located or proposed within significant ecological resource area shall ensure the resource is protected.
- The county shall utilize performance criteria and standards which seek to regulate uses in and adjacent to significant ecological resources.
- Natural woodlands shall be preserved to the maximum extent possible in the course of land development.
- The critical ecological and scenic characteristics of rangelands, woodlands, and wildlands shall be recognized and protected.
- Existing vegetation, both native and nonnative, and wildlife habitat areas shall be maintained in the major open space areas sufficient for the maintenance of a healthy balance of wildlife populations.
- The ecological value of wetlands areas, especially the salt marshes and tidelands of the bay and delta, shall be recognized. Existing wetlands in the county shall be identified and regulated. Restoration of degraded wetland areas shall be encouraged and supported whenever possible.
- The planting of native trees and shrubs shall be encouraged in order to preserve the visual integrity of the landscape, provide habitat conditions suitable for native wildlife, and ensure that a maximum number and variety of well-adapted plants are sustained in urban areas.
- The county shall strive to identify and conserve remaining upland habitat areas that are adjacent to wetlands and are critical to the survival and nesting of wetland species.
- The county shall protect marshes, wetlands, and riparian corridors from the effects of potential industrial spills.

- Efforts shall be made to identify and protect the county's mature native oak, bay, and buckeye trees.

Contra Costa County Tree Protection and Preservation Ordinance

The main components of the Contra Costa County Tree Protection and Preservation Ordinance are summarized below (Contra Costa County 2008).

- A tree permit is required for the removal of 6.5-inch diameter at breast height (dbh) oak trees in or adjacent to riparian, foothill woodland, or oak savanna areas or those that form part of a stand of four or more trees.
- A tree permit is required to trench, grade, fill within the dripline of protected oak trees, or use fencing. Accidental destruction of the tree mandates replacement with an equivalent tree.
- Trees designated as heritage trees may not be removed without a permit issued if the tree is a nuisance. Special construction techniques are required within 12 feet of the trunk or within the dripline.

Environmental Setting

Nineteen habitat types in seven major categories were designated in a classification scheme designed specifically for the Project islands (Table 4.6-2). Habitat types as described in the 2001 FEIR and 2001 FEIS were mapped on the Project islands in December 1987. These same habitat types were used in the 2008 habitat update.

Table 4.6-2. Classification of Habitat Types on the Project Islands

Habitat Group	Code	Habitat Type	Comments	Dominant or Typical Plant Species
Riparian	R1	Cottonwood-willow woodland	Cottonwood and willow trees	Fremont cottonwood, red willow, yellow willow
	R2	Great Valley willow scrub	Willow shrubs and trees	Red willow, yellow willow, sandbar willow, Goodding's willow
Marsh	M1	Freshwater marsh	Inside islands	Cattail, bulrush, yellow nutsedge, pondweed, buttonbush
	M3	Exotic marsh[a]	Dense upland and wetland weeds (sometimes dry in summer)	Annual smartweed, peppergrass, amaranth, wild radish, nettles, cocklebur, watergrass
Herbaceous Upland	H1	Annual grassland	True uplands and sand hill	Wild oats, barley, rip-gut brome, Italian rye-grass, legumes
	H2	Exotic perennial grassland[a]	Mixed weeds in fields and on levee slope	Bermuda grass, perennial ryegrass, Johnson grass

Habitat Group	Code	Habitat Type	Comments	Dominant or Typical Plant Species
Agriculture	A1	Grain and seed crops		Corn, wheat, sunflowers, potatoes
	A2	Perennial crops		Asparagus, vineyards
	A3	Pasture	Permanently grazed	Tall fescue, orchard grass, canary grass, ryegrass, legumes
	A4	Waterfowl food crops	Managed wetlands	Smartweed, watergrass, bulrush
	A5	Fallow	Short-term fallow fields	Yellow star-thistle, Russian thistle, houseweed, lamb's quarter, telegraph weed
Open Water	O1	Canals and ditches	Permanent water	Dallis grass, knot grass, Himalayan blackberry, smartweed
	O2	Permanent ponds	Still water	Water hyacinth, water primrose, azolla
Developed	D1	Structures	Buildings and marinas	Largely unvegetated
	D2	Paving and exposed earth	Roads, landfills, and unvegetated exposed areas	Largely unvegetated

[a] Exotic habitats are dominated by weedy plant species that are not native to the Delta. On Holland Tract these areas are sometimes synonymous with the agricultural category pasture.

Table 4.6-3. Special-Status Plants Identified as Potentially Occurring on the Project Islands

Common and Scientific Name[a]	Legal Status[b] Federal/State/ CNPS	Geographic Distribution/Floristic Province	Habitat Requirements	Blooming Period	Likelihood of Occurrence
Bristly sedge *Carex comosa*	–/–/2.1	Inner North Coast Ranges, High Cascade Range, Central Valley, northern Central Coast, San Francisco Bay, San Bernardino mountains, Modoc Plateau	Coastal prairie, marshes and swamps (lake margins), valley and foothill grassland; below 625 meters (2,050 feet)	May–Sep	Known to occur in the blowout ponds on the northern side of Webb Tract.
Brown fox sedge *Carex vulpinoidea*	–/–/2.2	Scattered occurrences from Siskiyou to Los Angeles Counties.	Freshwater marshes and swamps, riparian woodland; 30–1,200 meters (98–3,937 feet)	May–Jun	Known to occur on the western shore of Bacon Island.
Slough thistle *Cirsium crassicaule*	–/–/1B.1	Known from the Delta and San Joaquin Valley in Kings, Kern, San Joaquin Counties	Shallow water or saturated soils in chenopod scrub, marshes, swamps, and riparian scrub; 3–100 meters`	May–Aug	Not known to occur in the Project area
Hoover's Cryptantha *Cryptantha hooveri*	–/–/1A	Known historically from Alameda, Contra Costa, Madera, Merced, San Joaquin, and Stanislaus Counties	Inland dunes, sandy soils in valley and foothill grassland; 9–150 meters (29–492 feet)	Apr–May	Not known to occur in the Project area
Contra Costa wallflower *Erysimum capitatum* var. *angustatum*	E/E/1B.1	Known only from Contra Costa County	Inland dunes; 3–20 meters (10–66 feet)	Mar–Jul	Not known to occur in the Project area.
Delta button-celery *Eryngium racemosum*	–/E/1B.1	Northern San Joaquin Valley, adjacent Sierra Nevada foothills	Riparian scrub in vernally mesic clay depressions; 3–30 meters	Jun–Sep	Not known to occur in the Project area.
Bogg's Lake hedge-hyssop *Gratiola heterosepala*	–/–/1B.1	Inner North Coast Ranges, central Sierra Nevada foothills, Sacramento Valley, Modoc Plateau, and elsewhere.	Shallow water along the margins of lakes, marshes, swamps, and vernal pools; 10–2,375 meters	Apr–Aug	Not known to occur in the Project area
Rose mallow *Hibiscus lasiocarpus*	–/–/2.2	Central and southern Sacramento Valley, deltaic Central Valley, and elsewhere in the U.S.	Freshwater marshes and swamps; below 120 meters (394 feet)	Jun–Sep	Known to occur on the shores of all Project islands
Delta tule pea *Lathyrus jepsonii* var. *jepsonii*	–/–/1B.2	Central Valley, San Francisco Bay	Freshwater and brackish marshes and swamps; below 4 meters (13 feet)	May–Jul (uncommonly Sep)	Known to occur near Webb and Holland Tracts

Common and Scientific Name[a]	Legal Status[b] Federal/State/ CNPS	Geographic Distribution/Floristic Province	Habitat Requirements	Blooming Period	Likelihood of Occurrence
Marsh pea *Lathyrus palustrus*	–/–/2.2	Scant within widespread range throughout lowland and montane California	Freshwater marsh		Not known to occur in the Project area.
Mason's lilaeopsis *Lilaeopsis masonii*	–/R/1B.1	Southern Sacramento Valley, northeastern San Francisco Bay	Riparian scrub, brackish or freshwater marshes and swamps; below 10 meters (33 feet)	Apr–Nov	Known to occur on the shores of all Project islands
Delta mudwort *Limosella subulata*	–/–/2.1	Deltaic Central Valley with occurrences in Contra Costa, Sacramento, San Joaquin, and Solano Counties; Oregon	Marshes and swamps; below 3 meters (10 feet)	May–Aug	Known to occur on the shores of all Project islands
Antioch Dunes evening-primrose *Oenothera deltoides* ssp. *howellii*	E/E/1B.1	Known from three native occurrences in northeastern San Francisco Bay	Inland dunes; below 30 meters (98 feet)	Mar–Sep	Not known to occur in the Project area.
Eel-grass pondweed *Potamogeton zosteriformis*	–/–/2.2	Southern Inner North Coast Ranges, Central Valley, Modoc Plateau; Idaho, Oregon, Utah, Washington	Assorted freshwater marshes and swamps; below 1,860 meters (6,102 feet)	Jun–Jul	Known to occur in the vicinity of Webb Tract.
Tall woolly marbles *Psilocarphus brevissimus* var. *globiferus* (also known as *Psilocarphus tenellus* var. *globiferus*)	–/–/–	In San Francisco Bay and the Sacramento–San Joaquin Delta	Vernal pools and other seasonal wetlands 0–100 meters	Apr–May	No longer listed as a special-status plant.
Sanford's arrowhead *Sagittaria sanfordii*	–/–/1B.2	Scattered locations in Central Valley and Coast Ranges	Freshwater marshes, sloughs, canals, and other slow-moving water habitats; below 650 meters (2,132 feet)	May–Oct	Not known to occur in the Project area.
Marsh skullcap *Scutellaria galericulata*	–/–/2.2	Northern High Sierra Nevada, Modoc Plateau; Oregon	Lower montane coniferous forest, mesic meadows and seeps, marshes and swamps; below 2,100 meters (6,890 feet)	Jun–Sep	Not known to occur in the Project area.

Common and Scientific Name[a]	Legal Status[b] Federal/State/ CNPS	Geographic Distribution/Floristic Province	Habitat Requirements	Blooming Period	Likelihood of Occurrence
Side-flowering skullcap *Scutellaria lateriflora*	–/–/2.2	Northern San Joaquin Valley, east of Sierra Nevada; New Mexico, Oregon	Mesic meadows and seeps, marshes and swamps; below 500 meters (1,640 feet)	Jul–Sep	Known to occur in the vicinity of Bouldin Island
Suisun Marsh aster *Symphyotrichum lentum* (formerly *Aster lentus*)	–/–/1B.2	Sacramento Valley, Central Coast, San Francisco Bay	Brackish and freshwater marshes and swamps; below 3 meters (10 feet)	May–Nov	Known to occur on the shores of all Project islands.

Notes:

[a] Species indicated in bold were identified in the 2001 FEIS Table 3G-1 as having the potential to occur on the Project islands.

[b] Status explanations:

Federal

E = listed as endangered under the federal Endangered Species Act.

– = no listing.

State

E = listed as endangered under the California Endangered Species Act.

R = listed as rare under the California Native Plant Protection Act (this category is no longer used for newly listed plants, but some plants previously listed as rare retain this designation)

– = no listing.

California Native Plant Society (CNPS)

1A = List 1A species; presumed extinct in California

1B = List 1B species; Rare, Threatened, or Endangered in California and elsewhere.

2 = List 2 species; Rare, Threatened, or Endangered in California but more common elsewhere.

0.1 = seriously endangered in California.

0.2 = fairly endangered in California.

0.3 = not very endangered in California.

* = known populations believed extirpated from that County

– = no listing.

Table 4.6-4. Comparison of Waters of the United States, Including Wetlands, Identified for the 1994 and 2001 Delineations and Preliminary 2008 Delineation

Island Name	Habitat Classification	Delineated Acreage (1994)	Delineated Acreage (2001)	Preliminary Delineated Acreage[1] (2008)	Change Since 2001 FEIS
Bacon Island	Freshwater marsh	1.0	22.37	41.37	19
	Exotic marsh	2.0	42.64	10.94	-31.70
	Cottonwood-willow woodland	0.0	5.06	5.26	0.20
	Great Valley willow scrub	2.4	1.39	0.3	-1.09
	Tidal marsh	0.0	0.76	0.76	0.00
	Total wetlands	**5.4**	**72.22**	**58.63**	**-13.59**
	Canals and ditches	17.8	23.42	42.37	18.95
	Permanent ponds	0.8	0.21	0	-0.21
	Delta channel	0.0	3.14	3.14	0
	Total other waters	**18.6**	**26.77**	**45.51**	**18.74**
Bouldin Island	Freshwater marsh	16.5	70.45	74.25	3.80
	Exotic marsh	65.3	38.25	46.81	8.56
	Cottonwood-willow woodland	6.9	2.01	2.27	0.26
	Great Valley willow scrub	7.9	7.46	8.26	0.80
	Tidal marsh	0.0	0.01	0.01	0
	Total wetlands	**96.6**	**118.18**	**131.6**	**13.42**
	Canals and ditches	35.3	30.18	38.94	8.76
	Permanent ponds	0.0	1.01	10.25	9.24
	Delta channel	0.0	0.07	0.07	0
	Total other waters	**35.3**	**31.26**	**49.26**	**18.00**
Holland Tract	Freshwater marsh	13.9	58.97	84.11	25.14
	Exotic marsh (i.e., pasture)	12.9	60.47	1,506.81	1,446.34
	Cottonwood-willow woodland	67.7	75.03	107.67	32.64
	Great Valley willow scrub	14.3	7.76	16.03	8.27
	Tidal marsh	0.0	0.01	0.01	0
	Total wetlands	**108.8**	**202.24**	**1,714.63**	**1,512.39**
	Canals and ditches	21.8	15.29	21.16	5.87
	Permanent ponds	13.2	9.81	14.87	5.06
	Delta channel	0.0	0.05	0.05	0
	Total other waters	**35.0**	**25.15**	**36.08**	**10.93**
Webb Tract	Freshwater marsh	24.7	47.90	51.37	3.47
	Exotic marsh	66.9	59.60	55.29	-4.31
	Cottonwood-willow woodland	47.5	95.25	106.63	11.38
	Great Valley willow scrub	56.2	64.58	68.81	4.23
	Tidal marsh	0.0	0.15	0.15	0
	Total wetlands	**195.3**	**267.48**	**105.8**	**-11.37**
	Canals and ditches	19.7	29.44	27.21	-2.23

Island Name	Habitat Classification	Delineated Acreage (1994)	Delineated Acreage (2001)	Preliminary Delineated Acreage[1] (2008)	Change Since 2001 FEIS
	Permanent ponds	97.1	84.49	75.35	-9.14
	Delta channel	0.0	3.24	3.24	0
	Total other waters	**116.8**	**117.17**	**105.8**	**-11.37**
All Islands	Freshwater marsh	56.1	199.69	251.1	51.41
	Exotic marsh	147.1	200.96	1,619.85	1,418.89
	Cottonwood-willow woodland	122.1	177.35	221.83	44.48
	Great Valley willow scrub	80.8	81.19	93.4	12.21
	Tidal marsh	0.0	0.93	0.93	0
	Total wetlands	**406.1**	**660.12**	**2,187.11**	**1,526.99**
	Canals and ditches	94.6	98.33	129.68	31.35
	Permanent ponds	111.1	95.52	100.47	4.95
	Delta channel	0.0	6.50	6.50	0
	Total other waters	**205.7**	**200.35**	**236.65**	**36.30**
Total Waters of the United States		**762.7**	**860.47**		

[1] Acreages have not been verified by the U.S. Army Corps of Engineers.

Changes since the 2001 FEIR and 2001 FEIS

Changes have occurred on the Project islands, and several new sources of information have become available since the publication of the 2001 FEIR and 2001 FEIS.

Changes that pertain to vegetation and wetlands on the Project islands since the publication of the 2001 FEIR and 2001 FEIS can be summarized as:

- changes in habitat types associated with agriculture;
- updates to the list of special-status species with the potential to occur or known to occur on and near the Project islands;
- updates to wetland types and acreages on the Project islands;
- publication of a national invasive species management plan; and
- adoption of local regulations (e.g., general plans, tree ordinances, habitat conservation plans).

DWR completed surveys for special-status plants on all the islands in 2002, and Jones & Stokes completed a wetland delineation that was verified by the Corps in 2002 and additional wetland and habitat mapping in 2008.

Habitat Types

Although overall land use on most of the Project islands has not changed dramatically since the 2001 FEIR and 2001 FEIS, annual fluctuations in agricultural market conditions as well as land management decisions made in anticipation of Project implementation have resulted in changes to the composition of crop types on each of the Project islands. The crop history of the Project islands from 2002 to 2008 is provided in Table 4.6-5 (Delta Wetlands Properties 2008a, 2008b, 2008c, 2008d). Changes in the composition of agricultural lands attributable to fluctuations in market conditions also have resulted in changes to specific habitat types. The current (2008) habitat types on each of the islands, including the current agricultural crop types, are provided in Table 4.6-5. Generally, this information indicates that there has been a significant shift to corn as the primary agricultural crop on three of the islands, and the fourth island (Holland Tract) has been managed as grazing land since 2002. Wetland habitat types and acreages also have changed on each of the islands, with intensively cultivated lands now being used as grazing lands, a change in management that resulted in portions of the area becoming exotic marsh habitat on Holland Tract.

Table 4.6-5. Crop History for Bouldin Island, Webb Tract, Holland Tract, and Bacon Island (Acres)

Crop	2008	2007	2006	2005	2004	2003	2002
Bouldin Island							
Corn	4,002.0	4,063.0	3,264.0	3,041.0	3,036.0	3,010.0	3,531.0
Wheat	–	–	1,013.0	1,251.0	1,239.0	1,488.0	1,048.0
Rice	623.0	620.0	488.0	488.0	488.0	285.0	235.0
Tomatoes	308.0	250.0	168.0	150.0	170.0	150.0	119.0
Fallow	–	–	–	–	–	–	–
Subtotal	**4,933.0**	**4,933.0**	**4,933.0**	**4,930.0**	**4,933.0**	**4,933.0**	**4,933.0**
Webb Tract							
Corn	4,000.0	4,000.0	3,163.0	3,282.0	3,135.0	3,282.0	3,135.0
Wheat	–	–	924.0	807.0	955.0	807.0	955.0
Fallow	87.0	87.0	–	–	–	–	–
Subtotal	**4,087.0**	**4,087.0**	**4,087.0**	**4,089.0**	**4,090.0**	**4,089.0**	**4,090.0**
Holland Tract							
Pasture	2,884.0	2,884.0	2,884.0	2,884.0	2,884.0	2,884.0	2,884.0
Fallow	–	–	–	–	–	–	–
Subtotal	**2,884.0**	**2,884.0**	**2,884.0**	**2,884.0**	**2,884.0**	**2,884.0**	**2,884.0**
Bacon Island							
Corn	1,913.8	3,040.0	607.0	2,008.0	2,758.0	1,720.0	1,788.0
Wheat	577.5	–	–	–	865.0	69.0	308.0
Sunflowers	373.6	–	1,413.0	1,798.0	911.0	1,115.0	1,373.0
Safflower	–	–	935.0	–	–	1,014.0	450.0
Garbanzos	–	–	–	–	–	–	93.0
Alfalfa	1,786.7	1,807.0	1,892.0	1,054.0	237.0	154.0	60.0
Oats	207.4	–	–	–	–	–	–
Milo	–	–	–	–	79.0	–	–
Potatoes	–	–	–	–	–	570.0	570.0
Asparagus	–	–	–	–	–	218.0	218.0
Fallow	14.0	26.0	26.0	13.0	23.0	13.0	13.0
Subtotal	**4,873.0**	**4,873.0**	**4,873.0**	**4,873.0**	**4,873.0**	**4,873.0**	**4,873.0**
Total	**16,777.0**	**16,777.0**	**16,777.0**	**16,776.0**	**16,780.0**	**16,779.0**	**16,780.0**

Special-Status Species

Special-status plant species are those that are legally protected under the CESA, ESA, or other regulations, as well as species considered sufficiently rare by the scientific community to qualify for such listing. For the purposes of this EIR, special-status plant species include:

- species listed or proposed for listing as Threatened or Endangered under the ESA (Title 50 CFR §17.12 for listed plants and various notices in the *Federal Register* [FR] for proposed species);
- species that are candidates for possible future listing as Threatened or Endangered under ESA (72 FR 69034, December 6, 2007);
- species that are listed or proposed for listing by the State of California as Threatened or Endangered under the CESA (Title 14, *California Code of Regulations* [CCR], Section 670.5);
- plants listed as Rare under the California Native Plant Protection Act of 1977 (California Fish and Game Code [CFGC], Section 1900 et seq.);
- plants considered by CNPS to be "rare, threatened, or endangered in California" (Lists 1B and 2, CNPS 2008); and
- species that meet the definitions of Rare or Endangered under the State CEQA Guidelines, Section 15380.

Fourteen special-status plant species were identified in the 2001 FEIR and 2001 FEIS as having the potential to occur on the Project islands. The list of 14 potentially occurring species was developed using information from the CNDDB, CNPS, and correspondence with regulatory agencies. As summarized in the 2001 FEIR and 2001 FEIS, botanical surveys were conducted in September 1988 and in August 1994. Five special-status plant species were observed on the Project islands (only on the water side of levees) during botanical surveys conducted in April and August–September 1988 and in August 1994: Suisun Marsh aster (*Symphyotrichum lentum*), Mason's lilaeopsis (*Lilaeopsis masonii*), rose mallow (*Hibiscus lasiocarpus*), Delta tule pea (*Lathyrus jepsonii* var. *jepsonii*), and Delta mudwort (*Limosella subulata*). This list was updated in 2008 based on previous consultation with the USFWS and DFG to remove several species that are unlikely to occur and to add several species with the potential to occur (Table 4.6-3).

The number of special-status plant species identified as having the potential to occur on the Project islands has changed since the 2001 FEIR and 2001 FEIS. Of the original 14 special-status species identified in the 2001 FEIR and 2001 FEIS, three are no longer identified by DFG as having the potential to occur on the Project islands or are no longer listed as special status: slough thistle (*Cirsium crassicaule*), marsh pea (*Lathyrus palustris*), and tall woolly marbles (*Psilocarphus brevissimus* var. *globiferus*; correctly known as *Psilocarphus tenellus* var. *globiferus*) (see Table 4.6-3) (Hickman 1993: 329; CNDDB 2008; CNPS 2008). Additionally, the federal Category 2 (C2) listing status indicated in the 2001 FEIS has been discontinued. A search of the 2008 CNDDB records, CNPS online *Inventory of Rare & Endangered Plants*, and USFWS lists, identified five additional special-status plant species that are known to occur or that potentially could occur on the Project islands, which were not identified in the 2001 FEIS (CNDDB 2008; CNPS 2008; USFWS 2008) (Table 4.6-3).

The geographic distribution, habitat requirements, blooming period, and local occurrence information for all special-status plant species potentially occurring on the Project islands are provided in Table 4.6-3.

The number of special-status plant occurrences located on or close to the Project islands has increased since the 2001 FEIS (CNDDB 2008; California Department of Water Resources 2003) (Table 4.6-3). In addition to the five special-status plant species observed during the botanical surveys conducted in 1988 and 1994, occurrences of the following species have been reported on or near the Project islands: bristly sedge (*Carex comosa*), brown fox sedge (*Carex vulpinoidea*), eel-grass pondweed (*Potamogeton zosteriformis*), and side-flowering skullcap (*Scutellaria lateriflora*) (CNDDB 2008). The CNDDB occurrence of bristly sedge is located in the blowout ponds on the northern side of Webb Tract (CNDDB 2008). Bristly sedge could not be located on Webb Tract during surveys conducted by DWR (California Department of Water Resources 2003) but is assumed still to be present. Brown fox sedge is documented on the western shore of Bacon Island (CNDDB 2008). The occurrence was located by DWR in 2002 and represents the first record of the species in the Delta. The exact location of eel-grass pondweed is unknown; however, it was mapped in the vicinity of Webb Tract (CNDDB 2008). Similarly, the exact location of side-flowering skullcap also is unknown, but it was mapped in the vicinity of Bouldin Island (CNDDB 2008).

Wetlands

Approximately 763 acres of riparian woodland, riparian scrub, freshwater marsh, exotic marsh, canal and ditch, permanent pond, herbaceous upland, and seed and grain crop habitats were delineated by the NRCS, Corps, EPA, and USFWS as jurisdictional wetlands under Section 404 of the CWA, and were reported in the 2001 FEIS (Table 4.6-4). The Corps and the NRCS verified the wetland delineation in December 1994 and January 1995, respectively; however, the verification of the previous delineation expired after 5 years. At the time of publication of the 2001 FEIR and 2001 FEIS, the Project proponent was working to update the 1994 delineation to reflect current (2001) conditions on the Project islands. The 2001 FEIR and 2001 FEIS assumed that because farming conditions were basically unchanged since the 1994 delineation, the acreage of wetlands on the islands also would remain unchanged after the update.

After the verification of the 1994 wetland delineation expired in 2000, the Project applicant requested that the Corps renew the verification of wetlands on the Project islands. In July 2001, Corps staff confirmed that additional field work and reporting would be required to update the wetland delineation to current (2001) conditions. Jones & Stokes conducted a new wetland delineation in June and September 2001 using the methods described in the 1987 *U.S. Army Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987: 42–95). The delineation study area encompassed the four Project islands—Bacon Island (5,500 acres), Bouldin Island (5,960 acres), Webb Tract (5,450 acres), and a portion of Holland Tract (2,875 acres). The delineation study area also included areas in the Delta channels surrounding the Project islands (i.e., outside the levees) that may be affected by construction and modification of siphons and pumps. Following the verification and review process, the Corps verified 860.47 acres of wetlands and other waters in the delineation study area (U.S. Army Corps of Engineers 2002). The 2001 wetland delineation verification expired in 2007. The Project applicant currently is consulting with the Corps regarding necessary updates to the wetland delineation and plans to conduct any field studies necessary to re-verify the wetland delineation. Preliminary wetland mapping was completed by Jones & Stokes in 2008 to determine the magnitude of wetland changes that might have occurred since the 2001 wetland delineation. The current (2008) estimated wetland types and acreages are provided in Table 4.6-4. In general, the type and extent of wetlands on the Project islands have not changed significantly overall since 2001. The type and extent of wetlands on individual islands have changed, with the most substantial change occurring on Holland Tract.

Invasive Plant Species

The status of invasive plant species (also known as "noxious weeds") on the Project islands was not evaluated in the 2001 FEIR and 2001 FEIS, and new information pertaining to invasive species has become available since the 2001 FEIR and 2001 FEIS. DWR conducted surveys on the Project islands in 2002 and identified 28 invasive plant species occurring or potentially occurring on each of the islands (Table 4.6-6). The type and distribution of invasive species in a particular area or region can change relatively quickly as control methods and priorities evolve, and as new weeds are introduced. Seven species were identified by DWR as "weed species of concern" for the Project islands because they have a high potential to affect and displace wetlands and riparian areas on the islands:

- Giant reed (*Arundo donax*),
- Water hyacinth (*Eichhornia crassipes*),
- Perennial pepperweed (*Lepidium latifolium*),
- Cape ivy (*Delairea odorata* [*Senecio mikanioides*]),
- Pampas grass (*Cortaderia jubata*),
- Purple loosestrife (*Lythrum salicaria*), and
- Himalayan blackberry (*Rubus discolor*).

The Project islands are actively managed for agricultural crops, and various management techniques are implemented to control weeds. Disking and flooding, along with the application of herbicides, are currently the primary methods of weed control on the islands.

Table 4.6-6. Invasive Plant Species Identified as Occurring on the Project Islands or Listed by Weed Management Areas in the Project Vicinity

Common Name	Scientific Name	Known on Project Islands[a]	Listed by Weed Management Areas in Project Vicinity[b]	Cal-IPC Status[c]	CDFA Status[d]
Kangaroo thorn	*Acacia paradoxa*		X		B
Puna grass	*Achnatherum brachychaetum*		X		A
Russian knapweed	*Acroptilon repens*	X	X	Moderate	B
Barbed goatgrass	*Aegilops triuncialis*		X	High	B
Tree of heaven	*Ailanthus altissima*	X		Moderate	C
Giant reed	*Arundo donax*	X	X	High	B
Black mustard	*Brassica nigra*	X		Moderate	
Red brome	*Bromus madritensis* ssp. *rubens*	X		High	
Thoroughwax	*Bupleurum lancifolium*		X		
Hoary cress	*Cardaria draba*		X	Moderate	B
Globe-podded hoary cress	*Cardaria pubescens*		X	Limited	B
Plumeless thistle	*Carduus acanthoides*		X	Limited	A
Italian thistle	*Carduus pycnocephalus*	X	X	Moderate	C
Smooth distaff thistle	*Carthamus baeticus*		X		B
Purple star-thistle	*Centaurea calcitrapa*		X	Moderate	B
Iberian star-thistle	*Centaurea iberica*		X		A
Yellow star-thistle	*Centaurea solstitialis*	X	X	High	C
Canada thistle	*Cirsium arvense*		X	Moderate	B
Bull thistle	*Cirsium vulgare*	X	X	Moderate	C
Poison hemlock	*Conium maculatum*	X		Moderate	
Jubata grass	*Cortaderia jubata*		X	High	B
Pampas grass	*Cortaderia selloana*	X		High	
Monterey cypress	*Cupressus macrocarpa*		X		
Japanese dodder	*Cuscuta japonica*		X		A
Artichoke thistle	*Cynara cardunculus*		X	Moderate	B
Nutsedge	*Cyperus spp.*		X		
Cape ivy	*Delairea odorata*			High	
Brazilian egeria	*Egeria densa*	X	X	High	C
Veldt grass	*Ehrharta calycina*			Moderate	
Water hyacinth	*Eichhornia crassipes*	X	X	High	C
Blue gum	*Eucalyptus globulus*	X		Moderate	
Oblong spurge	*Euphorbia oblongata*		X	Limited	B
Edible fig	*Ficus carica*	X		Moderate	
Fennel	*Foeniculum vulgare*	X		High	
Wavy-leaved gaura	*Gaura sinuata*		X		B
Velvet grass	*Holcus lanatus*	X		Moderate	
Hydrilla	*Hydrilla verticillata*			High	A
Yellow water iris	*Iris pseudacorus*	X		Limited	Q
Perennial pepperweed	*Lepidium latifolium*	X	X	High	B

Common Name	Scientific Name	Known on Project Islands[a]	Listed by Weed Management Areas in Project Vicinity[b]	Cal-IPC Status[c]	CDFA Status[d]
Dalmatian toadflax	*Linaria dalmatica* ssp. *dalmatica* (formerly *L. genistifolia* ssp. *dalmatica*) *genistifolia*		X	Moderate	A
Purple loosestrife	*Lythrum salicaria*	X	X	High	B
Parrot's feather	*Myriophyllum aquaticum*	X		High	
Eurasian watermilfoil	*Myriophyllum spicatum*	X		High	C
Crispate-leaved pondweed	*Potamogeton crispus*	X		Moderate	
Himalayan blackberry	*Rubus armeniacus* (*R. discolor*)	X	X	High	
Russian thistle	*Salsola* spp.		X		
Golden thistle	*Scolymus hispanicus*		X		A
Red sesbania	*Sesbania punicea*		X	High	Q
Milk thistle	*Silybum marianum*		X	Limited	
Silverleaf nightshade	*Solanum elaeagnifolium*	X	X	Evaluated but not listed	B
Johnson grass	*Sorghum halepense*	X	X		C
Medusahead	*Taeniatherum caput-medusae*	X	X	High	C
Tamarisk	*Tamarisk* spp.	X	X		
Puncture vine	*Tribulus terrestris*		X		C
Spiny cocklebur	*Xanthium spinosum*		X		

[a] As reported in California Department of Water Resources 2003.

[b] Weed Management Areas (WMAs) in the Project Vicinity are the Alameda-Contra Costa WMA and the Central Valley WMA.

[c] According to California Invasive Plant Council 2006. Cal-IPC Status Explanations:

High: Species that have severe ecological impacts on physical processes, plant and animal communities, and vegetation structure. These species have moderate to high rates of dispersal and establishment based on their reproductive biology and other characteristics and have a wide ecological distribution.

Moderate: Species that have substantial and apparent—but generally not severe—ecological impacts on physical processes, plant and animal communities, and vegetation structure. These species have moderate to high rates of dispersal based on their reproductive biology and other characteristics; however, establishment is generally dependent upon ecological disturbance. The ecological amplitude and distribution of these species varies from widespread to limited.

Limited: Species that are invasive but have ecological impacts are relatively minor on a statewide level or adequate data was not available to justify a higher score. These species have low to moderate rates of invasiveness based on their reproductive biology and other characteristics. Although these species may be locally persistent and problematic, their ecological amplitude and distribution are generally limited.

[d] According to California Department of Food and Agriculture 2008. CDFA Status Explanations:

A = Eradication, containment, rejection, or other holding action at the state-county level. Quarantine interceptions to be rejected or treated at any point in the state.

B = Eradication, containment, control or other holding action at the discretion of the agricultural commissioner.

C = State endorsed holding action and eradication only when found in a nursery; action to retard spread outside of nurseries at the discretion of the commissioner; reject only when found in a cropseed for planting or at the discretion of the agricultural commissioner.

Q = Temporary "A" action outside of nurseries at the state-county level pending determination of a permanent rating.

CDFA = California Department of Food and Agriculture.

Cal-IPC = California Invasive Plant Council.

Local Regulations

As described above under Regulatory Setting, San Joaquin and Contra Costa Counties have adopted local regulations since the 2001 FEIR and 2001 FEIS that have implications for vegetation and wetlands on the Project islands located within their respective counties. Contra Costa County's General Plan includes policies applicable to vegetation and wetlands on the Project islands. Furthermore, Contra Costa County and San Joaquin County have enacted tree protection ordinances. Trees that would be protected under the applicable county tree ordinance may be present on the Project islands.

Environmental Commitments

Several changes in Project design and many prior agreements with Delta water rights holders or agencies have resulted in the Project environmental commitments. These commitments would reduce or eliminate impacts on particular resources or would minimize the impacts of the original Project design and operation.

Environmental commitments specific to vegetation and wetlands, which will be included in the Final HMP, include the following:

- Compensate for the loss of riparian and pond habitats by preserving or creating a minimum of 339 acres (3:1 ratio of acres impacted to acres preserved) of riparian woodland habitat, a minimum of 150 acres (2:1 ratio of acres impacted to acres preserved) of riparian scrub habitat, and 76 acres of permanent pond habitat (1:1 ratio of acres impacted to acres preserved) on the Habitat Islands.
- Inclusion of invasive plant management goals and measures in the final HMP with an emphasis on an adaptive management approach and a focus on prevention and early detection of new invasive plant infestations, as well as physical, chemical, and biological control measures.

Environmental Effects

Methods

In the 2001 FEIR and 2001 FEIS, impacts on vegetation on the Project islands were evaluated through comparison of predictions of future habitat types and acreages under the Project alternatives with existing vegetation conditions. Changes in vegetation types would result from the construction of facilities, upgrading of levees, inundation of Reservoir Islands during water storage and seasonal wetland periods, and implementation of the HMP (Jones & Stokes Associates Inc. 1995).

The 2001 FEIR and 2001 FEIS conservatively assumed that because future habitat conditions on Reservoir Islands are unpredictable and cannot be quantified, Reservoir Islands would provide no vegetation or wetland values that would offset Project impacts.

Overall, the methods and assumptions used below to evaluate impacts on vegetation and wetlands are the same as the methods used in the 2001 FEIR and 2001 FEIS.

Alternatives 1, 2, and 3

In the 2001 FEIR and 2001 FEIS, analysis of future vegetation conditions on the Habitat Islands under Alternatives 1 and 2 was based on habitat types and acreages described in the HMP (Table 4.6-7). These estimates are still valid though the location and mix of habitats may change slightly in the final HMP.

Table 4.6-7. Acreages of Habitats to Be Developed on the Habitat Islands

	Bouldin Island		Holland Tract		Habitat Islands Combined	
Habitat Type	Total Acres	Percentage of Total Acres	Total Acres	Percentage of Total Acres	Total Acres	Percentage of Total Acres
Corn/wheat	1,629	27	955	31	2,584	29
Small grains	106	2	152	5	258	3
Mixed agriculture/seasonal wetland	1,014	17	631	21	1,645	18
Seasonal managed wetland	1,723	29	393	13	2,116	23
Seasonal pond	66	1	68	2	134	1
Pasture/hay	132	2	72	2	204	2
Emergent marsh*	208	3	194	6	402	4
Riparian*	170	3	217	7	387	4
Lake*	111	2	33	1	144	2
Herbaceous upland*	479	8	253	8	732	8
Developed	177	3	58	2	235	3
Canal*	70	1	10	0	80	1
Borrow pond	89	1	0	0	89	1
Total	**5,974**	**100**	**3,036**	**100**	**9,010**	**100**

Note: Minor discrepancies in totals are the result of rounding.

* Includes existing acres of habitat unaffected by the Project.

No-Project Alternative

Estimates of island conditions under the No-Project Alternative are based on a feasibility study prepared by the McCarty Company, Diversified Agricultural Services (McCarty pers. comm.). The general recommendation for all islands is to increase cultivated acreage and crop diversification, with a greater emphasis on perennial crops such as asparagus and vineyards.

Significance Criteria

The vegetation and wetlands impact analysis considered several criteria for determining the significance of impacts related to this resource. The analysis took into account both relevant criteria contained in Appendix G of the State CEQA Guidelines (Association of Environmental Professionals 2009) and Project-specific criteria developed by the lead agency to address potential impacts unique to the Project's location and elements.

Based on these guidelines, the Project would cause a significant impact if it would:

- have a substantial adverse effect, either directly or through habitat modification, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations or by DFG or USFWS;
- have a substantial adverse effect on federally protected wetlands, as defined by CWA Section 404 (including, but not limited to, marsh, vernal pool, and coastal wetlands) through direct removal, filling, hydrological interruption, or other means;
- conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance; or
- conflict with the provisions of an adopted habitat conservation plan, such as the SJMSCP, natural communities conservation plan, or other approved local, regional, or state habitat conservation plan.

Alternatives were considered to have beneficial effects if they would result in increases in the quality or extent of riparian or wetland habitats.

Impacts and Mitigation Measures

Changes in the type and extent of wetlands and habitats have occurred on the islands since the 2001 FEIR and 2001 FEIS, and the magnitude of wetland and habitat impacts is different from the magnitude described in the 2001 FEIR and 2001 FEIS; however, the change is attributable to the type and extent of wetlands on the islands, not differences in the Project description or the impact methods.

The HMP incorporated into the Project description as an Environmental Commitment for Alternatives 1 and 2 provides for compensation habitat to be established on the Habitat Islands to offset the effects of Reservoir Island operations on vegetation and wetlands. The impact assessment for Alternatives 1 and 2 therefore is based on the assumption that Project implementation would include the establishment of compensation as specified in the draft HMP. A summary of Project impacts and compensation requirements for vegetation communities, using the ratios specified in the HMP and current (2008) habitat acreages, is provided in Table 4.6-8. Under Alternative 3, all four Project islands would be used as reservoirs, and the North Bouldin Habitat Area (NBHA) on Bouldin Island would be used to provide limited compensation habitat. This information forms the basis for the Project impacts described below.

Table 4.6-8. Changes in Habitat Acreages from Existing Conditions to Conditions under Alternatives 1 and 2

		Existing Conditions		Alternatives 1 and 2[a]		
Affected Habitat Type	Corresponding Habitat Island Habitat Type	Reservoir Islands (acres)	Habitat Islands (acres)	Reservoir Islands (acres)	Habitat Islands (acres)	Change under Alternatives 1 and 2 (acres)
Riparian woodland	Riparian woodland	113.24	109.94	0	275[b]	51.82
Riparian scrub	Riparian scrub	75.36	27.6	0	112[b]	9.04
Freshwater marsh	Emergent marsh	92.74	156.36	0	402	152.90
Exotic marsh	Mixed agriculture/seasonal wetland, seasonal managed wetland, seasonal pond	66.23	1,553.62[c]	0	3,895	2,275.15
Herbaceous upland	Herbaceous upland	1,201.67	856.08	0	732	(1,325.75)
Corn, wheat, and milo	Corn rotated with wheat, small grains	6,679.83	4,148.73	0	2,842	(7,986.56)
Pasture	Pasture/hay	0	0[c]	0	204	204.00
Other crops and fallow fields	None	2,484.64	2,070.41	0	0	(4,555.05)
Canals and ditches	Canal	69.59	60.11	0	80	(49.70)
Permanent pond	Permanent lake and borrow areas	76.22	25.12	0	233	131.66
Developed	Developed	193.21	79.71	0	235	(37.92)
Total		**11,052.73**	**9,087.68[d]**	**0**	**9,010[d]**	

[a] As reported in Table 3 of the HMP.

[b] The HMP reported a total of 387 acres of riparian habitat to be created/managed on the Habitat Islands however, the HMP did not split the total into riparian woodland versus riparian scrub habitats. These numbers assume the intent of the HMP was to maintain the approximate ratio of woodland/scrub on the islands as was present in 1988, an approximate 1.4:1 ratio.

[c] Holland island is currently used as pasture but was classified from a natural community perspective as exotic marsh.

[d] Minor discrepancies in numbers are the result of rounding and conversion of 1995 data to a Geographic Information System.

Proposed Project (Alternative 2)

Vegetation Communities and Wetlands

The 2001 FEIR and 2001 FEIS identified impacts on vegetation communities and wetlands from Alternative 2, the Proposed Project, based on habitat mapping conducted in 1987. Each impact on vegetation communities is described below with updated acreages to reflect current conditions. Additionally, invasive species were not discussed in the 2001 FEIR and 2001 FEIS, but they are now known to present a new impact on vegetation communities and special-status species as described below.

Impact VEG-1: Increase in Freshwater Marsh and Exotic Marsh Habitats

Implementing Alternative 2 would result in the loss of approximately 93 acres of freshwater marsh and 66 acres of exotic marsh (Table 4.6-8). The HMP team, in consultation with the Corps, established a mitigation ratio requirement of 2:1 for both of these habitats; however, implementation of the HMP on the Habitat Islands would exceed this requirement. Approximately 353 acres of tule-dominated emergent marsh will be used to replace affected freshwater marsh. Affected exotic marsh will be replaced with approximately 3,761 acres of out-of-kind seasonal managed wetland and mixed agriculture/seasonal wetland that will provide higher wildlife values than the existing exotic marsh habitat. Therefore, this impact is considered beneficial and less than significant.

Mitigation
No mitigation is required.

Impact VEG-2: Loss of Riparian and Permanent Pond Habitats

Implementation of Alternative 2 would result in the loss of approximately 113 acres of riparian woodland, 75 acres of riparian scrub, and 76 acres of permanent pond habitat. The HMP identifies the appropriate mitigation ratio for each habitat type and the amount of each habitat type provided on the Habitat Islands. Under the HMP, riparian woodland would be replaced at a 3:1 mitigation ratio, riparian scrub would be replaced at a ratio of 2:1, and permanent ponds would be replaced at a ratio of 1:1 (Table 4.6-8).

As outlined in the Environmental Commitments for the Project, the Project applicant will revise the management goals for the Habitat Islands in the final HMP to meet or exceed the mitigation established in the draft HMP for riparian woodland, riparian scrub, and permanent pond habitats. With implementation of the Environmental Commitments, this impact is considered less than significant.

Mitigation
No mitigation is required.

Impact VEG-3: Loss of Upland and Agricultural Habitats

Implementation of Alternative 2 would result in the loss of canals and ditches, grain and seed crops, annual grassland, exotic perennial grassland, and unvegetated disturbed habitats. The Project applicant will manage 7,335 acres of similar habitats on the Habitat Islands that will provide greater wildlife values than are associated with affected habitats. These mitigation habitats would consist of corn/wheat fields, seasonal managed wetlands, mixed agriculture/seasonal wetlands, small grain fields, herbaceous uplands, and canals and ditches necessary to maintain the aforementioned habitats. Upland and agricultural habitats are not considered wetlands or unique habitats and they are not considered unique or unusual habitats in the region. Because they are not considered unique or unusual, impacts are considered less than significant.

Mitigation
No mitigation is required.

Impact VEG-4: Consistency with Local Policies or Ordinances Protecting Biological Resources

Implementing Alternative 2 could result in the loss of native oak trees from the flooding of the Reservoir Islands and levee improvements on the Habitat Islands. Depending on the diameter of the trees, these losses could trigger compliance with the tree ordinance. However, the final HMP will require the creation and restoration of riparian habitats and this will meet or exceed the County's ordinance. Because the Project applicant will comply with this local ordinance and ensure that these standards are met or exceeded, there is no impact.

Mitigation
No mitigation is required.

Impact VEG-5: Conflict with Provisions of an Adopted HCP/NCCP

Implementation of Alternative 2 would result in the loss of agricultural habitats. However, the Project applicant will manage 7,335 acres of similar habitats on the Habitat Islands that will provide greater wildlife values than are associated with affected habitats. These mitigation habitats will consist of corn/wheat fields, seasonal managed wetlands, mixed agriculture/seasonal wetlands, small grain fields, herbaceous uplands, and canals and ditches necessary to maintain the aforementioned habitats. The Project was not considered a covered activity by the SJMSCP or the East Contra Costa County HCP/NCCP and the conservation efforts proposed by the Project would not conflict with the establishment of conservation areas in either County; therefore the Project does not conflict with an established HCP or NCCP. This is not considered an impact.

Mitigation
No mitigation is required.

Impact VEG-6: Introduction and Spread of Invasive Plants

Implementation of Alternative 2 has the potential to spread existing invasive plants and to introduce new invasive plants to previously uninfested areas. Flooding and earth moving during Project construction are potential mechanisms for the introduction of invasive plants. Invasive plants are known to disrupt natural ecosystems, obstruct navigation and recreation, and reduce the suitability of habitats for special-status species. The introduction and spread of invasive plants may result in a substantial adverse effect on federally protected wetlands as defined by CWA Section 404 through the removal of native species and hydrological changes. As outlined in the Environmental Commitments for the Project, the Project applicant will revise the management goals in the final HMP to address invasive plants on both the Habitat and Reservoir Islands. The measures adopted in the final HMP will have an emphasis on an adaptive management approach but will focus on prevention and early detection of new infestations, as well as physical, chemical, and biological control measures. With implementation of the Environmental Commitments, this impact is considered less than significant.

Mitigation
No mitigation is required.

Special-Status Plants

The 2001 FEIR and 2001 FEIS concluded that construction and operation of recreation facilities on the exterior of levees could result in potentially significant impacts; however, implementation of appropriate mitigation measures would reduce the level of impact to less-than-significant. While the number of species known from the area has increased, the potential impact (i.e., loss of special-status plants from facilities) has not changed. The potential loss of special-status species on the interior of Webb Tract is a new impact not previously identified for the Project.

Impact VEG-7: Loss of Special-Status Plants

Under Alternative 2, the siting of a pump station, siphon station, recreation facility, or other Project facility on a site occupied by special-status plants could result in the loss of individual special-status plants or populations. This impact would be considered significant, but the implementation of Mitigation Measures VEG-MM-1, VEG-MM-2, and VEG-MM-3 (Mitigation Measures VEG-MM-1, VEG-MM-2, and VEG-MM-3 from the 2001 FEIR and 2001 FEIS) as described below would reduce the level of impact to less than significant.

The conversion of Webb Tract to a Reservoir Island could result in the direct loss of bristly sedge, a CNPS List 2.1 special-status species, if present. Bristly sedge is a species adapted to wetland conditions, but the duration and depth of flooding on the Reservoir Islands are unpredictable, and it is unknown whether the species can persist during operation of the Project. The impact is considered significant because it may completely remove the species from the island. Implementation of Mitigation Measure VEG-MM-3 would reduce the level of impact to less than significant.

Mitigation Measure VEG-MM-1: Site Project Facilities to Avoid Special-Status Plant Populations
The Project applicant will conduct special-status plant surveys before construction of Project facilities and will site facilities to avoid special-status plant populations. If special-status plant species are discovered, Mitigation Measures VEG-MM-2 and VEG-MM-3 will be required.

Mitigation Measure VEG-MM-2: Protect Special-Status Plant Populations from Construction and Recreation Activities

To mitigate potential indirect impacts of construction, the Project will use several measures to protect special-status plants that are within 200 feet of Project facility sites. First, the boundaries of each population will be determined and marked with surveyor's flagging. Second, special-status plants within 100 feet of Project facility sites will be protected by temporary barricades erected 50 feet from the edge of the population nearest the facility site. Plants 100–200 feet from the construction sites will be identified with brightly colored flagging on vegetation and/or surveyor's stakes that are plainly visible to construction personnel approaching the area occupied by the plants. Flagging will not be obscured by vegetation. Construction crews and Project maintenance personnel will be informed of the presence of the plants, the function of the barricades and flagging, and the strict avoidance requirements. If special-status plant populations are inadvertently affected by construction, the Project applicant will contact DFG and discuss appropriate mitigation to offset impacts, including development of a mitigation monitoring program and performance standards.

Areas that support special-status plant populations will be posted as sensitive and public access limited. If special-status plant populations are inadvertently affected by recreational uses, per Mitigation Measure VEG-MM-3 the Project will contact DFG and discuss appropriate mitigation to offset impacts, including development of a mitigation monitoring program and performance standards.

Mitigation Measure VEG-MM-3: Develop and Implement a Special-Status Plant Species Monitoring and Mitigation Plan

The Project applicant, in consultation with DFG and USFWS, will develop and implement a plan for mitigating unavoidable impacts on special-status plant populations. At a minimum, this plan will include:

- guidelines for conducting preconstruction surveys,
- avoidance and protection guidelines for individual species, and
- measures that promote the protection and enhancement of existing populations.

Although the protection and enhancement of existing habitat will be the primary focus of the plan, it may also include the transplantation of individuals or colonies, collection and planting of seeds or nursery grown plants, and creation of new habitat, provided such mitigation has a high potential for success.

Additionally, the plan will include monitoring guidelines to ensure the successful protection, avoidance, and/or establishment of special-status plants.

Alternative 1

Vegetation and Wetlands

The impacts and mitigation measures of Alternative 1 are identical to those of Alternative 2.

Special-Status Plants

The impact and mitigation measures of Alternative 1 are identical to those of Alternative 2.

Alternative 3

Vegetation and Wetlands

Changes in the habitat types on the Reservoir Islands under Alternative 3 would be similar to those described under Alternative 2. Therefore, Impacts VEG-1 through VEG-4 also would result from the implementation of Alternative 3. Additionally, water storage activities under Alternative 3 would cause the loss of an additional 1,113 acres of riparian, exotic marsh, herbaceous upland, agricultural, open water, and developed habitats in the southwestern quarter of the Holland Tract. Lastly, agricultural habitats would be substantially reduced in the NBHA as the result of conversion to perennial pond, seasonal managed wetland, riparian woodland, and herbaceous upland habitats.

Impact VEG-8: Loss of Jurisdictional Wetlands on Reservoir Islands

Implementing Alternative 3 would result in the loss from the Reservoir Islands of the following wetlands subject to Section 404 jurisdiction: approximately 203 acres of riparian woodland and riparian scrub, 56 acres of freshwater marsh, 147 acres of exotic marsh, 111 acres of perennial ponds, and 188 acres of upland and agricultural habitats. These losses would be partially offset with development of Section 404 wetland habitats on the NBHA. Substantial losses of jurisdictional wetland acreage, however, still would occur because of inundation of the Reservoir Islands (Table 4.6-8). Therefore, this impact is considered significant. Implementation of Mitigation Measure VEG-MM-4 (Mitigation Measure VEG-MM-4 from the 2001 FEIR and 2001 FEIS) would reduce the level of impact to less-than-significant.

Mitigation Measure VEG-MM-4: Develop and Implement an Off-Site Mitigation Plan

The Project applicant, in consultation with the Corps, DFG, and USFWS, will implement an off-site mitigation plan for mitigating impacts on Section 404 jurisdictional wetlands that would result from implementation of Alternative 3. Once the Project applicant has identified off-site mitigation areas, an HMP team will be established to develop the off-site mitigation plan. No diversions will be allowed until a feasible compensation plan that guarantees compensation acreage has been developed by the Project applicant and approved by the Corps.

Special-Status Plants

The impact and mitigation measures of Alternative 3 pertaining to special-status plants are the same as those described for Alternative 2.

No-Project Alternative

Vegetation Communities, Wetlands, and Special-Status Plants

Implementation of the No-Project Alternative would have an impact on existing habitat types, primarily as the result of conversion of fallow, herbaceous upland, riparian, and wetland habitats to agricultural use. The increase in agricultural land use would result in the loss of existing habitat types. The 2001 FEIR and 2001 FEIS indicated that the changes in vegetation types under the No-Project Alternative would result in a 50% decrease in riparian woodland and riparian scrub as well as a decrease in freshwater marsh of more than 80%. Under current conditions, these totals would increase to approximately 60% and 85% respectively. Implementation of the No-Project Alternative potentially could result in the loss of special-status plants. Although increasing agricultural production under the No-Project Alternative would not result in direct impacts on special-status plants, future levee maintenance required as the result of increased rates of subsidence could potentially eliminate special-status plants. Over the long term as agricultural production declines or levees fail, natural land-cover types could reestablish as plants colonize uncultivated areas, canals, and levee margins.

Section 4.7
Wildlife

Introduction

This section describes recent changes to the existing environmental conditions and regulatory setting of the Project area, summarizes the unchanged affected environment, and describes changed environmental effects related to wildlife for the Project. This section contains a review and update of the 1995 DEIR/EIS wildlife impact assessment, incorporated by reference in the 2001 FEIR. The wildlife impacts of the Project were analyzed most recently in the 2001 FEIS, which also served as a basis for this analysis. Fishery resources are discussed in Section 4.5.

The 2001 FEIR and 2001 FEIS concluded that impacts of the Project on wildlife were associated with the conversion of existing habitats (primarily agricultural) to reservoir uses on the Reservoir Islands or to habitat types managed specifically to provide high wildlife habitat values on the habitat islands.

Under Alternatives 1 and 2, the habitat islands (Bouldin Island and Holland Tract) would be managed primarily to offset wildlife impacts resulting from operation of the Reservoir Islands. Implementation of the HMP developed for the Habitat Islands would result in creation of seasonal managed wetlands, emergent marshes, seasonal ponds, lakes, herbaceous uplands, riparian woodland and scrub habitats, pastures, and corn and wheat fields that would be managed specifically to provide high wildlife habitat values. In addition to offsetting Project impacts on wildlife, implementation of the HMP was expected to benefit many special-status and other wildlife species. In general, flooding the Reservoir Islands was expected to result in a loss of habitat, and implementing the HMP would result in a gain in habitat.

Other impacts on wildlife from implementation of the Project alternatives included potential increased incidence of waterfowl disease; temporary construction impacts on state-listed species; disturbance of greater sandhill crane and waterfowl from use of the Bouldin Island airstrip; losses of upland habitats, foraging habitats for wintering waterfowl, upland game species habitats, foraging habitat for Aleutian Canada goose, and wintering habitat for tricolored blackbird; losses of riparian and herbaceous habitats; disruption of waterfowl use and of greater sandhill crane use of the Habitat Islands as a result of increased hunting; increases in waterfowl harvest mortality; potential changes in local and regional waterfowl use patterns; and potential effects on wildlife and wildlife habitats resulting from Delta outflow changes.

New impacts are identified for western pond turtle, giant garter snake, several bird species, and bats. Implementation of the environmental commitments, including the final HMP, is expected to mitigate effects on these species. A substantial increase in the severity of impacts is not anticipated because the final HMP is still expected to mitigate Project effects.

Summary of Impacts

Table 4.7-1 provides a summary and comparison of the impacts and mitigation measures for wildlife from the 2001 FEIR, 2001 FEIS, and this Place of Use EIR.

Table 4.7-1. Comparison between Delta Wetlands Project 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures for Wildlife

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
ALTERNATIVES 1 AND 2	
Impact H-1: Loss of Upland Habitats (LTS) **Mitigation:** No mitigation is required.	**Impact W-6:** Loss of Upland Habitats (LTS) **Mitigation:** No mitigation is required.
Impact H-2: Increase in Suitable Wetland Habitats for Nongame Water and Wading Birds (B) **Mitigation:** No mitigation is required.	**Impact W-7:** Increase in Suitable Wetland Habitats for Nongame Water and Wading Birds (B and LTS) **Mitigation:** No mitigation is required.
Impact H-3: Loss of Foraging Habitats for Wintering Waterfowl (LTS) **Mitigation:** No mitigation is required.	**Impact W-8:** Loss of Foraging Habitats for Wintering Waterfowl (LTS) **Mitigation:** No mitigation is required.
Impact H-4: Increase in Suitable Breeding Habitats for Waterfowl (B) **Mitigation:** No mitigation is required.	**Impact W-9:** Increase in Suitable Breeding Habitats for Waterfowl (B and LTS) **Mitigation:** No mitigation is required.
Impact H-5: Loss of Habitats for Upland Game Species (LTS) **Mitigation:** No mitigation is required.	**Impact W-10:** Loss of Habitats for Upland Game Species (LTS) **Mitigation:** No mitigation is required.
Impact H-6: Increase in Suitable Foraging Habitat for Greater Sandhill Crane (B) **Mitigation:** No mitigation is required.	**Impact W-11:** Loss of Suitable Foraging Habitat for Greater Sandhill Crane (LTS) **Mitigation:** No mitigation is required.
Impact H-7: Increase in Suitable Roosting Habitat for Greater Sandhill Crane (B) **Mitigation:** No mitigation is required.	**Impact W-12:** Increase in Suitable Roosting Habitat for Greater Sandhill Crane (B and LTS) **Mitigation:** No mitigation is required.
Impact H-8: Increase in Suitable Foraging Habitat for Swainson's Hawk (B) **Mitigation:** No mitigation is required.	**Impact W-13:** Loss of Suitable Foraging Habitat for Swainson's Hawk (LTS) **Mitigation:** No mitigation is required.
Impact H-9: Increase in Suitable Nesting Habitat for Swainson's Hawk (B) **Mitigation:** No mitigation is required.	**Impact W-14:** Loss of Suitable Nesting Habitat for Swainson's Hawk, Cooper's Hawk, and White-Tailed Kite (LTS) **Mitigation:** No mitigation is required.

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
Impact H-10: Loss of Foraging Habitat for Aleutian Canada Goose (LTS) **Mitigation:** No mitigation is required.	**Impact W-17:** Loss of Foraging Habitat for Cackling (Aleutian Canada) Goose (LTS) **Mitigation:** No mitigation is required.
Impact H-11: Increase in Suitable Nesting Habitat for Northern Harrier (B) **Mitigation:** No mitigation is required.	**Impact W-18:** Loss of Suitable Nesting and Foraging Habitat for Northern Harrier and Short-Eared Owl (LTS) **Mitigation:** No mitigation is required.
Impact H-12: Loss of Wintering Habitat for Tricolored Blackbird (LTS) **Mitigation:** No mitigation is required.	**Impact W-19:** Loss of Winter Foraging Habitat for Tricolored Blackbird (LTS) **Mitigation:** No mitigation is required.
Impact H-13: Increase in Suitable Nesting Habitat for Tricolored Blackbird (B) **Mitigation:** No mitigation is required.	**Impact W-20:** Change in Acreage of Suitable Nesting Habitat for Tricolored Blackbird (LTS) **Mitigation:** No mitigation is required.
Impact H-14: Increase in Suitable Habitats for Special-Status Wildlife Species (B) **Mitigation:** No mitigation is required.	**Impact W-21:** Increase in Suitable Habitats for Special-Status Bird Species (B and LTS) **Mitigation:** No mitigation is required.
Impact H-15: Temporary Construction Impacts on State-Listed Species (LTS-M) **Mitigation Measure H-1:** Develop and Implement a Construction Mitigation Plan for the Reservoir Islands	See analysis and mitigation for individual species effects.
Impact H-16: Disturbance to Greater Sandhill Cranes and Wintering Waterfowl from Aircraft Operations (LTS-M) **Mitigation Measure H-2:** Monitor Effects of Aircraft Flights on Greater Sandhill Cranes and Wintering Waterfowl and Implement Actions to Reduce Aircraft Disturbances of Wildlife	**Impact W-23:** Disturbance to Greater Sandhill Cranes and Wintering Waterfowl from Aircraft Operations (LTS-M) **Mitigation Measure W-MM-1:** Monitor Effects of Aircraft Flights on Greater Sandhill Cranes and Wintering Waterfowl and Implement Actions to Reduce Aircraft Disturbances of Wildlife
Impact H-17: Potential for Increased Incidence of Waterfowl Diseases (LTS-M) **Mitigation Measure H-3:** Monitor Waterfowl Populations for Incidence of Disease and Implement Actions to Reduce Waterfowl Mortality	**Impact W-24:** Potential for Increased Incidence of Waterfowl Diseases (LTS-M) **Mitigation Measure W-MM-2:** Monitor Waterfowl Populations for Incidence of Disease and Implement Actions to Reduce Waterfowl Mortality
Impact H-18: Potential Disruption of Waterfowl Use as a Result of Increased Hunting (LTS) **Mitigation:** No mitigation is required.	**Impact W-25:** Potential Disruption of Waterfowl Use as a Result of Increased Hunting (LTS) **Mitigation:** No mitigation is required.
Impact H-19: Potential Disruption of Greater Sandhill Crane Use of the Habitat Islands as a Result of Increased Hunting (LTS) **Mitigation:** No mitigation is required.	**Impact W-26:** Potential Disruption of Greater Sandhill Crane Use of the Habitat Islands as a Result of Increased Hunting (LTS) **Mitigation:** No mitigation is required.
Impact H-20: Increase in Waterfowl Harvest Mortality (LTS) **Mitigation:** No mitigation is required.	**Impact W-27:** Increase in Waterfowl Harvest Mortality (LTS) **Mitigation:** No mitigation is required.
Impact H-21: Potential Changes in Local and Regional Waterfowl Use Patterns (LTS) **Mitigation:** No mitigation is required.	**Impact W-28:** Potential Changes in Local and Regional Waterfowl Use Patterns (LTS) **Mitigation:** No mitigation is required.

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
Impact H-22: Potential Effects on Wildlife and Wildlife Habitats Resulting from Delta Outflow Changes (LTS) **Mitigation:** No mitigation is required.	**Impact W-29:** Potential Impacts on Wildlife and Wildlife Habitats Resulting from Delta Outflow Changes (LTS) **Mitigation:** No mitigation is required.
	Impact W-1: Potential Injury or Mortality of, and Potential Loss of Suitable Habitat for, Valley Elderberry Longhorn Beetle (LTS) **Mitigation:** No mitigation is required.
	Impact W-2: Potential Injury or Mortality of Western Pond Turtle (LTS) **Mitigation:** No mitigation is required.
	Impact W-3: Loss of Suitable Aquatic and Upland Habitat for Western Pond Turtle (LTS) **Mitigation:** No mitigation is required.
	Impact W-4: Potential Injury or Mortality of Giant Garter Snake (LTS) **Mitigation:** No mitigation is required.
	Impact W-5: Loss of Suitable Aquatic and Upland Habitat for Giant Garter Snake (LTS) **Mitigation:** No mitigation is required.
	Impact W-15: Loss of Suitable Breeding/Wintering Habitat for Western Burrowing Owl (LTS) **Mitigation:** No mitigation is required.
	Impact W-16: Loss of Suitable Foraging Habitat for Cooper's Hawk, White-Tailed Kite, Western Burrowing Owl, and Loggerhead Shrike (LTS) **Mitigation:** No mitigation is required.
	Impact W-22: Potential Injury or Mortality of Northern Harrier, Cooper's Hawk, Swainson's Hawk, White-Tailed Kite, California Black Rail, Greater Sandhill Crane, Western Burrowing Owl, Short-Eared Owl, Loggerhead Shrike, and Non–Special-Status Migratory Birds (LTS) **Mitigation:** No mitigation is required.
	Impact W-30: Loss of Roost Sites and Foraging Habitat for and Potential Injury or Mortality of Bats (LTS) **Mitigation:** No mitigation is required.
ALTERNATIVE 3	
Impact H-23: Loss of Upland Habitats (LTS-M) **Mitigation Measure H-4:** Develop and Implement an Offsite Wildlife Habitat Mitigation Plan	**Impact W-6:** Loss of Upland Habitats (LTS-M) **Mitigation Measure W-MM-5:** Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan
Impact H-24: Loss of Foraging Habitats for Wintering Waterfowl (LTS-M) **Mitigation Measure H-4:** Develop and Implement an Offsite Wildlife Habitat Mitigation Plan	**Impact W-8:** Loss of Foraging Habitats for Wintering Waterfowl (LTS-M) **Mitigation Measure W-MM-5:** Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
Impact H-25: Increase in Suitable Breeding Habitats for Waterfowl (B) **Mitigation:** No mitigation is required.	**Impact W-9:** Increase in Suitable Breeding Habitats for Waterfowl (B and LTS) **Mitigation:** No mitigation is required
Impact H-26: Loss of Habitats for Upland Game Species (LTS-M) **Mitigation Measure H-4:** Develop and Implement an Offsite Wildlife Habitat Mitigation Plan	**Impact W-10:** Loss of Habitats for Upland Game Species (LTS-M) **Mitigation Measure W-MM-5:** Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan
Impact H-27: Loss of Foraging Habitat for Greater Sandhill Crane **Mitigation Measure H-4:** Develop and Implement an Offsite Wildlife Habitat Mitigation Plan	**Impact W-11:** Loss of Suitable Foraging Habitat for Greater Sandhill Crane (LTS-M) **Mitigation Measure W-MM-5:** Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan
Impact H-28: Loss of Foraging Habitat for Swainson's Hawk (LTS-M) **Mitigation Measure H-4:** Develop and Implement an Offsite Wildlife Habitat Mitigation Plan	**Impact W-13:** Loss of Suitable Foraging Habitat for Swainson's Hawk (LTS-M) **Mitigation Measure W-MM-5:** Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan
	Impact W-14: Loss of Suitable Nesting Habitat for Swainson's Hawk, Cooper's Hawk, and White-Tailed Kite (LTS-M) **Mitigation Measure W-MM-5:** Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan
Impact H-29: Loss of Foraging Habitat for Aleutian Canada Goose (LTS) **Mitigation:** No mitigation is required.	**Impact W-17:** Loss of Foraging Habitat for Cackling (Aleutian Canada) Goose (LTS) **Mitigation:** No mitigation is required.
Impact H-30: Loss of Nesting Habitat for Northern Harrier (LTS-M) **Mitigation Measure H-4:** Develop and Implement an Offsite Wildlife Habitat Mitigation Plan	**Impact W-18:** Loss of Suitable Nesting and Foraging Habitat for Northern Harrier and Short-Eared Owl (LTS-M) **Mitigation Measure W-MM-5:** Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan
Impact H-31: Loss of Wintering Habitat for Tricolored Blackbird (LTS) **Mitigation:** No mitigation is required.	**Impact W-19:** Loss of Winter Foraging Habitat for Tricolored Blackbird (LTS-M) **Mitigation Measure W-MM-5:** Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan
	Impact W-20: Change in Acreage of Suitable Nesting Habitat for Tricolored Blackbird (LTS-M) **Mitigation Measure W-MM-5:** Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan
Impact H-32: Temporary Construction Impacts on State-Listed Species (LTS-M) **Mitigation Measure H-1:** Develop and Implement a Construction Mitigation Plan for the Reservoir Islands	See analysis and mitigation for individual species effects.

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
Impact H-33: Potential for Increased Incidence of Waterfowl Diseases (LTS-M) **Mitigation Measure H-3:** Monitor Waterfowl Populations for Incidence of Disease and Implement Actions to Reduce Waterfowl Mortality	**Impact W-24:** Potential for Increased Incidence of Waterfowl Diseases (LTS-M) **Mitigation Measure W-MM-2:** Monitor Waterfowl Populations for Incidence of Disease and Implement Actions to Reduce Waterfowl Mortality
Impact H-34: Potential Disruption of Waterfowl Use as a Result of Increased Hunting (LTS) **Mitigation:** No mitigation is required.	**Impact W-25:** Potential Disruption of Waterfowl Use as a Result of Increased Hunting (LTS) **Mitigation:** No mitigation is required
Impact H-35: Increase in Waterfowl Harvest Mortality (LTS) **Mitigation:** No mitigation is required.	**Impact W-27:** Increase in Waterfowl Harvest Mortality (LTS) **Mitigation:** No mitigation is required
Impact H-36: Potential Changes in Local and Regional Waterfowl Use Patterns (LTS) **Mitigation:** No mitigation is required.	**Impact W-28:** Potential Changes in Local and Regional Waterfowl Use Patterns (LTS) **Mitigation:** No mitigation is required
Impact H-37: Potential Effects on Wildlife and Wildlife Habitats Resulting from Delta Outflow Changes (LTS) **Mitigation:** No mitigation is required.	**Impact W-29:** Potential Impacts on Wildlife and Wildlife Habitats Resulting from Delta Outflow Changes (LTS) **Mitigation:** No mitigation is required.
	Impact W-1: Potential Injury or Mortality of, and Potential Loss of Suitable Habitat for, Valley Elderberry Longhorn Beetle (LTS-M) **Mitigation Measure W-MM-3:** Avoid or Compensate for the Loss of Habitat for the Valley Elderberry Longhorn Beetle
	Impact W-2: Potential Injury or Mortality of Western Pond Turtle (LTS-M) **Mitigation Measure W-MM-4:** Avoid and Minimize Injury and Mortality of Western Pond Turtle
	Impact W-3: Loss of Suitable Aquatic and Upland Habitat for Western Pond Turtle (LTS-M) **Mitigation Measure W-MM-5:** Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan
	Impact W-4: Potential Injury or Mortality of Giant Garter Snake (LTS-M) **Mitigation Measure W-MM-6:** Avoid and Minimize Injury and Mortality of Giant Garter Snake
	Impact W-5: Loss of Suitable Aquatic and Upland Habitat for Giant Garter Snake (LTS-M) **Mitigation Measure W-MM-5:** Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan
	Impact W-15: Loss of Suitable Breeding/Wintering Habitat for Western Burrowing Owl (LTS-M) **Mitigation Measure W-MM-5:** Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
	Impact W-16: Loss of Suitable Foraging Habitat for Cooper's Hawk, White-Tailed Kite, Western Burrowing Owl, and Loggerhead Shrike (LTS-M) **Mitigation Measure W-MM-5:** Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan
	Impact W-22: Potential Injury or Mortality of Northern Harrier, Cooper's Hawk, Swainson's Hawk, White-Tailed Kite, California Black Rail, Greater Sandhill Crane, Western Burrowing Owl, Short-Eared Owl, Loggerhead Shrike, and Non–Special-Status Migratory Birds (LTS-M) **Mitigation Measure W-MM-7:** Prepare a Construction Implementation Plan to Avoid Impacts on Roosting and Nesting Birds
	Impact W-30: Loss of Roost Sites and Foraging Habitat for and Potential Injury or Mortality of Bats (LTS-M) **Mitigation Measure W-MM-5:** Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan **Mitigation Measure W-MM-8:** Conduct Preconstruction Surveys for Roosting Bats and Compensate for Loss of Roosting Habitat If Bats Are Found

Note: SU = Significant and unavoidable; LTS = Less than significant; LTS-M = Less than significant with mitigation; B = Beneficial.

Summary of Changes, New Circumstances, and New Information

Substantial Changes in the Project

Since the 2001 FEIR and 2001 FEIS, there have been no substantial changes to the Project design regarding wildlife resources. Project operations have not substantially changed, although the diversion and discharge periods likely will change to be more protective of biological resources consistent with new circumstances and new information. The Project will obtain revised BOs from DFG, USFWS, and NMFS, and a Final Habitat Management Plan (HMP) is now included as an environmental commitment.

New Circumstances

Since the 2001 FEIR and 2001 FEIS, several changes have occurred that have resulted in modifications to the affected environment and environmental effects on wildlife. Two species, bald eagle and cackling (Aleutian Canada) goose, have been removed from the federal listing under the ESA, and two species (Cooper's hawk and ferruginous hawk) no longer are considered California species of special concern (California Department of Fish and Game 2009).

Regional conservation planning efforts have proceeded in urbanized areas of both counties and is currently occurring in the Delta related to fish, but the Project area is not included in these conservation plans. Otherwise, there are no new circumstances surrounding the Project.

New Information

New information regarding the presence of special-status wildlife on the Project islands has been obtained through surveys conducted by the DWR during 2002–2003 and through a search of the current version of the CNDDB (2009) (see Special-Status Species below). In addition, updated lists of Threatened and Endangered species that may occur in the Project area were obtained from the USFWS website (U.S. Fish and Wildlife Service 2009). Using this information, discussions for several special-status wildlife species (e.g., western pond turtle, giant garter snake) have been added to this report.

Habitat information in the 2001 FEIR and 2001 FEIS was based on 1988 conditions. Since 1988, the types and distribution of crops and distribution of wetlands on the islands have changed, with the greatest changes occurring on Holland Tract. Crop data from 2002–2008 (Table 4.6-4), information from DWR surveys (California Department of Water Resources 2003), aerial photo interpretation, and wetland mapping by ICF Jones & Stokes during a 2008 field survey were used where appropriate to revise the impacts and mitigation for impacts on particular special-status species.

The key sources of data and information used to assess changes in the environmental setting following the publication of the 2001 FEIR and 2001 FEIS that relate to wildlife are listed below.

- A CNDDB records search within a 5-mile radius of the Project islands, which included all or a portion of the Woodward Island, Brentwood, Bouldin Island, Jersey Island, Rio Vista, Isleton, Thornton, Terminous, and Holt USGS 7.5-minute quadrangles (California Natural Diversity Database 2009).
- A USFWS list (dated June 3, 2009) of Endangered, Threatened, and candidate animal species for the Woodward Island, Bouldin Island, Jersey Island, Isleton, and Terminous USGS 7.5-minute quadrangles (U.S. Fish and Wildlife Service 2009).
- In-Delta Storage Program Draft Feasibility Study Report on Environmental Evaluations (California Department of Water Resources 2003).
- 2006 Supplemental Report to the 2004 Draft Feasibility Study In-Delta Storage Project (California Department of Water Resources 2006).

- The San Joaquin County Multi Species Habitat Conservation and Open Space Plan (SJMSCP) (San Joaquin Council of Governments 2000: 2-16–2-32).
- The Contra Costa County General Plan (Contra Costa County 2005: 8-12–8-16).

Affected Environment

This section provides an overview of federal and state regulations and describes wildlife habitat conditions on the Project islands and discusses changes in the existing conditions or regulatory setting since the 2001 FEIR and 2001 FEIS. Wildlife habitat information is based in part on information collected for the 1995 Draft EIR/EIS and on the 2001 FEIR and 2001 FEIS, and has been updated to current conditions where these changes would affect the impact analysis.

As a result of land management decisions made since 1988, some changes in agricultural land use and wildlife habitat conditions on the islands have occurred. Some of these changes were made in response to annual fluctuations in agricultural market conditions. Between 1990 and 2001, some cropping decisions that changed agricultural land use on the Project islands were made in anticipation of Project implementation. Additional cropping decisions made since 2001 have resulted in further changes in agricultural land use on the Project islands. Existing wildlife habitat conditions are based on recent crop information from 2008 (Delta Wetlands Properties 2008), information from DWR's surveys of the Project islands in 2002–2003 (California Department of Water Resources 2003), and 2008 wetland mapping and aerial photo interpretation completed by ICF Jones & Stokes. These sources of information were used to determine the baseline conditions for assessing the impacts of the Project alternatives.

Regulatory Setting

The following section describes regulations affecting wildlife relative to the Project.

Federal

Federal Endangered Species Act

The ESA protects fish and wildlife species and their habitats identified by the USFWS and NMFS as Threatened or Endangered. *Endangered* refers to species, subspecies, or distinct population segments that are in danger of extinction through all or a significant portion of their range; *Threatened* refers to species, subspecies, or distinct population segments that are likely to become Endangered in the near future. The ESA is administered by the USFWS and NMFS. In general, NMFS is responsible for protection of ESA-listed marine species and anadromous fishes, whereas other listed species are under USFWS jurisdiction.

Endangered Species Act Prohibitions (Section 9)

Section 9 of the ESA prohibits the take of any fish or wildlife species listed under ESA as Endangered. Take of Threatened species is also prohibited under Section 9, unless otherwise authorized by federal regulations. *Take*, as defined by ESA, means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." (Section 3 of the ESA; 16 USC Section 1532(19). *Harm* is defined by regulation as "any act that kills or injures the species, including significant habitat modification." (50 CFR Sections 17.3; 222.102). In addition, Section 9 prohibits removing, digging up, cutting, and maliciously damaging or destroying federally listed plants on sites under federal jurisdiction. Section 9 does not prohibit take of federally listed plants on sites not under federal jurisdiction. If the Project may result in take prohibited by Section 9, this take would need to be authorized through ESA Sections 7 or 10 (providing for the issuance of incidental take permits).

Endangered Species Act Consultation Process (Section 7)

Section 7 consultation provides a means for authorizing take of listed species for actions by federal agencies. Federal agency actions include activities that are:

- on federal land,
- conducted by a federal agency,
- funded by a federal agency, or
- authorized by a federal agency (including issuance of federal permits and licenses).

Under Section 7, the federal agency conducting, funding, or permitting an action (the federal lead agency) must consult USFWS or NMFS, as appropriate, to ensure its proposed action would not jeopardize the continued existence of an Endangered or Threatened species or destroy or adversely modify designated critical habitat. If a proposed project "may affect" a listed species or designated critical habitat, the lead agency is required to prepare a BA evaluating the nature and severity of the expected effect. The BA is prepared for the proposed action, and is submitted to USFWS and/or NMFS to initiate consultation. In response to a BA, USFWS and/or NMFS issues a BO, with a determination that the proposed action either:

- may jeopardize the continued existence of one or more listed species (jeopardy finding) or result in the destruction or adverse modification of critical habitat (adverse modification finding) or

- will not jeopardize the continued existence of any listed species (no jeopardy finding) or result in adverse modification of critical habitat (no adverse modification finding).

The BO issued by USFWS and/or NMFS may stipulate discretionary “reasonable and prudent” conservation measures. If the proposed action would not jeopardize a listed species, USFWS and/or NMFS may issue an incidental take statement to authorize the proposed activity and may include appropriate measures to offset the impacts of take.

Summary of Project Endangered Species Act Compliance

A BA was prepared for the Project that addressed valley elderberry longhorn beetle (VELB), bald eagle, American peregrine falcon, Aleutian Canada goose, and giant garter snake (Jones & Stokes Associates 1995a). The BO issued in May 1997 concluded that the Project would not have significant effects on bald eagle, California clapper rail, salt marsh harvest mouse, VELB, and giant garter snake (U.S. Fish and Wildlife Service 1997a: 1). Since the receipt of the BO, bald eagle and Aleutian Canada goose have been delisted.

ESA compliance for fish is discussed in Section 4.5, and ESA compliance for special-status plants is discussed in Section 4.6.

Migratory Bird Treaty Act

The federal Migratory Bird Treaty Act (MBTA) (16 USC 703) authorizes the U.S. Secretary of the Interior to protect and regulate the taking of migratory birds. It establishes seasons and bag limits for hunted species and protects migratory birds, their occupied nests, and their eggs (16 USC 703, 50 CFR 21, 50 CFR 10). Most actions that result in taking or in permanent or temporary possession of a protected species constitute violations of MBTA. Examples of permitted actions that do not violate MBTA are the possession of a hunting license to pursue specific gamebirds, legitimate research activities, display in zoological gardens, banding, and other similar activities. USFWS is responsible for overseeing compliance with MBTA, and the U.S. Department of Agriculture’s Animal Damage Control Officer makes recommendations on related animal protection issues.

Executive Order 13186 (January 10, 2001) directs each federal agency taking actions having or likely to have a negative impact on migratory bird populations to work with USFWS to develop a memorandum of understanding (MOU) to promote the conservation of migratory bird populations. Protocols developed under the MOU must include the following agency responsibilities:

- avoid and minimize, to the extent practicable, adverse impacts on migratory bird resources when conducting agency actions;
- restore and enhance habitat of migratory birds, as practical; and

- prevent or abate the pollution or detrimental alteration of the environment for the benefit of migratory birds, as practical.

The executive order is designed to assist federal agencies in their efforts to comply with MBTA and does not constitute any legal authorization to take migratory birds.

Bald Eagle Protection Act

Under the Bald Eagle Protection Act, it is illegal to import, export, take (which includes molest or disturb), sell, purchase, or barter any bald eagle or golden eagle or part thereof.

State

California Endangered Species Act

CESA generally parallels the main provisions of the ESA and is administered by the DFG.

Under CESA, *Endangered species* is defined as a species of plant, fish, or wildlife that is “in serious danger of becoming extinct throughout all, or a significant portion of its range” and is limited to species or subspecies native to California (CA Fish & Game Code Section 2062). *Threatened species* is defined as a native species or subspecies of a bird, mammal, fish, amphibian, reptile, or plant that, although not presently threatened with extinction, is likely to become an Endangered species in the foreseeable future in the absence of the special protection and management efforts (California Fish and Game Code Section 2062).

Section 2080 of CESA prohibits the take of Endangered and Threatened species, except as otherwise provided under Fish and Game Code Section 2080.1. Habitat destruction, however, is not included in the state’s definition of *take* (CA Fish & Game Code Section 86; 2080). The California Fish and Game Code defines *take* as “hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill.” DFG authorizes take through a variety of sections in the CA Fish & Game Code. If the species is listed under both ESA and CESA and take authorization has already been provided through the ESA, under Section 2080.1 of CESA, DFG can write a consistency determination where it determines that the avoidance, minimization, and compensation measures are consistent with the provisions of CESA. DFG may issue a take permit under 2081(b) of CEQA where DFG makes findings that, among other things, the impacts of take are minimized and fully mitigated and that the take would not lead to jeopardy. DFG may also authorize take per Section 2835 of the CA Fish & Game Code, as part of the Natural Communities Conservation Planning Act, where it has been covered under an approved Natural Communities Conservation Plan. Unlike its federal counterpart, CESA also applies the take prohibitions to species petitioned for listing (state candidates).

Summary of Project CESA Compliance

DFG issued a no-jeopardy opinion in 1998 for Project effects on state-listed fish and wildlife species. The 1998 DFG BO stated that the Project would not jeopardize the continued existence of greater sandhill crane, Swainson's hawk, and other terrestrial listed species with full implementation and adherence to the HMP (California Department of Fish and Game 1998: 38–39).

Other Provisions of the California Fish and Game Code

Fully Protected Species

In addition to CESA, the California Fish and Game Code provides protection from take for a variety of species, referred to as *fully protected species*. Section 5050 lists protected amphibians and reptiles. Birds that are fully protected are listed under Section 3511, and mammals that are fully protected are included in Section 4700. Except for take related to scientific research, all take of fully protected species is prohibited. Three fully protected species (greater sandhill crane, white-tailed kite, and California black rail) have the potential to occur in the Project area.

Sections 3503, 3513, and 3800

Section 3503 of the California Fish and Game Code prohibits the killing, possession, or destruction of bird eggs or of bird nests. Sections 3503.5 and 3513 prohibit the killing, possession, or destruction of all nesting birds (including raptors and passerines). Section 3513 prohibits the take or possession of any migratory non-game birds designated under the federal MBTA. Section 3800 prohibits take of non-game birds. These sections do not provide for the issuance of an incidental take permit.

Species of Special Concern

DFG maintains lists for candidate Endangered species and candidate Threatened species. California candidate species are afforded the same level of protection as listed species. California also designates species of special concern, which are species of limited distribution, declining populations, diminishing habitat, or of unusual scientific, recreational, or educational value. These species do not have the same legal protection as listed species or fully protected species, but may be added to official lists in the future. DFG intends the species of special concern list to be a management tool for consideration in future land use decisions.

Local

Bacon and Bouldin Islands are in San Joaquin County and Webb and Holland Tracts are in Contra Costa County. The local regulations established by San Joaquin and Contra Costa Counties that pertain to the islands that fall within their respective boundaries are described below.

San Joaquin County Multi-Species Habitat and Open Space Conservation Plan

The SJMSCP was adopted in 2001 and covers all of San Joaquin County. Permit holders under the SJMSCP include the county; the cities of Escalon, Lodi, Manteca, Stockton, Lathrop, Ripon, and Tracy; the San Joaquin Council of Governments (SJCOG); and others. The SJMSCP is designed to provide a regional approach to mitigating development impacts on the 97 listed and non-listed plant, fish, and wildlife species covered by the SJMSCP and compensating for the conversion of open space to non–open space uses. The plan provides compensation for habitat losses through collection of fees that are used to preserve habitats elsewhere.

East Contra Costa County Habitat Conservation Plan

The East Contra Costa County Habitat Conservation Plan/Natural Community Conservation Plan (ECCCHCP/NCCP) was adopted in January 2008. Permit holders under the ECCCHCP/NCCP include the County; the cities of Brentwood, Clayton, Oakley, and Pittsburg; and Contra Costa County Flood Control and Water Conservation District and the East Bay Regional Park District. The ECCCHCP/NCCP is designed to provide a regional approach to mitigating housing, transportation, and growth impacts on the 28 covered species. The plan provides compensation for habitat losses through collection of fees that are used to preserve and restore habitats and natural communities in the County as well as a framework to pursue other conservation efforts in the County. It does not include Delta lands, and therefore does not affect the Project.

Contra Costa County General Plan

The goals and policies of the Contra Costa County General Plan that are relevant to wildlife on the Project islands are summarized below (Contra Costa County 2005: 8-15, 8-16).

Goals

- To protect ecologically significant lands, wetlands, plants and wildlife habitats.
- To protect Rare, Threatened, and Endangered species of fish, wildlife, and plants, significant plant communities, and other resources that stand out as unique because of their scarcity, scientific value, aesthetic quality or cultural significance. Attempt to achieve a significant net increase in wetland values and functions within the County over the life of the General Plan. The definition of Rare, Threatened, and Endangered species includes those definitions provided by ESA, CESA, the California Native Plant Protection Act, and CEQA.
- To encourage the preservation and restoration of the natural characteristics of the San Francisco Bay/Delta estuary and adjacent lands, and recognize the

role of Bay vegetation and water area in maintaining favorable climate, air and water quality, and fisheries and migratory waterfowl.

Policies

- Significant trees, natural vegetation, and wildlife populations generally shall be preserved.
- Important wildlife habitats that would be disturbed by major development shall be preserved, and corridors for wildlife migration between undeveloped lands shall be retained.
- Areas determined to contain significant ecological resources, particularly those containing Endangered species, shall be maintained in their natural state and carefully regulated to the maximum legal extent.
- Any development located or proposed within significant ecological resource area shall ensure the resource is protected.
- The County shall utilize performance criteria and standards which seek to regulate uses in and adjacent to significant ecological resource areas.
- Natural woodlands shall be preserved to the maximum extent possible in the course of land development.
- The critical ecological and scenic characteristics of rangelands, woodlands, and wildlands shall be recognized and protected.
- Existing vegetation, both native and nonnative, and wildlife habitat areas shall be maintained in the major open space areas sufficient for the maintenance of a healthy balance of wildlife populations.
- The ecological value of wetlands areas, especially the salt marshes and tidelands of the Bay and Delta, shall be recognized. Existing wetlands in the county shall be identified and regulated. Restoration of degraded wetland areas shall be encouraged and supported whenever possible.
- Fish, shellfish, and waterfowl management shall be considered the appropriate land use for marshes and tidelands, with recreation being allowed as a secondary use in limited locations, consistent with the marshland and tideland preservation policies of the General Plan.
- The planting of native trees and shrubs shall be encouraged in order to preserve the visual integrity of the landscape, provide habitat conditions suitable for native wildlife, and ensure that a maximum number and variety of well-adapted plants are sustained in urban areas.
- The County shall strive to identify and conserve remaining upland habitat areas that are adjacent to wetlands and are critical to the survival and nesting of wetland species.
- The County shall protect marshes, wetlands, and riparian corridors from the effects of potential industrial spills.
- The environmental impacts of using poisons to control ground squirrel populations in grasslands shall be thoroughly evaluated by the County.

- Efforts shall be made to identify and protect the County's mature native oak, bay, and buckeye trees.

Environmental Setting

Changes since the 2001 FEIR and 2001 FEIS

Habitat Types

As mentioned previously, the types and coverage of crops on some of the islands have changed since 1988 (the year that baseline conditions were based on for the 2000 FEIR). Changes in the types of crops present could result in a change in the composition of bird species using the islands for foraging. In addition, changes in the amount of various crops could result in modification of impact acreages for species using the particular crop type. On Bacon Island, corn and alfalfa were the majority of crops in 2008, whereas potatoes and asparagus were the primary crops reported in the 2001 FEIR and 2001 FEIS. Crops on Webb Tract have remained relatively the same, with corn being the main crop in 1988 and 2008. The 2001 FEIR and 2001 FEIS reports corn, wheat, and sunflowers as the primary crops on Bouldin Island in 1988. The major crops on Bouldin Island in 2008 were corn, wheat, rice, and tomatoes. Whereas there were 2,208 acres of agriculture and 542 acres of pasture lands on Holland Tract in 1988, there were 1,160 acres of agriculture (all fallow land) and 1,672 acres of exotic grassland and exotic marsh in 2008 (pasture was mapped as fallow and exotic marsh by ICF Jones & Stokes in 2008). The increase in grassland and marsh could result in an increase in the number or diversity of species occurring on this island because these areas have not been intensively managed as agriculture in recent years. The 2008 crop information (Delta Wetlands Properties 2008), information from DWR surveys (California Department of Water Resources 2003; Patterson pers. comm.), aerial photo interpretation, and wetland mapping by ICF Jones & Stokes during a 2008 field survey were used to update the island descriptions in the Summary of Setting from the 2001 FEIR and 2001 FEIS section below.

Special-Status Species

Special-status species include species that are state or federally listed as Threatened or Endangered, proposed and candidates for federal listing, DFG species of special concern, and species fully protected under the California Fish and Game Code. Fourteen special-status wildlife species originally were identified as occurring or potentially occurring on the Project islands. Of these 14 species, two species (cackling [Aleutian Canada] goose and bald eagle) have been removed from the ESA list and two species (Cooper's hawk and ferruginous hawk) are no longer California species of special concern (California Department of Fish and Game 2009). Bald eagle is still listed by the state as a Threatened species and is protected by the Bald and Golden Eagle Protection Act, so it is still considered a special-status species. Because the federal status of cackling goose was the only status that this species had, it is not longer considered a special-status species. Similarly, the species of special concern status was the only status that Cooper's hawk and ferruginous hawk had, and therefore these species are no longer considered special-status species. However, discussions of these species are still included within this document.

Based on a review of the CNDDB (California Natural Diversity Database 2009) and the USFWS (2009) list for the quadrangles listed above under Sources of Information, and previous documents prepared for the Project, 39 special-status (or former special-status) wildlife species have the potential to occur in the Project vicinity (Table 4.7-2). Seventeen of these species would not occur or are unlikely to occur in the Project area because suitable habitat is not present or the Project area is outside of the species historical and/or current range (see Table 4.7-2 for the rationale for why each species would not occur). Three species (golden eagle, mountain plover, and bank swallow) from the CNDDB and USFWS lists occasionally may forage in the Project area but would not be affected by the Project. The remaining 19 species have the potential to occur in the Project area and may be affected by the Project. These species are listed below.

- valley elderberry longhorn beetle
- western pond turtle
- giant garter snake
- cackling (Aleutian Canada) goose
- northern harrier
- bald eagle
- Cooper's hawk
- Swainson's hawk
- ferruginous hawk
- white-tailed kite
- American peregrine falcon
- California black rail
- greater sandhill crane
- western burrowing owl
- short-eared owl
- loggerhead shrike
- tricolored blackbird
- western red bat
- pallid bat

The geographic distribution, habitat requirements, and potential for occurrence in the Project area for all special-status wildlife species identified as occurring in the Project vicinity are provided in Table 4.7-2. All of the species listed above were addressed in the 2001 FEIR and 2001 FEIS except for white-tailed kite, loggerhead shrike, western red bat, and pallid bat. New CNDDB records for white-tailed kite, loggerhead shrike, western red bat, and pallid bat have been added since the analysis for the 2001 FEIR and 2001 FEIS (California Natural Diversity Database 2009). In addition, since the 2001 FEIR and 2001 FEIS, several new occurrences of western pond turtle, giant garter snake, Swainson's hawk, and California black rail have been reported in and along the edges of the islands or in the immediate vicinity of the islands (California Natural Diversity Database 2009).

Table 4.7-2. Special-Status Wildlife Species with Potential to Occur in the Vicinity of the Project Study Area

Common and Scientific Name	Status[a] Fed/State	California Distribution	Habitats	Occurrence in the Study Area
Longhorn fairy shrimp *Branchinecta longiantenna*	E/–	Eastern margin of central Coast Ranges from Contra Costa County to San Luis Obispo County; disjunct population in Madera County	Small, clear pools in sandstone rock outcrops of clear to moderately turbid clay- or grass-bottomed pools	Would not occur—suitable habitat not present
Conservancy fairy shrimp *Branchinecta conservatio*	E/–	Disjunct occurrences in Solano, Merced, Tehama, Ventura, Butte, and Glenn Counties	Large, deep vernal pools in annual grasslands	Would not occur—suitable habitat not present
Vernal pool fairy shrimp *Branchinecta lynchi*	T/–	Central Valley, central and south Coast Ranges from Tehama County to Santa Barbara County. Isolated populations also in Riverside County	Common in vernal pools; also found in sandstone rock outcrop pools	Would not occur—suitable habitat not present
Vernal pool tadpole shrimp *Lepidurus packardi*	E/–	Shasta County south to Merced County	Vernal pools and ephemeral stock ponds	Would not occur—suitable habitat not present
Valley elderberry longhorn beetle *Desmocerus californicus dimorphus*	T/–	Stream side habitats below 3,000 feet throughout the Central Valley	Riparian and oak savanna habitats with elderberry shrubs; elderberries are the host plant	Suitable habitat present—one large cluster of elderberry shrubs on Holland Tract; no VELB observed during surveys in 2002 and 2003.
Delta green ground beetle *Elaphrus viridus*	T/–	Restricted to Olcott Lake and other vernal pools at Jepson Prairie Preserve, Solano County	Sparsely vegetated edges of vernal lakes and pools; occur up to 250 feet from pools	Would not occur—suitable habitat not present
California tiger salamander *Ambystoma californiense*	T/C	Central Valley, including Sierra Nevada foothills, up to approximately 1,000 feet, and coastal region from Butte County south to Santa Barbara County	Small ponds, lakes, or vernal pools in grass-lands and oak woodlands for larvae; rodent burrows, rock crevices, or fallen logs for cover for adults and for summer dormancy	Would not occur—not known to occur in the Delta area currently or historically (Jennings and Hayes 1994; CNDDB 2009).
California red-legged frog *Rana aurora draytonii*	T/SSC	Found along the coast and coastal mountain ranges of California from Marin County to San Diego County and in the Sierra Nevada from Tehama County to Fresno County	Permanent and semipermanent aquatic habitats, such as creeks and cold-water ponds, with emergent and submergent vegetation. May estivate in rodent burrows or cracks during dry periods	Would not occur—not known to occur in the Delta area currently or historically (Jennings and Hayes 1994; CNDDB 2009).

Common and Scientific Name	Status[a] Fed/State	California Distribution	Habitats	Occurrence in the Study Area
Western pond turtle *Actinemys marmorata*	–/SSC	The range of the northwestern subspecies extends from Oregon border of Del Norte and Siskiyou Counties south along coast to San Francisco Bay, inland through Sacramento Valley, and on the western slope of Sierra Nevada; the southwestern subspecies occurs along the central coast of California east to the Sierra Nevada and along the southern California coast inland to the Mojave and Sonora Deserts; the subspecies' range overlaps through the Delta and Central Valley to Tulare County	Woodlands, grasslands, and open forests; occupies ponds, marshes, rivers, streams, and irrigation canals with muddy or rocky bottoms and with watercress, cattails, water lilies, or other aquatic vegetation	Ditches and blowout ponds provide suitable aquatic habitat; may occur in grassland and along edges of islands; several observed on islands during 2002 surveys (DWR 2003) and many known occurrences in waterways surrounding the four islands (CNDDB 2009)
California horned lizard *Phrynosoma coronatum frontale*	–/SSC	Sacramento Valley, including foothills, south to southern California; Coast Ranges south of Sonoma County; below 4,000 feet in northern California	Grasslands, brushlands, woodlands, and open coniferous forest with sandy or loose soil; requires abundant ant colonies for foraging	Would not occur—not known to occur in the Delta area currently or historically (Jennings and Hayes 1994; CNDDB 2009).
Silvery legless lizard *Anniella pulchra pulchra*	–/SSC	Along the Coast, Transverse, and Peninsular Ranges from Contra Costa County to San Diego County with spotty occurrences in the San Joaquin Valley	Habitats with loose soil for burrowing or thick duff or leaf litter; often forages in leaf litter at plant bases; may be found on beaches, sandy washes, and in woodland, chaparral, and riparian areas	Unlikely to occur because of the amount of disturbance from agricultural activities on the islands.
Giant garter snake *Thamnophis gigas*	T/T	Central Valley from the vicinity of Burrel in Fresno County north to near Chico in Butte County; has been extirpated from areas south of Fresno	Sloughs, canals, low gradient streams and freshwater marsh habitats where there is a prey base of small fish and amphibians; also found in irrigation ditches and rice fields; requires grassy banks and emergent vegetation for basking and areas of high ground protected from flooding during winter	Ditches and canals on the islands provide suitable aquatic habitat; ungrazed pasture and riparian areas provide suitable upland habitat; one known occurrence at Webb Tract and one occurrence northeast of Bacon Island (CNDDB 2009)
Alameda whipsnake *Masticophis lateralis euryxanthus*	T/T	Restricted to Alameda and Contra Costa Counties	Valleys, foothills, and low mountains associated with northern coastal scrub or chaparral habitat; requires rock outcrops for cover and foraging	Would not occur—suitable habitat not present

Common and Scientific Name	Status[a] Fed/State	California Distribution	Habitats	Occurrence in the Study Area
San Joaquin whipsnake *Masticophis flagellum ruddocki*	–/SSC	From Colusa County in the Sacramento Valley southward to the grapevine in the San Joaquin Valley and westward into the inner coast ranges. An isolated population occurs at Sutter Buttes. Known elevation range from 20 to 900 meters	Occurs in open, dry, vegetative associations with little or no tree cover. It occurs in valley grassland and saltbush scrub associations. Often occurs in association with mammal burrows	Would not occur—suitable habitat not present
Cackling (Aleutian Canada) goose *Branta hutchinsii leucopareia*	D/–	The entire population winters in Butte Sink, then moves to Los Banos, Modesto, the Delta, and East Bay reservoirs; stages near Crescent City during spring before migrating to breeding grounds	Roosts in large marshes, flooded fields, stock ponds, and reservoirs; forages in pastures, meadows, and harvested grainfields; corn is especially preferred	Suitable habitat present; no longer a federally listed species.
Northern harrier *Circus cyaneus*	–/SSC	Occurs throughout lowland California. Has been recorded in fall at high elevations	Grasslands, meadows, marshes, and seasonal and agricultural wetlands	Suitable nesting and foraging habitat present. Many harriers observed during 1988 surveys.
Golden eagle *Aquila chrysaetos*	PR/FP	Foothills and mountains throughout California. Uncommon nonbreeding visitor to lowlands such as the Central Valley	Nest on cliffs and escarpments or in tall trees overlooking open country. Forages in annual grasslands, chaparral, and oak woodlands with plentiful medium and large-sized mammals	Would not nest in Project area; could occasionally forage in Project area but would not be affected by Project
Bald eagle *Haliaeetus leucocephalus*	D, PR/E	Nests in Siskiyou, Modoc, Trinity, Shasta, Lassen, Plumas, Butte, Tehama, Lake, and Mendocino Counties and in the Lake Tahoe Basin. Reintroduced into central coast. Winter range includes the rest of California, except the southeastern deserts, very high altitudes in the Sierra Nevada, and east of the Sierra Nevada south of Mono County	In western North America, nests and roosts in coniferous forests within 1 mile of a lake, reservoir, stream, or the ocean	Would not nest but may forage in Project area
Cooper's hawk *Accipiter cooperii*	–/–	Throughout California except high altitudes in the Sierra Nevada. Winters in the Central Valley, southeastern desert regions, and plains east of the Cascade Range	Nests in a wide variety of habitat types, from riparian woodlands and digger pine-oak woodlands through mixed conifer forests	Could nest in riparian habitat or forage in the Project area; observed on all islands during 2002–2003 surveys (DWR 2003).

Common and Scientific Name	Status[a] Fed/State	California Distribution	Habitats	Occurrence in the Study Area
Swainson's hawk *Buteo swainsoni*	–/T	Lower Sacramento and San Joaquin Valleys, the Klamath Basin, and Butte Valley. Highest nesting densities occur near Davis and Woodland, Yolo County	Nests in oaks or cottonwoods in or near riparian habitats. Forages in grasslands, irrigated pastures, and grain fields	Documented nesting on Webb Tract and Bacon Island during 2002 surveys (DWR 2003). Suitable nesting and foraging habitat present on all islands. Also known to nest adjacent to islands (CNDDB 2009).
Ferruginous hawk *Buteo regalis*	–/–	Does not nest in California; winter visitor along the coast from Sonoma County to San Diego County, east-ward to the Sierra Nevada foothills and south-eastern deserts, the Inyo-White Mountains, the plains east of the Cascade Range, and Siskiyou County	Open terrain in plains and foothills where ground squirrels and other prey are available	Would not nest but may forage in Project area. Only observed on Holland Tract during 2002–2003 surveys.
White-tailed kite *Elanus leucurus*	–/FP	Lowland areas west of Sierra Nevada from the head of the Sacramento Valley south, including coastal valleys and foothills to western San Diego County	Low foothills or valley areas with valley or live oaks, riparian areas, and marshes near open grasslands	Suitable nesting and foraging habitat present. Known to nest near the Project area (CNDDB 2009). Many kites observed during 1988 surveys and were suspected to nest on islands. Observed on all islands in 2002–2003.
American peregrine falcon *Falco peregrinus anatum*	–/E, FP	Permanent resident along the north and south Coast Ranges. May summer in the Cascade and Klamath Ranges and through the Sierra Nevada to Madera County. Winters in the Central Valley south through the Transverse and Peninsular Ranges and the plains east of the Cascade Range	Nests and roosts on protected ledges of high cliffs, usually adjacent to lakes, rivers, or marshes that support large prey populations	Would not nest but may forage in Project area. Observed on all islands during 2002–2003 surveys.
California clapper rail *Rallus longirostris obsoletus*	E/E, FP	Marshes around the San Francisco Bay and east through the Delta to Suisun Marsh	Restricted to salt marshes and tidal sloughs; usually associated with heavy growth of pickleweed; feeds on mollusks removed from the mud in sloughs	Project area is outside of species known range; suitable habitat not present.

Common and Scientific Name	Status[a] Fed/State	California Distribution	Habitats	Occurrence in the Study Area
California black rail *Laterallus jamaicensis coturniculus*	–/T, FP	Permanent resident in the San Francisco Bay and east-ward through the Delta into Sacramento and San Joaquin Counties; small populations in Marin, Santa Cruz, San Luis Obispo, Orange, Riverside, and Imperial Counties	Tidal salt marshes associated with heavy growth of pickleweed; also occurs in brackish marshes or freshwater marshes at low elevations	Lower-quality habitat present on Webb Tract and Holland Tract. Surveys conducted around Bacon Island in 2002 and none were heard (DWR 2003). Known to nest immediately adjacent to all islands except Webb Tract (CNDDB 2009).
Greater sandhill crane *Grus canadensis tabida*	–/T, FP	Breeds in Siskiyou, Modoc, Lassen, Plumas, and Sierra Counties. Winters in the Central Valley, southern Imperial County, Lake Havasu National Wildlife Refuge, and the Colorado River Indian Reserve	Summers in open terrain near shallow lakes or freshwater marshes. Winters in plains and valleys near bodies of fresh water	Islands provide wintering habitat; observed on Bouldin Island during 1988 surveys; observed on all islands during 2002–2003 surveys (DWR 2003).
Mountain plover *Charadrius montanus*	–/SSC	Does not breed in California; in winter, found in the Central Valley south of Yuba County, along the coast in parts of San Luis Obispo, Santa Barbara, Ventura, and San Diego Counties; parts of Imperial, Riverside, Kern, and Los Angeles Counties	Occupies open plains or rolling hills with short grasses or very sparse vegetation; nearby bodies of water are not needed; may use newly plowed or sprouting grainfields	Would not nest in Project area; may occasionally forage but would not be affected by Project.
Western burrowing owl *Athene cunicularia hypugaea*	–/SSC	Lowlands throughout California, including the Central Valley, northeastern plateau, southeastern deserts, and coastal areas. Rare along south coast	Level, open, dry, heavily grazed or low stature grassland or desert vegetation with available burrows	Suitable breeding and foraging habitat present. No owls were observed during 2002–2003 surveys (DWR 2003); 1 owl was observed on Bacon Island during the 1988 surveys.
Short-eared owl *Asio flammeus*	–/SSC	Permanent resident along the coast from Del Norte County to Monterey County although very rare in summer north of San Francisco Bay, in the Sierra Nevada north of Nevada County, in the plains east of the Cascades, and in Mono County; small, isolated populations	Freshwater and salt marshes, lowland meadows, and irrigated alfalfa fields; needs dense tules or tall grass for nesting and daytime roosts	Limited suitable nesting habitat present; may forage in the Project area; not observed during 1988 or 2003 surveys.

Common and Scientific Name	Status[a] Fed/State	California Distribution	Habitats	Occurrence in the Study Area
Bank swallow *Riparia riparia*	–/T	Occurs along the Sacramento River from Tehama County to Sacramento County, along the Feather and lower American Rivers, in the Owens Valley; and in the plains east of the Cascade Range in Modoc, Lassen, and northern Siskiyou Counties. Small populations near the coast from San Francisco County to Monterey County	Nests in bluffs or banks, usually adjacent to water, where the soil consists of sand or sandy loam	Suitable nesting habitat may be present adjacent to islands but species would not nest on islands; may occasionally forage in Project area but would not be affected by Project.
Loggerhead shrike *Lanius ludovicianus*	–/SSC	Resident and winter visitor in lowlands and foothills throughout California. Rare on coastal slope north of Mendocino County, occurring only in winter	Prefers open habitats with scattered shrubs, trees, posts, fences, utility lines, or other perches	Suitable breeding and foraging habitat may be present on islands; many shrikes observed during surveys in 1988 and 2002–2003 (DWR 2003).
Saltmarsh common yellowthroat *Geothlypis trichas sinuosa*	–/SSC	Found only in the San Francisco Bay Area in Marin, Napa, Sonoma, Solano, San Francisco, San Mateo, Santa Clara, and Alameda Counties	Breeds in fresh and brackish marsh associated with and close to Bay wetlands. Freshwater marshes are used in summer and salt or brackish marshes in fall and winter; requires tall grasses, tules, and willow thickets for nesting and cover	Project area is outside of the subspecies known range.
Suisun song sparrow *Melospiza melodia maxillaris*	–/SSC	Restricted to the extreme western edge of the Delta, between the cities of Vallejo and Pittsburg near Suisun Bay	Brackish and tidal marshes supporting cattails, tules, various sedges, and pickleweed	Project area is outside of the subspecies known range.
Tricolored blackbird *Agelaius tricolor*	–/SSC	Permanent resident in the Central Valley from Butte County to Kern County. Breeds at scattered coastal locations from Marin County south to San Diego County; and at scattered locations in Lake, Sonoma, and Solano Counties. Rare nester in Siskiyou, Modoc, and Lassen Counties	Nests in dense colonies in emergent marsh vegetation, such as tules and cattails, or upland sites with blackberries, nettles, thistles, and grainfields. Habitat must be large enough to support 50 pairs. Probably requires water at or near the nesting colony	Suitable nesting and foraging habitat present. No nesting colonies observed during 2002 surveys. Observed foraging on Bacon Island and Webb tract during 2002–2003 surveys (DWR 2003).
Western red bat *Lasiurus blossevillii*	–/SSC	Scattered throughout much of California at lower elevations	Found primarily in riparian and wooded habitats. Occurs at least seasonally in urban areas. Day roosts in trees within the foliage. Found in fruit orchards and sycamore riparian habitats in the central valley	Could roost in riparian areas and forage over or near the islands. Three occurrences within 5 miles of the Project (CNDDB 2009).

Common and Scientific Name	Status[a] Fed/State	California Distribution	Habitats	Occurrence in the Study Area
Pallid bat *Antrozous pallidus*	–/SSC	Occurs throughout California except the high Sierra from Shasta to Kern County and the northwest coast, primarily at lower and mid elevations.	Occurs in a variety of habitats from desert to coniferous forest. Most closely associated with oak, yellow pine, redwood, and giant sequoia habitats in northern California and oak woodland, grassland, and desert scrub in southern California. Relies heavily on trees for roosts.	Could roost in riparian areas or forage over or near the islands; no occurrences within 5 miles of the Project (CNDDB 2009).
Salt marsh harvest mouse *Reithrodontomys raviventris*	E/E, FP	San Francisco, San Pablo, and Suisun Bays; the Delta	Salt marshes with a dense plant cover of pickleweed and fat hen; adjacent to an upland site	Suitable habitat not present in the Project area.
San Joaquin kit fox *Vulpes macrotis mutica*	E/T	Principally occurs in the San Joaquin Valley and adjacent open foothills to the west; recent records from 17 counties extending from Kern County north to Contra Costa County	Saltbush scrub, grassland, oak, savanna, and freshwater scrub	Unlikely to occur—may occasionally move through Project area but unlikely due to limited access/being surrounded by waterways.
American badger *Taxidea taxus*	–/SSC	Throughout California, except for the humid coastal forests of northwestern California in Del Norte County and the northwestern portion of Humboldt County	Requires sufficient food, friable soils, and relatively open uncultivated ground. Preferred habitat includes grasslands, savannas, and mountain meadows near timberline	Would not occur- marginally suitable foraging habitat present and water surrounding islands likely excludes presence.

[a] Status explanations:

Federal

E = listed as Endangered under the federal Endangered Species Act.
T = listed as Threatened under the federal Endangered Species Act.
PR = protected by the Bald and Golden Eagle Protection Act proposed
D = delisted; species that are delisted are monitored for 5 years after delisting.
– = no listing.

State

E = listed as Endangered under the California Endangered Species Act.
T = listed as Threatened under the California Endangered Species Act.
C = candidate for listing under the California Endangered Species Act.
FP = fully protected under the California Fish and Game Code.
SSC = species of special concern in California.
– = no listing.

Sources: California Department of Fish and Game 2009; California Department of Water Resources 2003; Jennings and Hayes 1994.

Existing Environment

General habitat information present in the 2001 FEIR and 2001 FEIS has been updated in this section where changes in crop types or other habitat changes have occurred. Information on trends for waterfowl abundance in the Delta region is similar to that reported in 2001 but has been updated with current data. For the most part, information on specific birds or groups of birds observed on the islands has been removed from this discussion since these data were collected 20 years ago. The sections related to special-status species have been revised substantially to include new information and information lacking from the 2001 FEIR and 2001 FEIS.

Waterfowl and Other Birds

The size of waterfowl populations wintering in the Delta fluctuates between years because of changes in weather, habitat conditions, and flyway populations. Despite annual fluctuation, large populations of waterfowl had used the Delta area in most years until the early 1980s. Between 1970 and 1982, wintering waterfowl populations in the Delta declined by approximately 83% (Weaver pers. comm.). The decline was most pronounced for ducks, but declines were also evident for swans and geese.

Population declines in the Delta during the 1980s reflect the larger waterfowl population decline that occurred in the Central Valley and Pacific Flyway. The decline was attributable to a variety of factors, the most important of which was probably the prolonged drought in northern breeding areas that resulted in unfavorable land use changes (i.e., intensified farming of former wetland areas and adjacent nesting habitats). Loss of winter habitat also was considered an important factor that contributed to the population reduction (Implementation Board of the Central Valley Habitat Joint Venture 1990). Duck and goose populations began to recover in the 1990s. The wet years of 1993 through 1995 in northern breeding areas provided favorable breeding conditions that resulted in substantially higher production of ducks and geese. From 1992 to 2008, the average number of waterfowl recorded in the Delta was 156,203 during midwinter surveys (Weaver pers. comm.). Although this is still substantially lower than the number of waterfowl observed in the 1970s, the data suggest that populations are slowly increasing in the Delta.

Specific information on types and numbers of waterfowl and other birds (piscivorous [fish-eating] birds, wading birds, shorebirds, gulls and terns, swallows, blackbirds and starlings, bird species typically associated with riparian woodland and scrub, and bird species typically associated with grassland and agricultural habitats) on the Project islands was provided in the 2001 FEIR and 2001 FEIS. In general, habitats on the islands have remained relatively the same since the 1988 surveys were conducted (Tables 4.7-3 and 4.7-4). Although some of the changes in habitat between 1988 and 2008 may appear quite large in Tables 4.7-3 and 4.7-4, the changes relative to the amount of each habitat type on the islands in 1988 and 2008 are not substantially different. For example, on the Reservoir Islands (Bacon Island and Webb Tract), there was an 84% decrease in marsh between 1988 and 2008; however, the relative loss of this habitat was 3.8% (Table 4.7-3). In addition, differences in mapping techniques and habitat categories between 1988 and 2008 data may inflate the differences in acreages of habitat between the two years. Differences in habitat types and quantities between 1988 and 2008 and corresponding expected changes in waterfowl and other birds based on these changes are described for each island below.

Table 4.7-3. Changes in Land Use/Habitats on the Reservoir Islands between 1988 and 2008

	1988 (acres)	2008 (acres)	Difference (acres)	% Change	1988 % Relative[1]	2008 % Relative[2]	% Relative Change[3]
Agriculture	8187.90	9164.47	976.57	12	37.4	41.8	4.4
Herbaceous uplands	1,367.20	1,201.67	-165.53	-12	6.2	5.5	-0.8
Marsh	988.40	158.97	-829.43	-84	4.5	0.7	-3.8
Open water	249.90	145.81	-104.09	42	1.1	0.7	-0.5
Riparian	109.10	188.61	79.51	73	0.5	0.9	0.4
Developed	105.90	193.22	87.32	82	0.5	0.9	0.4

[1] 1988 % relative was calculated by dividing the acres of the particular land use/habitat by the total acres in 1988.
[2] 2008 % relative was calculated by dividing the acres of the particular land use/habitat by the total acres in 2008.
[3] % relative change was calculated by subtracting 1988% relative from 2008 % relative.

Table 4.7-4. Changes in Land Use/Habitats on the Habitat Islands between 1988 and 2008

	1988 (acres)	2008 (acres)	Difference (acres)	% Change	1988 % Relative	2008 % Relative	% Relative Change
Agriculture	8,026.10	6,219.14	-1,806.96	-23	44.8	34.5	-10.3
Herbaceous uplands	349.10	856.08	506.98	145	1.9	4.7	2.8
Marsh	359.00	1,709.97	1,350.97	76	2	9.5	7.5
Open Water	184.30	85.23	-99.07	-54	1	0.5	-0.5
Riparian	122.0	137.54	15.54	13	0.7	0.8	0.1
Developed	74.80	79.71	4.91	7	0.4	0.4	0

[1] 1988 % relative was calculated by dividing the acres of the particular land use/habitat by the total acres in 1988.
[2] 2008 % relative was calculated by dividing the acres of the particular land use/habitat by the total acres in 2008.
[3] % relative change was calculated by subtracting 1988% relative from 2008 % relative.

Bacon Island

Bacon Island is 5,500 acres and is the most intensively farmed of the four Project islands. Between 1988 and 2008, an additional 123 acres has gone into agricultural production. The primary crops grown have shifted from potatoes, asparagus, and corn in 1988 to corn and alfalfa in 2008. The amount of corn on the island has increased from 776 acres in 1988 to approximately 1,920 acres in 2008; median corn production from 1988 and 2002 to 2008 was 1,914 acres. The greater amount of corn provides additional foraging habitat for wintering waterfowl. In addition, the presence of alfalfa may provide nesting opportunities for waterfowl. Although the types of crops grown have changed somewhat, the overall amount of land in agricultural production has been relatively the same. Therefore, types and numbers of other bird species on the island are expected to be similar to those reported in the 2001 FEIR and 2001 FEIS.

Waste Grain Availability

In 1988, approximately 82,000 pounds of corn was estimated to be available immediately after harvest, but postharvest disking for planting to winter wheat on approximately half the corn acreage reduced the availability to approximately 67,500 pounds (see Appendix H2, "Wildlife Inventory Methods and Results," in the 1995 EIR/EIS). The amount of waste corn is likely greater in 2008 since the amount of corn planted on Bacon Island has increased since 1988 (Delta Wetland Properties 2008).

Hunting Harvest

No waterfowl or upland game is harvested on Bacon Island.

Webb Tract

Webb Tract is 5,450 acres and is less intensively farmed than Bacon Island. Approximately 103 acres of open water habitat consisting of permanent ponds, canals, and ditches are present on the island. There are also 183 acres of riparian woodland and scrub and 51 acres of freshwater marsh on Webb Tract. Between 1988 and 2008, approximately 853 acres of additional crops have been established. Corn and wheat were the primary crops in 1988 and 2008. The amount of corn on the island has increased from 2,223 acres in 1988 to approximately 4,178 acres in 2008; median corn production from 1988 and 2002 to 2008 was 3,282 acres. The greater amount of corn provides additional foraging habitat for wintering waterfowl. The diversity and numbers of other bird species on the island may have declined from what was reported in the 2001 FEIR and 2001 FEIS as the amount of corn has nearly doubled since surveys initially were conducted.

Waste Grain Availability

In 1988, approximately 567,000 pounds of waste corn were produced on Webb Tract and were available for waterfowl and other wildlife (see Appendix H2, "Wildlife Inventory Methods and Results," in the 1995 EIR/EIS). The amount of waste corn is likely greater in 2008 as the amount of corn planted on Webb Tract has increased since 1988 (Delta Wetland Properties 2008). Wheat also provides seed following harvest in summer and green forage for geese and other wintering birds during late fall and winter.

Hunting Harvest

Harvest rates of ducks and geese are highest on Webb Tract among the four Project islands. The harvest represents a small proportion of the total numbers of birds that use the island.

Bouldin Island

Bouldin Island is 5,957 acres, the majority of which is agricultural lands. Smaller amounts of other habitats exist, including herbaceous upland. Between 1988 and

2008, approximately 218 acres have been taken out of agricultural production. Corn and wheat were the primary crops in 1988, and corn was the primary crop in 2008. Sunflower was also a main crop in 1988, and this was shifted to rice and tomatoes in 2008. The amount of corn on the island has increased from 2,459 acres in 1988 to approximately 4,149 acres in 2008; median corn production from 1988 and 2002 to 2008 was 3,153 acres. The greater amount of corn provides additional foraging habitat for wintering waterfowl. Therefore, the number of waterfowl on the island may have increased. The types and numbers of other bird species on the island are expected to be similar to those reported in the 2001 FEIS.

Waste Grain Availability

In 1988, approximately 214,000 pounds of waste corn were produced and available for waterfowl use on Bouldin Island (see Appendix H2, "Wildlife Inventory Methods and Results," in the 1995 EIR/EIS). Average corn availability shortly after harvest was 87 pounds per acre. Field measurements on the island yielded an average of 106 pounds per acre of grain left in the half of the cornfields that were not disked after harvest, and 68 pounds per acre in remaining areas disked prior to the planting of winter wheat (Jones & Stokes Associates Inc. 1989). The amount of waste corn on Bouldin Island was likely greater in 2008 as the amount of corn planted on the island has increased since 2008 (Delta Wetland Properties 2008).

Approximately 1,200 acres of wheat, another important source of waste grain for waterfowl, was grown on the island on the island in 1988. Waterfowl, especially Canada and white-fronted geese, graze extensively on green wheat foliage during winter and early spring (Fredrickson et al. 1988; Miller pers. comm.). Wheat was not grown on the island in 2007 or 2008 (Delta Wetland Properties 2008a).

Hunting Harvest

Small numbers of ducks and geese are harvested annually by hunters on Bouldin Island. Harvested birds represent only a small proportion of the total number of birds that use the island.

Holland Tract

Holland Tract is 4,053 acres and currently is grazed but not farmed. In 1988, approximately 2,750 acres were agricultural lands consisting of wheat, asparagus, corn, fallow, and pasture. In 2008, approximately 1,161 acres of fallow land and 1,507 acres of exotic marsh were mapped on the island. In addition, the island contains 127 acres of woody riparian vegetation. Given the increase in exotic marsh habitat on Holland Tract, the number of shorebirds, wading birds, and wetland songbirds using the island for foraging and/or breeding is probably greater than in 1988. Types and numbers of other birds using the island are probably similar to those in 1988.

Waste Grain Availability

In 1988, Holland Tract produced approximately 61,000 pounds of waste corn for waterfowl (Jones & Stokes Associates Inc. 1989). Since at least 2002, no corn or wheat has been grown on Holland Tract and the majority of the island has been pasture/exotic marsh (Delta Wetland Properties 2008). Therefore, no or low amounts of waste grain are available for waterfowl on this island.

Hunting Harvest
Few ducks, geese, and pheasants are harvested annually by hunters on Holland Tract. The estimated harvest represents only a small proportion of the total numbers that use the island.

Upland Game

Because the amounts of agriculture on Bacon Island, Webb Tract, and Bouldin Island in 2008 are similar to those in 1988, populations of upland game species (ring-necked pheasant, mourning dove, California quail, and desert cottontail) are expected to be unchanged. The change in crops since at least 2002 on Holland Tract may have resulted in an increase in local populations of upland game species (e.g., pheasants, quail, mourning doves).

Special-Status Species

As described in the Environmental Setting of this document, 19 special-status (or former special-status) wildlife species have the potential to occur in the Project area. A list of all wildlife species evaluated for this report is in Table 4.7-2. The following sections summarize information from surveys conducted by Jones & Stokes in 1987–1988 and by DWR in 2002–2003 for the presence of special-status wildlife and/or suitable habitat on the Project islands. In addition, Eric Hansen, an expert on giant garter snake was contacted for information on habitat for this species and his opinion of the potential presence of this species on the islands.

Bacon Island

Five western pond turtles were observed on the exterior levee of Bacon Island, and one was observed on the interior of the island during 2002 surveys by DWR (California Department of Water Resources 2003). However, the interior of the island was not formally surveyed for this species. The CNDDB contains four records for western pond turtles observed in the waterways along the west and north sides of the island (California Natural Diversity Database 2009). Based on information from DWR (2003), the canals and associated banksides on Bacon Island provide approximately 86 acres of suitable aquatic habitat for western pond turtle. In addition, 70 acres of suitable upland habitat for western pond turtle is present on the island.

According to a habitat evaluation and surveys conducted in 2002 and 2003, Bacon Island has a total of 223 acres of suitable giant garter snake aquatic habitat, consisting of canals, ditches, and a small borrow pit (California Department of Water Resources 2003 and 2006). Most of this habitat was rated as low and moderate quality that would be used as transit corridors or provide only temporary habitat. Approximately 217 acres of suitable upland habitat for giant garter snake, which consisted of a large fallow field and a riparian area, is present on the island. (California Department of Water Resources 2003, 2006.) The Project islands do not support a resident/breeding population of giant garter snakes, and individual snakes found in the Delta are likely snakes that were displaced by flood events (Hansen pers. comm.)

Northern harrier was observed on Bacon Island during the 1987–1988 Jones & Stokes surveys and during 2002 surveys by DWR (California Department of Water Resources 2003). Suitable nesting and foraging habitat for this species is present on this island. Harriers are not known to nest on Bacon Island; nearly all the island is cultivated, and suitable nesting sites are limited.

Bacon Island provides suitable nesting and foraging habitat for Swainson's hawks. Two nest sites and two nest territories were found on or immediately adjacent to Bacon Island during 2002–2003 DWR surveys (California Department of Water Resources 2003). There are numerous (more than 15) known Swainson's hawk nests within 5 miles of the Project (California Department of Water Resources 2003; California Natural Diversity Database 2009). Bacon Island has an estimated 5,334 acres of suitable foraging habitat for Swainson's hawks.

Greater sandhill cranes were observed on Bacon Island during DWR's 2002–2003 surveys. There were fewer cranes on Bacon Island and Holland Tract than Webb Tract and Bouldin Island, most likely because Bacon Island and Holland Tract are farther away from traditional crane roosting sites at Staten Island and in the Thornton area. (California Department of Water Resources 2003.)

Although suitable nesting habitat for California black rail is not present on the interior of the island, suitable nesting habitat is present along the waterways surrounding the island. There are six records of observations of California black rails along the waterways surrounding the island (California Natural Diversity Database 2009).

Suitable nesting and wintering habitat for western burrowing owls is present on Bacon Island. In 2002–2003, there were extensive California ground squirrel burrows along the interior side of the levees on Bacon Island; however, the locations of these burrows are not ideal because they are on exposed levee slopes in which vegetation is intensely managed. No burrowing owls were observed during any of the bird surveys conducted during 2002–2003, and there were no signs of burrowing owls using abandoned ground squirrel burrows or artificial burrows on Bacon Island during nesting and wintering periods in 2002–2003; levee vegetation management was intensive on Bacon Island in 2002 (California Department of Water Resources 2003). One burrowing owl was observed on Bacon Island during the 1987–1988 surveys.

Loggerhead shrikes were observed on all Project islands through the spring, summer, fall, and winter during 2002–2003 surveys conducted by DWR. The primary loggerhead shrike habitat is on interior levees that contain utility lines or fences. Loggerhead shrikes were observed only in areas with aboveground utility lines located near levees on Bacon Island, where they move up and down the levees hunting for prey. (California Department of Water Resources 2003.)

Suitable nesting habitat for tricolored blackbirds, consisting of emergent marsh, willow scrub, riparian woodlands, Himalayan blackberry brambles, and grain crops, was present on all Project islands in 2002. No nesting tricolored blackbirds were observed on Bacon Island during 2002 surveys. Suitable foraging habitat is also present on all Project islands. Tricolored blackbirds were observed foraging on Bacon Island during the 2002–2003 fall and winter surveys. (California Department of Water Resources 2003.)

Bacon Island also provides suitable nesting and foraging habitat for Cooper's hawk, white-tailed kite, and short-eared owl. It provides suitable foraging/wintering habitat for ferruginous hawk, bald eagle, and American peregrine falcon. Cooper's hawk, white-tailed kite, and American peregrine falcon were observed on Bacon Island during 2002–2003 surveys (California Department of Water Resources 2003).

Special-status and other bat species could roost or forage on all Project islands. Suitable roosting sites consist of crevices and cavities of trees and structures, and among foliage of trees. Potential roosting habitat is available on the islands in vegetation and in numerous structures (abandoned homes and sheds, barns, warehouses, and pump housings). (California Department of Water Resources 2003.)

Webb Tract

Six western pond turtles were observed on the exterior levee of Webb Tract, and one was observed on the interior of the island during 2002 surveys by DWR (California Department of Water Resources 2003). The CNDDB (2009) contains one record for five western pond turtles observed in the waterway on the west side of the island. There are also two records of occurrences in the San Joaquin River, just southeast of the island (California Natural Diversity Database 2009). Based on information from DWR (2003), the canals and associated banksides and the blow-out ponds, and borrow pit on Webb Tract provide approximately 175 acres of suitable aquatic habitat for western pond turtle. In addition, 347 acres of suitable upland habitat for western pond turtle are present on the island.

A giant garter snake was observed on Webb Tract in 2002 (California Natural Diversity Database 2009). According to a habitat evaluation and surveys conducted in 2002 and 2003, Webb Tract has a total of 286 acres of suitable giant garter snake aquatic habitat, consisting of canals, ditches, blow-out ponds, and borrow pits (California Department of Water Resources 2003). More than one-third of this habitat was rated as moderate and high quality. While the lower-quality habitats on the island would provide transit corridors or temporary habitat, Webb Tract had a greater number of wide canals with persistent water relative to the other islands. In particular, the main north-south and east-west canals possessed all the characteristics necessary to support a permanent population of giant garter snakes (e.g., permanent water, aquatic and terrestrial vegetation, prey, subterranean retreats, a wide upland shelf between the canal and agricultural activity). Approximately 226 acres of suitable upland habitat for giant garter snake consisted of riparian vegetation surrounding the blow-out ponds and patches of fallow land that could provide basking, aestivation, and overwintering habitat. (California Department of Water Resources 2003.) As mentioned above, currently there is no resident/breeding population of giant garter snakes on the islands (Hansen pers. comm.).

Suitable nesting and foraging habitat is present for northern harrier on Webb Tract. Northern harriers were observed on Webb Tract during the 1987–1988 Jones & Stokes surveys and during 2002 surveys by DWR (California Department of Water Resources 2003). Webb Tract supported a high number of harriers during the winter in 1987–1988. Harriers could nest in densely vegetated wetlands or fallow fields on the island.

Suitable nesting and foraging habitat for Swainson's hawk is present on Webb Tract. Three nest sites and two nest territories were found on Webb Tract during DWR's 2002–2003 surveys (California Department of Water Resources 2003). There are more than 15 known Swainson's hawk nests within 5 miles of the Project (California Department of Water Resources 2003; California Natural Diversity Database 2009). Approximately 5,098 acres of suitable foraging habitat for Swainson's hawks are on Webb Tract.

Greater sandhill cranes were observed on Webb Tract during DWR's 2002–2003 surveys (California Department of Water Resources 2003). Although Webb Tract is not considered an important greater sandhill crane area by Pogson and Lindstedt (1988), it supports suitable foraging habitat, including grainfields, fallow fields, pastures, exotic marshes, and herbaceous uplands. DFG has designated Webb Tract as a greater sandhill crane wintering area.

Suitable nesting and wintering habitat for the western burrowing owls is present on Webb Tract. No burrowing owls were observed during any of the bird surveys conducted in 2002–2003. (California Department of Water Resources 2003.)

Loggerhead shrikes were observed on all Project islands through the spring, summer, fall, and winter during 2002–2003 surveys conducted by DWR. The primary loggerhead shrike habitat is on interior levees that contain utility lines or fences. Loggerhead shrikes were observed only in areas with aboveground utility lines located near levees on Webb Tract, where they move up and down the levees hunting for prey. (California Department of Water Resources 2003.)

Suitable nesting habitat for tricolored blackbirds, consisting of emergent marsh, willow scrub, riparian woodlands, Himalayan blackberry brambles, and grain crops, was present on all Project islands in 2002. No nesting tricolored blackbirds were observed on Webb Tract during 2002 surveys. Suitable foraging habitat is also present on all Project islands. Tricolored blackbirds were observed foraging on Webb Tract during the 2002–2003 fall and winter surveys. (California Department of Water Resources 2003.)

Webb Tract also provides suitable nesting and foraging habitat for Cooper's hawk, white-tailed kite, and short-eared owl. It provides suitable foraging/wintering habitat for ferruginous hawk, bald eagle, American peregrine falcon, and California black rail. Cooper's hawk, white-tailed kite, and American peregrine falcon were observed on Webb Tract during 2002–2003 surveys (California Department of Water Resources 2003). Many white-tailed kites were observed during the 1987–1988 surveys on Webb Tract.

Special-status and other bat species could roost or forage on all Project islands. Suitable roosting sites consist of crevices and cavities of trees and structures, and among foliage of trees. On Webb Tract, the principal roosting and foraging habitat components are riparian and mixed woodland habitat surrounding the two lake features (California Department of Water Resources 2003).

Bouldin Island

Fourteen western pond turtles were observed on the exterior levee of Bouldin Island, and three were observed on the interior of the island during 2002 surveys by DWR (California Department of Water Resources 2003). The CNDDB contains five records for occurrences of western pond turtles in the waterways surrounding the island and one record for a western pond turtle on the interior of the island (California Natural Diversity Database 2009). Based on information from DWR (2003), the canals and associated banksides and the borrow pits/emergent marsh on Bouldin Island provide approximately 173 acres of suitable aquatic habitat for western pond turtle. In addition, 153 acres of suitable upland habitat for western pond turtle are present on the island.

According to habitat evaluations conducted in 2002 and 2003, Bouldin Island has a total of 269 acres of moderate and high-quality giant garter snake aquatic habitat, consisting of canals, ditches, and borrow pits (California Department of Water Resources unpublished data). Areas of high-quality aquatic habitat consisted of a larger canal that meandered through part of the island, a few wider canals that held water throughout the year, and borrow pits with marsh and riparian habitat (California Department of Water Resources 2003). Bouldin Island has a total of 59 acres of moderate- and high-quality habitat giant garter snake upland habitat (California Department of Water Resources unpublished data). As mentioned above, there is no resident/breeding population of giant garter snakes currently on the islands (Hansen pers. comm.).

Suitable nesting and foraging habitat is present for northern harrier on Bouldin Island. Northern harriers were observed on Bouldin Island during the 1987–1988 Jones & Stokes surveys and during 2002 surveys by DWR (California Department of Water Resources 2003). Bouldin Island supported moderate numbers of harriers during winter and early spring during 1987–1988. Harriers are not known to nest on Bouldin Island.

Bouldin Island provides suitable foraging habitat for Swainson's hawks. One was observed flying over the island during surveys conducted in May 1988, and Swainson's hawks have been observed foraging on Bouldin Island during the breeding season and winter. Pasture, fallow fields, and agricultural fields provide suitable foraging habitat; vegetation in some fallow areas, however, may be too tall and dense to be used for foraging by Swainson's hawks. There are approximately 5,797 acres of suitable foraging habitat for Swainson's hawks on Bouldin Island. The nearest known Swainson's hawk nest site is approximately

1.5 miles from Bouldin Island (California Natural Diversity Database 2009). There are more than 15 known Swainson's hawk nests within 5 miles of the Project (California Department of Water Resources 2003; California Natural Diversity Database 2009).

Greater sandhill cranes were observed on Bouldin Island during DWR's 2002–2003 surveys (California Department of Water Resources 2003). During 1987–1988 surveys, 95% of the birds identified to subspecies in February–March were greater sandhill cranes. DFG has designated Bouldin Island as a greater sandhill crane wintering area.

Although suitable nesting habitat for California black rail is not present on the interior of the island, suitable nesting habitat may be present along the waterways surrounding the island. There is one record of an occurrence of a California black rail along one of the waterways surrounding the island (California Natural Diversity Database 2009).

Suitable nesting and wintering habitat for the western burrowing owls is present on Bouldin Island. No burrowing owls were observed during any of the bird surveys conduct in 2002–2003. (California Department of Water Resources 2003.)

Loggerhead shrikes were observed on all Project islands through the spring, summer, fall, and winter during 2002–2003 surveys conducted by DWR. The primary loggerhead shrike habitat is on interior levees that contain utility lines or fences. Loggerhead shrikes were observed only in areas with aboveground utility lines located near levees on Bouldin Island, where they move up and down the levees hunting for prey. (California Department of Water Resources 2003.)

Suitable nesting and foraging habitat for tricolored blackbirds, consisting of emergent marsh, willow scrub, riparian woodlands, Himalayan blackberry brambles, and grain crops, was present on all Project islands in 2002. No tricolored blackbirds were observed nesting or foraging on Bouldin Island during 2002–2003 surveys. (California Department of Water Resources 2003.)

Bouldin Island also provides suitable foraging and/or wintering habitat for Cooper's hawk, ferruginous hawk, bald eagle, white-tailed kite, American peregrine falcon, and short-eared owl. Cooper's hawk, white-tailed kite, and American peregrine falcon were observed on Bouldin Island during 2002–2003 surveys (California Department of Water Resources 2003). Since the 1987–1988 surveys Jones & Stokes biologists also have observed peregrine falcon, Cooper's hawk, ferruginous hawk, and short-eared owl on the island.

Special-status and other bat species could roost or forage on all Project islands. Potential roosting habitat on Bouldin Island is limited and consists of a few abandoned buildings and a few small stands of large, mature cottonwoods (California Department of Water Resources 2003).

Holland Tract

A large cluster of elderberry shrubs, habitat for VELB, is present on Holland Tract. These shrubs were surveyed by DWR in 2002–2003 and no evidence of VELB was found (California Department of Water Resources 2003).

Nine western pond turtles were observed on the exterior levee of Holland Tract, and three were observed in canals and other aquatic habitat on the island during 2002 surveys by DWR (California Department of Water Resources 2003). The CNDDB contains four records for western pond turtles in the waterways adjacent to the island and one record for an occurrence on the interior of the island (California Natural Diversity Database 2009). Based on information from DWR (2003), the canals and associated banksides and the blow-out pond on Holland Tract provide approximately 71 acres of suitable aquatic habitat for western pond turtle. In addition, 167 acres of suitable upland habitat for western pond turtle is present on the island.

According to habitat evaluations conducted in 2002 and 2003, Holland Tract has a total of 188 acres of moderate and high-quality giant garter snake aquatic habitat, consisting of canals, ditches, a blow-out pond, and borrow pits (California Department of Water Resources 2003 and unpublished data). Most of this habitat was determined likely to provide only temporary and/or transit corridor habitat. Holland Tract has 267 acres of moderate- and high-quality giant garter snake upland habitat. Suitable upland habitat on the island excludes areas grazed by cattle (California Department of Water Resources 2003). As mentioned above, there currently is no resident/breeding population of giant garter snakes on the islands (Hansen pers. comm.).

Northern harrier was observed on Holland Tract during the 1987–1988 Jones & Stokes surveys and during 2002 surveys by DWR (California Department of Water Resources 2003). Suitable nesting and foraging habitat is present on this island for this species.

One adult Swainson's hawk was observed during the 1987–1988 Jones & Stokes surveys of Holland Tract. Suitable nesting habitat is present on the island (trees older than 25 years), but no nests were found during 1987–1988 or 2002–2003 surveys. Fallow areas, pasture, grassland, and agricultural fields are suitable for foraging use by Swainson's hawks. The nearest known nest site is just east of Holland Tract on Bacon Island (California Department of Water Resources 2003). There are more than 15 known Swainson's hawk nests within 5 miles of the Project (California Department of Water Resources 2003; California Natural Diversity Database 2009). Holland Tract has approximately 2,832 acres of suitable foraging habitat for Swainson's hawks.

Greater sandhill cranes were observed on Holland Tract during DWR's 2002–2003 surveys (California Department of Water Resources 2003). Holland Tract provides suitable crane foraging habitat, although the amount of forage is expected to be smaller because of the conversion of corn and wheat fields in 1987 to pasture in 2002–2008.

Although suitable nesting habitat for California black rail is not present on the interior of the island, suitable nesting habitat may be present along the waterways surrounding the island. There are two records of occurrences of California black rails along waterways on the east and west sides of the island (California Natural Diversity Database 2009).

Suitable nesting and wintering habitat for the western burrowing owls is present on Holland Tract. In 2002–2003, there were extensive California ground squirrel burrows along the interior side of the levees on Holland Tract; however, the locations of these burrows are not ideal because they are on exposed levee slopes in which vegetation is intensely managed. No burrowing owls were observed during any of the bird surveys conducted during 2002–2003, and there were no signs of burrowing owls using abandoned ground squirrel burrows or artificial burrows on Holland Tract during nesting and wintering periods in 2002–2003; however, levee vegetation management was intensive on Holland Tract in 2002. (California Department of Water Resources 2003.)

Loggerhead shrikes were observed on all Project islands through the spring, summer, fall, and winter during 2002–2003 surveys conducted by DWR. The pasture (with fences and utility lines), riparian habitat, rows of trees and blackberry shrubs provide foraging and nesting habitat on Holland Tract. (California Department of Water Resources 2003.)

Suitable nesting and foraging habitat for tricolored blackbirds, consisting of emergent marsh, willow scrub, riparian woodlands, Himalayan blackberry brambles, and grain crops, was present on all Project islands in 2002. No tricolored blackbirds were observed nesting or foraging on Holland Tract during 2002–2003 surveys. (California Department of Water Resources 2003.)

Holland Tract also provides suitable nesting and foraging habitat for Cooper's hawk, white-tailed kite, and short-eared owl. It provides suitable foraging/wintering habitat for ferruginous hawk, bald eagle, American peregrine falcon, and California black rail. Cooper's hawk and white-tailed kite were observed on Holland Tract during 2002–2003 surveys (California Department of Water Resources 2003). Many white-tailed kites were observed during the 1987–1988 surveys on Holland Tract and were suspected to have nested on the island.

Special-status and other bat species could roost or forage on all Project islands. Various structures and mature willow trees and cottonwoods provide suitable roosting habitat on Holland Tract (California Department of Water Resources 2003).

Environmental Commitments

Several changes in Project design and many prior agreements with Delta water rights holders or agencies have resulted in the Project environmental commitments. One of the environmental commitments, the HMP described here, will reduce or eliminate impacts of the original Project design and operation on wildlife.

Habitat Management Plan

The Project applicant, in collaboration with DFG, State Water Board, and others, prepared a final HMP to describe how Bouldin Island and Holland Tract, the Habitat Islands, will be managed to offset Project impacts on state-listed Threatened and Endangered species, wintering waterfowl, and jurisdictional wetlands (Jones & Stokes Associates 1995). Land management practices to benefit other wildlife species also were incorporated into the plan. The HMP specifically describes:

- goals and objectives for wildlife habitat management,
- design and functions of habitats,
- management guidelines for habitat and recreation,
- island infrastructure and levee maintenance,
- procedures for ensuring the short- and long-term success of Project compensation, and
- a process for addressing changes in island management.

The HMP was prepared with the intent of integrating final permit conditions and agreements that affect management of the Habitat Islands. Three management goals for the Habitat Islands were identified by the HMP team. The HMP team designed island habitats, habitat juxtaposition, and habitat management criteria to achieve these goals, which are listed in order of descending priority:

- Compensation goals. Compensate for Project impacts on species listed as Threatened or Endangered under CESA; wintering waterfowl habitat; and jurisdictional wetlands, including riparian habitats. Compensation goals must be achieved to offset Project impacts.
- Species goals. Without compromising compensation goals, implement land management practices to provide the greatest benefit to upland wildlife species; enhance breeding habitat for waterfowl, roosting habitat for greater sandhill cranes, and nesting habitat for Swainson's hawks; and provide potential habitats for other special-status species. Species goals should be implemented to enhance overall wildlife values associated with compensation habitats.
- Other important goals. Implement best land management practices that do not detract from compensation and priority species goals to enhance habitat conditions for other important species or species groups, such as migratory shorebirds, nongame water birds, and species associated with riparian habitats.

Management prescriptions for habitat types and acreages of habitat types to be developed with implementation of the HMP will depend on the preparation of a final HMP that is subject to agency review and approval. As USFWS, DFG, Corps, and State Water Board permitting proceeds, the Project applicant will update the draft HMP to reflect the current environmental conditions and ensure that the Project's effects are fully mitigated. The HMP also includes a provision for the development of a Construction Implementation Plan to protect sensitive resources; this plan will be finalized. Environmental commitments specific to wildlife that will be included in the final HMP include those following.

- Compensate for the loss of riparian and pond habitats by preserving or creating a minimum of 339 acres of riparian woodland habitat, a minimum of 150 acres of riparian scrub habitat, and 76 acres of permanent pond habitat on the Habitat Islands.
- Compensate for the loss of aquatic and upland habitats for western pond turtle by preserving or creating a minimum of 305 acres of aquatic habitat and 417 acres of upland habitat on the Habitat Islands, including creating additional suitable upland (herbaceous upland and riparian) around the lakes, ponds, and emergent marsh on the Habitat Islands.
  - Consider reconfiguring the three proposed north-south blocks of herbaceous upland on Bouldin Island so that they run east-west and construct each block to have a low to moderate slope. This would improve the chances of western pond turtles successfully nesting on the Habitat Islands by creating a south-facing slope, which has the potential to be used by nesting turtles.
  - Include a measure to place logs around the perimeters of lakes, ponds, and emergent marsh to create basking habitat for western pond turtles.
  - Include a Best Management Practice Guideline to conduct maintenance of the levees after the western pond turtle hatchlings have emerged but before the females are attempting to nest (i.e., activities would be conducted before April 1).
- Compensate for the loss of aquatic and upland habitat for giant garter snake by preserving or creating a minimum of 509 acres of aquatic habitat and 443 acres upland habitat on the Habitat Islands.
- Compensate for the loss of foraging habitat for greater sandhill crane by preserving or creating between 7,673 and 10,071 acres of suitable foraging habitat.
- Compensate for the loss of foraging habitat for Swainson's hawk by preserving or creating a minimum of 6,929 acres of suitable foraging habitat. Ensure that preserved/created foraging habitat is higher quality than habitat lost on Reservoir Islands.
- Compensate for the loss of suitable breeding/wintering habitat for western burrowing owl by preserving or creating a minimum of 747 acres of suitable breeding/wintering habitat for western burrowing owl.
- Revise the Construction Implementation Plan described in the HMP to include additional special-status species (western pond turtle, giant garter snake, Cooper's hawk, white-tailed kite, western burrowing owl, short-eared owl, loggerhead shrike, nesting migratory birds, and bats). The Construction Implementation Plan will identify methods to avoid impacts on roosting greater sandhill cranes and on nesting northern harriers, Cooper's hawks, Swainson's hawks, white-tailed kites, western burrowing owls, short-eared owls, loggerhead shrikes, California black rails, and bats. These methods will

include conducting preconstruction surveys to locate nesting and roosting sites of these species and may include measures such as avoiding construction during sensitive use periods.

Additional elements of the Construction Implementation Plan will include:

- The Project applicant will avoid removal and maintain a 100-foot buffer around the cluster of elderberry shrubs on Holland Tract when working in the vicinity of the shrubs.
- The construction area will be clearly defined using orange barrier fencing to minimize disturbance to riparian vegetation and western pond turtle habitat.
    - A preconstruction survey for western pond turtles will be conducted by a qualified biologist within 24 hours of the start of construction activities in suitable aquatic habitat. If a turtle is located within the construction area, the turtle will be relocated out of this area, and exclusion fence will be installed to prevent the movement of turtles back into the construction area. If construction will occur in suitable upland habitat between April 1 and September 1, a survey for nests sites will be conducted within 24 hours prior to ground-disturbing activities in suitable upland habitat.
    - Grading and construction activities along ponds, borrow pits, ditches, and canals, and within 1,000 feet of these areas will be minimized between October 15 and April 15 to reduce potential mortality to hibernating turtles.
    - If a turtle becomes trapped during construction activities within aquatic habitat, the turtle will be removed from the work area by a qualified biologist with a valid scientific collecting permit and an MOU from DFG and placed downstream from the construction area or in adjacent suitable aquatic habitat outside the construction area.
- The take of giant garter snake will be minimized or avoided by:
    - Conducting a preconstruction survey in accordance with USFWS and DFG specifications. This could include visual surveys of suitable habitat within 24 hours of construction, or trapping of affected canals with suitable habitat within several weeks of construction. If giant garter snakes are detected, USFWS and DFG will be notified, and the snakes will be captured and relocated by individuals with valid 10(a)(1)(A) permits from USFWS.
    - Clearing of wetland vegetation will be confined to the minimal area necessary.

Also included will be:

- preconstruction survey protocols to locate Swainson's hawk nest sites and greater sandhill crane roosts on Reservoir Islands and nesting California black rails on the water side of perimeter levees;
- preconstruction survey protocols to locate nests of northern harrier, Cooper's hawk, white-tailed kite, western burrowing owl, short-eared owl, loggerhead shrike and other migratory birds;

- measures that would be instituted to avoid affecting state-listed wildlife species, including restriction of construction activities to areas at least 600 feet from nesting California black rails;
- establishment of protective buffers around active bird nests;
- preconstruction surveys by a qualified biologist to examine structures and trees that provide suitable roosting habitat for bats prior to their demolition or removal.

  If no bats are detected during the preconstruction survey, structure and tree removal should be conducted during the month of September to ensure that breeding and hibernating bats are avoided. If bats are observed, demolition and tree removal will be delayed until the bats leave the roosting sites or until DFG authorizes building demolition/ tree removal. In addition, bat boxes or other suitable roosting habitat should be constructed, per DFG recommendations, to mitigate the loss of roosting habitat on the Reservoir Islands.
- construction monitoring methods and schedule to be implemented to ensure compliance with the construction mitigation plan; and
- potential remedial measures to compensate for impacts incurred during construction that are not identified in the HMP.

Following construction, the Project applicant will submit a report describing success of construction impact avoidance measures to the State Water Board Chief of the Division of Water Rights and DFG.

Reservoir Island Construction Monitoring

The following environmental commitments will also occur on the Reservoir Islands.

- The take of giant garter snake will be minimized or avoided by:
  - Conducting a preconstruction survey in accordance with USFWS and DFG specifications. This could include visual surveys of suitable habitat within 24 hours of construction, or trapping of affected canals with suitable habitat within several weeks of construction. If giant garter snakes are detected, USFWS and DFG will be notified, and the snakes will be captured and relocated to the habitat islands by individuals with valid 10(a)(1)(A) permits from USFWS.
  - Clearing of wetland vegetation will be confined to the minimal area necessary.
- Impacts to avian species will be minimized or avoided by:
  - preconstruction survey protocols to locate Swainson's hawk nest sites and greater sandhill crane roosts and nesting California black rails on the water side of perimeter levees;

- preconstruction survey protocols to locate nests of northern harrier, Cooper's hawk, white-tailed kite, western burrowing owl, short-eared owl, loggerhead shrike and other migratory birds;
- measures that would be instituted to avoid affecting state-listed wildlife species, including restriction of construction activities to areas at least 600 feet from nesting California black rails; and
- establishment of protective buffers around active bird nests.

Environmental Effects

Methods

Impacts on wildlife were evaluated through comparison of wildlife values associated with habitat conditions predicted under the Project alternatives with existing habitat conditions. Existing wildlife habitats would change as a result of construction of facilities, upgrading of levees, inundation of Reservoir Islands during water storage and shallow-water management periods, and implementation of the HMP (see Appendix G3, "Habitat Management Plan for the Delta Wetlands Habitat Islands," in the 1995 EIR/EIS). For impacts on special-status species that were not addressed in the 1995 DEIR/EIS or the 2001 FEIR or 2001 FEIS (e.g., VELB, western pond turtle, giant garter snake, burrowing owl, several other bird species), an impact discussion has been added to this section based on information provided in reports prepared by DWR for the Project islands (California Department of Water Resources 2003 and 2006) and on wetland mapping conducted by ICF Jones & Stokes in 2008.

Analysis of Alternatives

The analysis of impacts of the Project alternatives on the Reservoir Islands was based on the amounts of Delta water that would be available for storage. The estimated amounts are based on the historical 1922–2003 monthly runoff for the Central Valley tributaries to the Delta and modeling based on the 2008 CVP–SWP OCAP evaluations (see Section 4.1, Water Supply).

A detailed description of the approach used to analyze future habitat conditions on the Project Reservoir Islands was presented in Appendix G2, "Prediction of Vegetation on the Delta Wetlands Reservoir Islands," in the 1995 DEIR/EIS. Although Reservoir Islands would support wildlife habitat, the actual duration and frequency of habitat conditions that would occur on Reservoir Islands is unpredictable. Because future habitat conditions are unpredictable and cannot be quantified, Reservoir Islands were assumed in this impact assessment to provide no wildlife values that would offset Project impacts. Therefore, for the impact analysis, operation of the Reservoir Islands was not used to offset or compensate for impacts of the Project on wildlife values.

In addition, there is potential for some level of continuing subsidence on the Project islands even with the cessation of farming activities. As a result, the water storage capacity of the Reservoir Islands could increase in future years. The rate of subsidence, however, would be substantially less than under existing conditions. Reduced rates of subsidence and increased water storage capacity on the Reservoir Islands would not be expected to substantially increase or decrease wildlife habitat impacts analyzed in this chapter.

Analysis of future vegetation conditions on Habitat Islands under Alternatives 1 and 2 is based on habitat types and acreages described in the draft HMP (see Appendix G3, "Habitat Management Plan for the Delta Wetlands Habitat Islands," in the 1995 EIR/EIS). Under Alternative 3 the development of the HMP would be precluded because all islands would be used as reservoirs. Because the draft HMP is based on the habitat evaluation procedures (HEP) analysis, this analysis is described below.

Habitat Evaluation Procedures Analysis

This section describes the HEP methods used to identify pre-Project and Project habitat conditions on the Project islands under the 1990 and 1992 versions of the Project. The HEP analysis was performed by a team consisting of representatives of State Water Board, USFWS, DFG, and Jones & Stokes. HEP methods were not used to evaluate the current Project. As with the 2001 FEIR and 2001 FEIS, the HMP team consulted the HEP results for the earlier versions of the Project and conducted an informal, modified HEP evaluation of the current Project to assist in identifying habitat types, acreages, and management required on the Project Habitat Islands to offset impacts on waterfowl.

Habitat Evaluation Procedure Methods

HEP is a habitat-based approach for assessing environmental impacts of proposed water and land resource development projects. The method can be used to document the quality and quantity of available habitat for selected wildlife species. The procedures provide information for two general types of wildlife habitat comparisons: the relative value of different areas at the same point in time; and the relative value of the same areas at future points in time. By combining the two types of comparisons, the impact of proposed or anticipated land and water use changes on wildlife habitat can be quantified (U.S. Fish and Wildlife Service 1980). Additional information on the HEP analysis can be found in the 1995 EIR/EIS.

Habitat Management Plan Development

Habitat Management Plan Objectives

The HMP team's (formerly the HEP team's) primary objectives were to design the Habitat Islands to:

- compensate for the loss of foraging habitat on the Reservoir Islands for Swainson's hawk and greater sandhill crane, which are protected under

CESA (see Appendix H4, "California Endangered Species Act Biological Assessment: Impacts of the Delta Wetlands Project on Swainson's Hawk and Greater Sandhill Crane," in the 1995 DEIR/EIS);

- compensate for loss of foraging habitat for wintering waterfowl; and
- mitigate Project impacts on jurisdictional waters of the United States, pursuant to Section 404 of the CWA and Section 10 of the Rivers and Harbors Act of 1899.

The HMP team's secondary planning objectives included creating habitats for upland wildlife species; enhancing habitat for waterfowl breeding, greater sandhill crane roosting, and Swainson's hawk nesting; and providing habitat for other special-status species.

The HMP will be revised and updated to reflect current habitat conditions, address special-status species not covered in the draft HMP, and if needed, revise quantities of habitat as recommended by USFWS and DFG.

Significance Criteria

The wildlife impact analysis considered several criteria for determining the significance of impacts related to this resource. The analysis took into account both relevant criteria contained in Appendix G of the State CEQA Guidelines (Association of Environmental Professionals 2009) and Project-specific criteria developed by the lead agency to address potential impacts unique to the Project's location and elements.

For this analysis, an alternative would be considered to have a significant adverse impact on wildlife if it would:

- substantially decrease the acreage of herbaceous upland habitats in the Delta region,
- decrease the acreage of wetland and riparian habitats on the Project islands,
- decrease forage quality or quantity available to wintering waterfowl on the Project islands,
- substantially disrupt wildlife use patterns in the Delta,
- increase the potential for outbreaks of wildlife diseases, or
- result in permanent loss of occupied special-status species habitat or direct mortality of special-status species.

An alternative would be considered to have a beneficial impact if it would result in a substantial increase in the quantity or quality of herbaceous upland, wetland, riparian woodland and scrub, wintering waterfowl, or special-status species habitat.

Impacts and Mitigation Measures

Proposed Project (Alternative 2)

Bacon Island and Webb Tract

If the Project is implemented, agricultural lands and natural habitat on Bacon Island and Webb Tract would be converted to reservoir. As indicated above, the analysis of impacts is based on the reservoirs at full storage conditions and assumes that no wildlife value would be retained.

Special-Status Species

Valley Elderberry Longhorn Beetle. There is no suitable habitat (elderberry shrubs) on Bacon Island or Webb Tract (California Department of Water Resources 2003). Consequently, there would be no impacts on VELB from the conversion of these islands for water storage.

This conclusion is unchanged from the 2001 FEIR and 2001 FEIS.

Western Pond Turtle. Suitable aquatic and upland habitat for western pond turtle is present on Bacon Island and Webb Tract, and western pond turtles were observed on both islands during 2002 surveys for this species (California Department of Water Resources 2003). Although some aquatic habitat could be maintained (in existing canals, ditches, or borrow pits) or created as reservoirs, it is assumed for this impact analysis that aquatic and upland habitat on the Reservoir Island would be lost and compensation would be required. In addition, construction and operation of the Project could result in the injury or mortality of individual turtles, which could decrease the population of turtles in the general area. Measures would be required to minimize injury and mortality of turtles during construction and operation activities.

Giant Garter Snake. A giant garter snake was observed on Webb Tract in 2002 (California Natural Diversity Database 2009). However, subsequent extensive surveys during 2003 and 2004 by Eric Hansen did not result in any confirmed individuals (Hansen pers. comm.) Suitable aquatic and upland habitat is present for this species on both Bacon Island and Webb Tract (California Department of Water Resources 2003). Loss of aquatic and upland habitat for giant garter snake would occur as a result of flooding the islands for water storage. Although some aquatic habitat could be maintained (in existing canals, ditches, or borrow pits) or created as reservoirs, it is assumed for this impact analysis that aquatic and upland habitat on the Reservoir Islands would be lost and compensation would be required. In addition, construction and operation of the Project could result in the injury or mortality of individual snakes. Measures would be required to minimize injury and mortality of giant garter snakes during construction and operation activities.

Cackling (Aleutian Canada) Goose. The cackling goose no longer is listed as Threatened under the ESA. Over 50% of the world's population of cackling geese uses the Delta during wintering (Rosen pers. comm.). Specific information on the presence of cackling goose on the Project islands could not be found. The overall availability of foraging habitat would decline with the loss of corn and other crops of high forage value with implementation of Alternative 2.

Bald Eagle. Bald eagles do not occur regularly in the Delta, and none were observed on Project islands during surveys. The Reservoir Islands currently support low-quality foraging habitat for bald eagle. Water storage on the Reservoir Islands would result in low-quality foraging habitat along reservoir shorelines, where diving ducks and resting coots typically would congregate (see Appendix H3 of the 1995 DEIR/EIS).

Northern Harrier. Both Bacon Island and Webb Tract provide suitable nesting and foraging habitat for northern harrier, although the amount of suitable nesting habitat on Bacon Island is limited. Potential prey populations for harriers would be largely eliminated because of the conversion of upland habitat to reservoir. Harriers are wide-ranging and would move to other areas to forage. Conversion of habitat to reservoir also could remove suitable nesting habitat, and construction activities could disturb or cause the mortality of individual birds.

Swainson's Hawk. Suitable nesting and foraging habitat for Swainson's hawks is present on Bacon Island and Webb Tract. Two nest sites and two nest territories were found on or immediately adjacent to Bacon Island, and three nest sites and two nest territories were found on Webb Tract during DWR's 2002–2003 surveys (California Department of Water Resources 2003). Agricultural, fallow, and herbaceous upland habitats present on the islands provide suitable foraging habitat for Swainson's hawk. Under implementation of Alternative 2, inundated portions of Reservoir Islands would be unsuitable as Swainson's hawk foraging habitat (i.e., foraging habitat would be lost), and rodent populations would be substantially reduced as a result of inundation. Conversion of habitat to reservoir also could remove suitable nesting habitat, and construction activities could disturb or cause the mortality of individual birds.

American Peregrine Falcon. Suitable foraging/wintering habitat for American peregrine falcon is present on Bacon Island and Webb Tract. American peregrine falcons were observed on both islands during 2002–2003 surveys (California Department of Water Resources 2003). Flooding of the Reservoir Islands would attract diving ducks and thus provide low- to moderate-quality foraging habitat. Because peregrine falcons mainly eat birds, foraging opportunities likely would decrease with conversion of islands to water storage as the variety and numbers of birds are likely to decrease on the Reservoir Islands.

California Black Rail. Webb Tract provides suitable foraging habitat for California black rail. Additionally, occupied nesting habitat exists on small islands supporting marsh vegetation adjacent to Bacon Island (California Natural Diversity Database2009). If present, California black rails nesting adjacent to Bacon Island could be affected by construction activities (e.g., levee refurbishment, siphon construction) on the water side of Reservoir Islands, which could decrease the population of rails in the general area.

Greater Sandhill Crane. Greater sandhill cranes were observed on Bacon Island and Webb Tract during DWR's 2002–2003 surveys (California Department of Water Resources 2003). Information from these surveys suggests that sandhill cranes were roosting on Webb Tract during the winter of 2002–2003. Corn and wheat fields provide suitable foraging habitat for this species. Storage of water on the Reservoir Islands would result in the loss of foraging habitat for greater sandhill cranes.

Western Burrowing Owl. Suitable nesting and wintering habitat for western burrowing owls is present on Bacon Island and Webb Tract. A burrowing owl was observed on Bacon Island during 1987–1988 surveys. Individual burrowing owls (if present) could be disturbed or killed by construction activities (e.g., levee refurbishment, siphon construction) on the land side of Reservoir Islands. Most of the habitat conditions associated with flooding of the islands for water storage would result in unsuitable foraging habitat for western burrowing owl (e.g., removal of foraging habitat).

Tricolored Blackbird. Suitable nesting and foraging habitat for tricolored blackbird is present on Bacon Island and Webb Tract. Tricolored blackbirds were observed foraging on both islands during the 2002–2003 fall and winter surveys (California Department of Water Resources 2003). Storage of water on the Reservoir Islands would result in the loss of foraging habitat for tricolored blackbirds. In addition, suitable nesting habitat could be removed during construction activities and flooding of islands.

Other Special-Status Birds. Bacon Island and Webb Tract provide suitable nesting and foraging habitat for Cooper's hawk, white-tailed kite, and loggerhead shrike. The islands also provide suitable foraging/wintering habitat for ferruginous hawk and short-eared owl. Storage of water on the Reservoir Islands would result in the loss of foraging habitat for white-tailed kite, ferruginous hawk, and short-eared owl. Flooded conditions could result in an increase of foraging opportunities for loggerhead shrike (from an increase in insects and amphibians) and a limited impact on Cooper's hawk because of its varied diet. Conversion of habitat to reservoir also could remove suitable nesting habitat and construction activities could disturb or cause the mortality of individual birds.

Bats. Bacon Island and Webb Tract provide suitable roosting and foraging habitat for special-status and other bat species. Bats that forage or roost on the islands could be affected by the conversion of the island to reservoir. The number of bats could decrease because the Project could remove suitable roosting habitat, and construction activities could disturb or cause the mortality of individual bats. However, the number of bats also could increase after Project completion because the number of insects likely would be greater over the inundated areas, which would attract more bats to the islands.

Other Wildlife

Waterfowl. Habitat conditions under Alternative 2 would substantially alter waterfowl populations and seasonal use patterns on Reservoir Islands. Habitat quality on Reservoir Islands would decrease substantially for swans, geese, dabbling ducks, and coots during water storage periods. However, dabbling ducks would make extensive use of the reservoir water surfaces for resting. Diving ducks make little use of Bacon Island and Webb Tract because little suitable habitat exists. Diving species, including scaup, ring-necked duck, ruddy duck, redhead, and canvasback, likely would increase on these islands once they are reservoirs.

Piscivorous Birds. Use of the Reservoir Islands by piscivorous birds (e.g., grebes, cormorants, and pelicans) would be expected to increase from implementation of the Project. These species would feed in the reservoirs, but little or no nesting of most of these species would occur on the Reservoir Islands.

Wading Birds. Water storage would reduce use of the Reservoir Islands by wading birds such as herons and egrets because shallow-flooded feeding areas on the islands would become inundated.

Raptors. Raptor use of the Reservoir Islands would decrease because of habitat changes caused by water storage operations. Most raptors are found on the islands in winter, when they forage for rodents and large insects in fallow grassland and agricultural habitats. Winter flooding of the islands would force most wintering raptors to forage elsewhere. Although most migratory raptors are adapted to moving in winter to locate adequate prey populations, it is uncertain whether displacement during winter would increase raptor mortality (Newton 1979). Rodent populations would be largely eliminated during full-storage periods.

Shorebirds. Water storage on the Reservoir Island would reduce the number of shorebirds because shallow-flooded feeding areas on the islands would become inundated. It is expected that no shorebird habitat would exist on the Reservoir Islands during full-storage periods.

Gulls and Terns. Gull and tern feeding on the Reservoir Islands probably would decline because of the loss of agricultural waste grain, but resting use would probably continue on the Reservoir Islands on calm days or in areas protected from wind.

Blackbirds and Starlings. Water storage on the Reservoir Islands would reduce use of the islands by blackbirds because shallow-water wetlands and agricultural areas on the islands would become inundated and would not be available for foraging.

Populations of the introduced European starling, a species that is more closely associated with agricultural lands than blackbirds, are expected to decline because of the loss of agricultural foods. The starling decline would be beneficial to native wildlife because it would reduce competition with native cavity-nesting birds (Remsen 1978; Weitzel 1988).

Riparian and Marsh Birds. Existing riparian woodland and scrub and freshwater marsh habitat on Reservoir Islands would be eliminated by Project construction and inundation under Project operations. Riparian shrubs and trees would not be expected to colonize interior levee slopes because interior levee slopes would be riprapped. Therefore, numbers of riparian and marsh birds on the islands would be expected to decline.

Grassland and Agricultural Birds. All species in the grassland and agricultural bird group are regionally common. Bird species that nest in grassland and agricultural habitats on the Reservoir Islands could be displaced by the Project. In addition to western meadowlarks, blackbirds, starlings, pheasants, and waterfowl, several species that use grassland and agricultural lands during migration and in winter, including California horned lark, American crow, yellow-billed magpie, and water pipit, would use these lands less because of habitat loss resulting from operation of the Reservoir Islands for water storage.

Upland Game

The breeding population of ring-necked pheasants on the Reservoir Islands would decline substantially as a result of inundation of the Reservoir Islands. Water storage would reduce the amount of available foraging habitat and cover for pheasants.

Quail populations on the Reservoir Islands would decline, and the species may become extirpated from the Reservoir Islands. Mourning dove populations would also decrease because of the loss of seasonal wetland and grassland habitat.

Bouldin Island and Holland Tract

Habitat Management Plan Implementation

If the proposed Project is implemented, various types of agriculture and habitats would be planted and created, respectively, on Bouldin Island and Holland Tract. These Habitat Islands would be managed primarily to offset impacts on wildlife associated with operation of the Reservoir Islands under Alternative 2. Because of changes in acreage of habitats and new information on species presence (e.g., Swainson's hawks nesting on the islands, presence of western pond turtle), the 1995 draft HMP will need to be revised to fully offset impacts on special-status wildlife. Implementation of the final HMP also would provide benefits to wildlife for which compensation is not required for Project impacts, including development of waterfowl nesting habitat and greater sandhill crane roosting habitat.

The primary goals of the draft HMP were to describe the Habitat Island habitats and management requirements necessary to offset impacts of Reservoir Island operations on state-listed Threatened species (i.e., impacts on Swainson's hawk and greater sandhill crane foraging habitat), wintering waterfowl foraging habitat, and jurisdictional wetlands pursuant to Section 404 of the CWA. Major elements of the draft HMP included:

- creation of approximately 9,010 acres of agricultural and nonagricultural habitats for species that would be affected by the Project;
- creation of Section 404 jurisdictional riparian woodland and scrub and wetland habitats;

- implementation of special habitat management practices that would increase wildlife habitat values beyond those typically associated with created habitats (e.g., specified flooding schedules for seasonal wetlands);
- regulation of hunting and other recreational activities to reduce the effects of human disturbance of wildlife;
- establishment of a closed hunting zone on Bouldin Island to provide greater sandhill crane foraging areas free from hunter disturbance;
- establishment of two additional closed hunting zones (one on each island) to provide waterfowl foraging and resting areas free from hunter disturbance; and
- establishment of a Habitat Island management oversight committee empowered to consult with the Project applicant and DFG to review monitoring data and develop recommendations for changes in Habitat Island management in future years as long as the primary goals of the HMP are not compromised.

Table 4.7-5 summarizes the acreages of habitats that would be preserved or created on the Habitat Islands under Alternative 2. Fields of corn rotated with wheat, mixed agriculture/seasonal wetlands, seasonal managed wetlands, and pasture/hay fields would be managed during fall and winter specifically to provide high-quality swan, goose, and duck foraging habitat. Seasonal ponds, some seasonal managed wetland, and small grain fields would be managed specifically to provide high-quality duck nesting and brood habitat.

Agricultural lands, seasonal wetland habitats, and herbaceous uplands would be managed during spring, summer, and fall to provide suitable Swainson's hawk habitat.

Habitats managed specifically to provide winter waterfowl foraging habitat and herbaceous uplands also would provide high-quality greater sandhill crane foraging habitat during winter. A portion of seasonal managed wetlands and cornfields on Bouldin Island would be managed specifically to provide crane roosting habitat and high-quality foraging habitat, respectively.

Riparian woodland and scrub habitats established to offset impacts on jurisdictional wetlands under Section 404 of the CWA (see Section 4.6, Vegetation and Wetlands) would provide habitat for a wide diversity of wildlife associated with riparian vegetation, including cavity-nesting bird species.

To offset the impact of hunting disturbance on foraging waterfowl and greater sandhill cranes, three closed hunting zones, totaling approximately 2,000 acres, would be established on the Habitat Islands.

Table 4.7-5. Acreages of Habitats to Be Created/Managed on the Habitat Islands under Alternative 2

	Bouldin Island		Holland Tract		Habitat Island Totals	
Habitat Type[a]	Total Acres	Percentage of Total Acres	Total Acres	Percentage of Total Acres	Total Acres[b]	Percentage of Total Acres
Corn/wheat	1,629	27	955	31	2,584	29
Small grains	106	2	152	5	258	3
Mixed agriculture/seasonal wetland	1,014	17	631	21	1,645	18
Seasonal managed wetland	1,723	29	393	13	2,116	23
Seasonal pond	66	1	68	2	134	1
Pasture/hay	132	2	72	2	204	2
Emergent marsh[c]	208	3	194	6	402	4
Riparian	170	3	217	7	387	4
Lake[c]	111	2	33	1	144	2
Herbaceous upland[c]	479	8	253	8	732	8
Developed	177	3	58	2	235	3
Canal[c]	70	1	10	0	80	1
Borrow pond	89	1	0	0	89	1
Total	5,974	100	3,036	100	9,010	100

Note: Minor inconsistencies in totals are the result of rounding.

[a] Habitat types and habitat management prescriptions are described in the draft Habitat Management Plan (HMP).

[b] These acreages are based on the draft HMP and may be revised in the final HMP.

[c] Includes existing acres of habitat unaffected by the Project.

Airstrip and Aircraft Restrictions. The Bouldin Island airstrip is located in the easternmost closed hunting zone on the island. Restrictions have been placed on use of the airstrip and aircraft on the Habitat Islands from September 1 through March 31 to reduce disturbance from airstrip and aircraft operations on waterfowl and greater sandhill cranes using closed hunting zones and other portions of the island. As described in the draft HMP, restrictions include limiting use of the airstrip and island overflights for farming and habitat management operations during the waterfowl hunting season to nonhunt days to prevent disturbance in closed hunting zones during periods of hunter disturbance.

Use of the airstrip and aircraft overflights of the islands for recreation and other uses also is restricted from September 1 through March 31. Restrictions include limiting use of the airstrip to 100 landings and takeoffs during the waterfowl use season. Use of the airstrip for landings and takeoffs of fixed-winged aircraft, however, is permitted during hunt days. Consequently, waterfowl, greater sandhill cranes, and other wildlife using Bouldin Island on hunt days could be disturbed periodically by aircraft during periods of hunter disturbance.

Special-Status Species

A summary of the habitats that would be created for special-status species on the Habitat Islands is provided in Table 4.7-6.

Valley Elderberry Longhorn Beetle. Suitable habitat for VELB (elderberry shrubs) is present on Holland Tract. Although no evidence of VELB was found by DWR during 2002–2003 surveys (California Department of Water Resources 2003), these shrubs still provide habitat for this Threatened species. In addition, surveys for VELB are valid only for a period of 2 years, and the shrubs would need to be resurveyed to ensure that VELB are not present. Planting elderberry shrubs within the 387 acres of riparian habitat to be planted on the Habitat Islands would expand the amount of suitable habitat available to this species.

Western Pond Turtle. Suitable aquatic and upland habitat for western pond turtle is present on Bouldin Island and Holland Tract, and western pond turtles were observed on both islands during 2002 surveys for this species (California Department of Water Resources 2003). Approximately 313 acres of suitable aquatic (lake, canals, borrow ponds) and 1,119 acres of suitable upland habitat (grassland and riparian) would be available to western pond turtle on the Habitat Islands with implementation of the final HMP. During habitat creation and improvements, individual turtles could be harmed or killed. Measures would be required to minimize injury and mortality of turtles during habitat creation and modification activities.

Giant Garter Snake. Approximately 313 acres of suitable aquatic (lake, canals, borrow ponds) and 1,119 acres (grassland and riparian) of suitable upland habitat would be available to giant garter snake on the Habitat Islands with implementation of the final HMP. During habitat creation and improvements, individual snakes could be harmed or killed. Measures would be required to minimize injury and mortality of giant garter snakes during habitat creation/improvement activities.

Northern Harrier. Implementation of the HMP would provide 3,250 acres of suitable nesting habitat and 7,941 acres of suitable foraging habitat for northern harriers on the Habitat Islands. During habitat creation and improvements, individual harriers could be disturbed, harmed, or killed if these activities occur during the nesting season. Measures would be required to minimize disturbance, injury, and mortality of northern harrier during habitat creation/modification activities.

Swainson's Hawk. As described in the draft HMP, approximately 387 acres of existing and created riparian woodland and scrub habitats would provide suitable Swainson's hawk nesting habitat. In addition, a total of 7,539 acres of suitable spring, summer, and fall foraging habitat for Swainson's hawks of poor, fair, and good quality would be created or maintained on the Habitat Islands. Suitable Swainson's hawk foraging habitat will include cornfields, wheat fields, and small grain fields, mixed agriculture/ seasonal wetlands, seasonal managed wetlands, pasture/hay fields, and herbaceous uplands. Portions of nonagricultural habitats also would be mowed to enhance foraging habitat quality.

Greater Sandhill Crane. As described in the draft HMP, a total of 7,673 acres of suitable winter foraging habitat for greater sandhill crane of poor, fair, and good quality would be developed on the Habitat Islands. Suitable habitat would include corn, wheat, and small grain fields; mixed agriculture/seasonal wetlands;

seasonal managed wetlands; seasonal ponds; pasture/hay fields; and herbaceous uplands.

Three closed hunting zones, totaling 2,008 acres, would be established on the Habitat Islands (two on Bouldin Island and one on Holland Tract) and would provide greater sandhill crane foraging areas that are free from hunter disturbance during hunt days. A portion of seasonal managed wetlands in one Bouldin Island closed hunting zone would be managed specifically to provide crane roosting habitat. A portion of cornfields near wetlands managed as roosts would be harvested in a manner that would provide optimum crane foraging habitat.

Western Burrowing Owl. Implementation of the HMP would provide 3,250 acres of suitable breeding/wintering habitat, and 7,941 acres of suitable foraging habitat for western burrowing owl are present on the Habitat Islands. During habitat creation and modification, individual owls could be disturbed, harmed, or killed if these activities occur during the nesting or wintering periods. Measures would be required to minimize disturbance, injury, and mortality of western burrowing owls during habitat creation/modification activities.

Other Special-Status Birds. Implementation of the HMP would provide suitable nesting and/or foraging/wintering habitat on Bouldin Island and Holland Tract for a number of special-status bird species, including Cooper's hawk, white-tailed kite, ferruginous hawk, bald eagle, American peregrine falcon, California black rail, short-eared owl, loggerhead shrike, and tricolored blackbird. Habitat creation and improvements likely would result in an increase in suitable breeding and foraging/wintering habitat for special-status birds and would benefit those species affected. However, special-status birds that may nest on these islands (Cooper's hawk, white-tailed kite, short-eared owl, loggerhead shrike, and tricolored blackbird) could be disturbed, harmed, or killed during habitat creation and improvement activities if these activities occur during the nesting period. Measures would be required to minimize disturbance, injury, and mortality of nesting special-status birds during habitat creation/modification activities.

Bats. Bouldin Island and Holland Tract provide suitable roosting and foraging habitat for special-status and other bat species. Habitat creation and modification could result in an increase in suitable roosting and foraging habitat for bats. However, bats could be disturbed, harmed, or killed during habitat creation and improvement activities if these activities remove or disturb occupied roost sites. Measures would be required to minimize disturbance, injury, and mortality of bats during habitat creation/modification activities.

Table 4.7-6. Suitable Habitat to Be Created or Managed on Habitat Islands for Special-Status Wildlife

Special-Status Species and Habitat Use	Habitat Type	Corn/ Wheat	Small Grains	Mixed Ag/ Seasonal Wetland	Seasonal Managed Wetland	Seasonal Pond	Pasture/ Hay	Emergent Marsh	Riparian	Lake	Herbaceous Upland	Developed	Canal	Borrow Pond	Total
Western Pond Turtle	Aquatic									144			80	89	313
	Upland								387		732				1,119
Giant Garter Snake	Aquatic									144			80	89	313
	Upland								387		732				1,119
Northern Harrier	Nesting				2,116			402			732				3,250
	Foraging	2,584	258	1,645	2,116		204	402			732				7,941
Swainson's Hawk	Nesting								387						387
	Foraging	2,584	258	1,645	2,116		204				732				7,539
Greater Sandhill Crane	Foraging	2,584	258	1,645	2,116	134	204				732				7,673
Western Burrowing Owl	Nesting/ Wintering										732				732
	Foraging	2,584	258	1,645			204				732				5,423
Cooper's Hawk	Foraging								387						387
White-Tailed Kite	Nesting								387						387
	Foraging	2,584	258	1,645			204				732				5,423
Loggerhead Shrike	Foraging	2,584	258	1,645			204				732				5,423
Short-Eared Owl	Nesting				2,116		204	402			732				3,250
	Foraging	2,584	258	1,645	2,116		204	402			732				7,941
Tricolored Blackbird	Nesting							402		144				89	635
	Foraging	2,584	258	1,645	2,116		204	402			732				7,941

Table 4.7-7. Expected Use of Habitats by Wildlife on the Habitat Islands

Species Group	Representative Species	Foraging Habitats	Breeding Habitats
Raptors	Red-tailed hawk American kestrel Great horned owl	• Unflooded corn and wheat • Small grains • Unflooded mixed agriculture/seasonal wetland • Unflooded seasonal managed wetland • Pasture/hay • Herbaceous upland • Riparian woodland • Riparian scrub	• Riparian woodland • Riparian scrub
Grassland and agricultural birds	Ring-necked pheasant Western meadowlark	• Unflooded corn and wheat • Small grains • Unflooded mixed agriculture/seasonal wetland • Unflooded seasonal managed wetland • Pasture/hay • Herbaceous upland	• Small grains • Unflooded mixed agriculture/seasonal wetland • Unflooded seasonal managed wetland • Pasture/hay • Herbaceous upland
Small mammals	California vole Deer mouse	• Unflooded corn and wheat • Small grains • Unflooded mixed agriculture/seasonal wetland • Unflooded seasonal managed wetland • Pasture/hay • Herbaceous upland • Riparian woodland • Riparian scrub • Developed	• Unflooded corn and wheat • Small grains • Unflooded mixed agriculture/seasonal wetland • Unflooded seasonal managed wetland • Pasture/hay • Herbaceous upland • Riparian woodland • Riparian scrub • Developed

Species Group	Representative Species	Foraging Habitats	Breeding Habitats
Furbearers	Raccoon Striped skunk	• Corn and wheat • Small grains • Mixed agriculture/seasonal wetland • Seasonal managed wetland • Pasture/hay • Emergent marsh • Permanent lake shoreline • Herbaceous upland • Riparian woodland • Riparian scrub • Canals • Developed	• Riparian woodland • Riparian scrub • Developed
Migrating and wintering shorebirds	Western sandpiper Dowitcher Long-billed curlew Dunlin	• Shallow-flooded corn and wheat • Shallow-flooded mixed agriculture/seasonal wetland • Shallow-flooded seasonal managed wetland • Seasonal pond • Shallow-flooded and dry pasture/hay • Shallow-flooded emergent marsh • Permanent lake shoreline	• Not applicable
Breeding shorebirds	American avocet Black-necked stilt	• Shallow-flooded corn and wheat • Shallow-flooded seasonal managed wetland • Seasonal pond • Shallow-flooded emergent marsh • Permanent lake shoreline	• Shallow-flooded seasonal wetland • Seasonal pond • Emergent marsh
Cavity-nesting birds	Nuttall's woodpecker House wren	• Riparian woodland • Riparian scrub	• Riparian woodland • Riparian scrub

Species Group	Representative Species	Foraging Habitats	Breeding Habitats
Wading birds	Great blue heron Great egret Black-crowned night heron	• Corn and wheat • Small grains • Mixed agriculture/seasonal wetland • Seasonal managed wetland • Seasonal pond • Pasture/hay • Emergent marsh • Permanent lake shoreline • Herbaceous upland	• Seasonal managed wetland • Emergent marsh • Riparian woodland • Riparian scrub
Migratory and resident songbirds	White-crowned sparrow Yellow warbler Yellow-rumped warbler Savannah sparrow Plain titmouse Bushtit	• Small grains • Unflooded mixed agriculture/seasonal wetland • Unflooded seasonal managed wetland • Pasture/hay • Herbaceous upland • Riparian woodland • Riparian scrub	• Small grains • Unflooded mixed agriculture/seasonal wetland • Unflooded seasonal managed wetland • Pasture/hay • Herbaceous upland • Riparian woodland • Riparian scrub
Wetland songbirds	Marsh wren Red-winged blackbird Yellow-headed blackbird	• Mixed agriculture/seasonal wetland • Seasonal managed wetland • Seasonal pond • Pasture/hay • Emergent marsh • Herbaceous upland • Canals	• Seasonal managed wetland • Seasonal pond • Emergent marsh • Canals

Waterfowl

Approximately 8,219 acres of suitable agricultural, wetland, and upland habitats would be created and/or managed on the Habitat Islands for waterfowl (Table 4.7-7). Fields of corn rotated with wheat, mixed agriculture/seasonal wetland, seasonal managed wetland, and pasture/hay habitats would be managed specifically to provide high-quality waterfowl foraging habitat. Permanent lakes would provide large bodies of open water for use by waterfowl for resting.

Mixed agriculture/seasonal wetland, seasonal managed wetland, seasonal pond, emergent wetland, permanent lake, and herbaceous upland habitats would provide suitable nesting habitat for mallards, cinnamon teal, and other dabbling ducks. Seasonal pond habitats would be managed specifically to provide high-quality duck brood water. To encourage Canada goose and wood duck nesting, approximately 800 nesting platforms and boxes will be constructed.

Levels of waterfowl hunting permitted on the Habitat Islands would be moderate relative to hunting levels on private duck clubs and state and federal waterfowl refuges. Approximately 22% of Habitat Island waterfowl habitats would be within the closed hunting zones as compared to state and federal waterfowl refuges in the Central Valley, which typically have between 15% and 50% of habitat designated as closed hunting zones. The hunting program is described in the draft HMP.

Other Birds

Habitat availability and quality would be increased for most bird species groups on the Habitat Islands with implementation of Alternative 2. Table 4.7-7 lists the habitats that would be used by the major wildlife species groups on the islands. Details of general wildlife habitat management objectives, habitat descriptions, and habitat management prescriptions for Habitat Islands are included in the HMP.

The acreages of riparian woodland and scrub, emergent marsh, and seasonal managed wetland habitats would increase substantially with Project implementation. Creation of riparian and wetland habitats on the islands would benefit primarily piscivorous birds, wading birds, shorebirds, gulls and terns, and riparian and marsh birds.

Acreages of habitats used by upland and agricultural species would decrease with implementation of Alternative 2. However, implementation of management prescriptions for these habitats would increase habitat quality from existing conditions.

Upland Game

Approximately 7,926 acres of corn, wheat, small grain, mixed agriculture/ seasonal wetland, seasonal managed wetland, pasture/hay, riparian woodland and scrub, and herbaceous upland habitats on the Habitat Islands would provide foraging and nesting habitat and escape cover for ring-necked pheasants, mourning doves, and quail (Table 4.7-7). During fall and winter, up to 3,688 acres of corn, wheat, mixed agriculture/ seasonal wetland, seasonal managed wetland, and pasture/hay habitats would be unsuitable upland game habitat as a result of shallow flooding to attract waterfowl.

Summary of Project Impacts and Recommended Mitigation Measures

Table 4.7-8 summarizes changes in habitat types and acreages from existing conditions to conditions that would occur under Alternative 2.

Table 4.7-8. Changes in Habitat Acreages from Existing Conditions to Conditions under Alternative 2

Habitat Type		Existing		Alternative 2		Change from Existing to Alternative 2 Conditions (acres)[b]
Existing Habitat	Corresponding (Created/Improved) Habitat on Habitat Islands	Reservoir Islands (acres)	Habitat Islands (acres)	Reservoir Islands (acres)	Habitat Islands (acres)[a]	
Corn, wheat, small grains	Corn, wheat, small grains	6,882	4,149	0	2,842	-8,189
Other crops/fallow	N/A	2,283	2,070	0	0	-4,353
Exotic marsh	Mixed agriculture/seasonal wetland, seasonal managed wetland, seasonal pond	66	1,554	0[c]	3,895	+2,275
N/A	Pasture/hay	0		0	204	+204
Herbaceous upland	Herbaceous upland	1,202	856	0[c]	732	-1,326
Freshwater marsh	Emergent marsh	93	156	0[c]	402	+153
Riparian	Riparian	189	138	0	387	+60
Canals and ditches	Canal	70	60	0	80	-50
Ponds	Lake and borrow ponds	76	25	0[c]	233	+133
Total					8,415	-11,093

[a] These acreages are based on the draft HMP and may be revised in the final HMP.

[b] See Summary of Project Impacts and Recommended Mitigation Measures for Alternative 2 for a description of how habitat losses would be mitigated.

[c] These habitats would exist on the Reservoir Islands during some operating years; however, because the areal extent of these habitat types and the frequency with which they would appear are unpredictable, no habitat acreage is credited.

Impact W-1: Potential Injury or Mortality of, and Potential Loss of Suitable Habitat for, Valley Elderberry Longhorn Beetle

Habitat creation and modification could result in disturbance or mortality of VELB if elderberry shrubs are removed or trimmed, or the roots of the shrubs are cut or disturbed. If the elderberry shrubs were removed, this also would result in the loss of habitat for the beetle. Because VELB is a federally listed species, this impact could be considered significant. However, as outlined in the environmental commitments to be included in the revised HMP, an avoidance and minimization measure that is part of the Construction Implementation Plan would avoid and protect VELB and its habitat by avoiding removal of elderberry shrubs and maintaining a 100-foot protective buffer around shrubs. With the implementation of the Construction Implementation Plan in the final HMP, this impact is less than significant.

Mitigation

No mitigation is required.

Impact W-2: Potential Injury or Mortality of Western Pond Turtle

Habitat creation and modification and construction activities associated with reservoir construction could result in injury or mortality of western pond turtles within suitable aquatic habitat. These activities also could cause injury or mortality of eggs or young individuals in nests in upland habitat if these areas are being used for egg deposition. Declines in populations of western pond turtles throughout the species' range have been documented (Jennings and Hayes 1994). Loss of individuals in the Project area could diminish the local population and lower reproductive potential, which could contribute to the further decline of this species. The loss of upland nesting sites or eggs also would decrease the local population. For these reasons, this impact would be considered significant. However, as outlined in the environmental commitments to be included in the final HMP, avoidance and minimization measures on the Habitat Islands, such as preconstruction surveys and construction setbacks, that are part of the Construction Implementation Plan would avoid or reduce the potential for injury or mortality of western pond turtles and direct effects on the Reservoir Islands would be compensated by improving conditions on the Habitat Islands. With the implementation of the final HMP, this impact is less than significant.

Mitigation

No mitigation is required.

Impact W-3: Loss of Suitable Aquatic and Upland Habitat for Western Pond Turtle

According to information gathered by DWR (2003), a total of 305 acres of suitable aquatic habitat would be lost from the interior and exterior of the Reservoir Islands from implementation of Alternative 2. Approximately 417 acres of suitable upland (herbaceous upland and riparian) habitat would be lost from the interior of the Reservoir Islands from implementation of Alternative 2. As outlined in the environmental commitments to be included in the final HMP, a minimum of 305 acres and 417 acres of suitable aquatic and upland habitat, respectively, would be preserved, created, or improved on the habitat islands to compensate for the loss of habitat on the Reservoir Islands. The draft HMP includes 313 acres of aquatic habitat (lake, canals, and borrow ponds) and 1,119 acres of upland habitat (herbaceous upland and riparian) that would be suitable for western pond turtle and would compensate for the loss of habitat on the Reservoir Islands (Table 4.7-9). Because giant garter snake and western pond turtle share similar habitats, this habitat could be managed in coordination with habitat preserved for giant garter snake. Furthermore, the final HMP will require additional environmental commitments, including reconfiguring the direction and slope of upland habitat, creation of basking habitat, and a BMP to avoid mortality of turtles during maintenance activities. With the implementation of the final HMP, including the additional environmental commitments described above, this impact is less than significant.

Mitigation
No mitigation is required.

Impact W-4: Potential Injury or Mortality of Giant Garter Snake

Construction activities associated with reservoir construction, as well as habitat creation and modification, could result in injury or mortality of giant garter snakes if they are present within suitable aquatic and upland habitat. However, it is unlikely there is a self-sustaining giant garter snake population on the islands because they are surrounded by canals and rivers and because extensive surveys by DWR during 2002 and 2003 did not discover the snake. Although there is low potential for injury or mortality of a giant garter snake during construction activities, the loss of an individual snake would be considered significant because giant garter snake has declined substantially throughout its range because of habitat loss and fragmentation from urban development and mortality as a result of water conveyance channel maintenance, leading to its state and federal Threatened status (U.S. Fish and Wildlife Service 1999). However, as outlined in the environmental commitments, avoidance and minimization measures, such as preconstruction surveys and relocation, would avoid or reduce the potential for injury or mortality of giant garter snakes. With the implementation of the environmental commitments, this impact is less than significant.

Mitigation
No mitigation is required.

Impact W-5: Loss of Suitable Aquatic and Upland Habitat for Giant Garter Snake

Using the information collected by DWR in 2002 and 2003 (the best information available), it was determined that approximately 509 acres of giant garter snake aquatic habitat and 443 acres of upland habitat would be lost from construction of the reservoirs (California Department of Water Resources 2006; Patterson pers. comm.). As outlined in the environmental commitments to be included in the revised HMP, a minimum of 509 acres and 443 acres of suitable aquatic and upland habitat, respectively, would be preserved, created, or improved on the habitat islands to compensate for the loss of habitat on the Reservoir Islands. The draft HMP includes 313 acres of aquatic habitat (lake, canals, and borrow ponds) and 1,119 acres of upland habitat (herbaceous upland and riparian) that would be suitable for giant garter snake, which would partially compensate for the loss of aquatic habitat and more than compensate for the loss of upland habitat on the Reservoir Islands (Table 4.7-10). Because the species share similar habitats, this habitat could be managed in coordination with habitat preserved for western pond turtle. With the implementation of this commitment in the revised HMP, this impact is less than significant.

Mitigation
No mitigation is required.

Impact W-6: Loss of Upland Habitats

Loss of herbaceous upland, exotic marsh, and agricultural habitats on the Reservoir Islands would reduce the acreage of habitat for western meadowlarks, white-crowned sparrows, and other regionally abundant song birds. Existing upland and agricultural habitats that also provide low to moderate forage value for several breeding and wintering raptor species also would be reduced. As part of the Project, implementation of the final HMP would offset impacts of Reservoir Island water storage operations under Alternative 2 by creating fewer, but higher-quality, upland habitats. Therefore, this impact is considered less than significant.

Mitigation
No mitigation is required.

Impact W-7: Increase in Suitable Wetland Habitats for Nongame Water and Wading Birds

Approximately 235 acres of wetland habitat (freshwater marsh, exotic marsh, and permanent ponds) would be lost on the Reservoir Islands. However, approximately 3,750 acres of wetland habitat would be preserved or created on the habitat islands under Alternative 2 with implementation of the revised HMP. Seasonal wetlands, emergent marshes, ponds, and lakes that would be preserved or created on the habitat islands would provide foraging or nesting habitat, or both, for resident and migrant grebes, shorebirds, egrets, herons, gulls, terns, and other wetland-associated birds in the Delta region. During water storage periods, the Reservoir Islands also would provide foraging and resting habitat for grebes, gulls, terns, cormorants, and other water birds. Although not required to offset impacts, management of the Reservoir Islands for shallow-water wetlands would provide habitat values for shorebirds, wading birds, and water birds similar to, but of lower quality than, those described for the habitat islands. This impact is considered beneficial and less than significant.

Mitigation
No mitigation is required.

Impact W-8: Loss of Foraging Habitats for Wintering Waterfowl

Wintering waterfowl are dependent on agricultural crops, primarily corn and wheat, for forage in the Delta. Water storage operations on the Reservoir Islands would decrease the amount of agricultural crops on the Reservoir Islands. However, implementation of the final HMP would include intensive management of corn, wheat, mixed agriculture/seasonal wetland, seasonal managed wetland, and pasture/hay habitats on habitat islands specifically to provide high-quality waterfowl forage values. Small grain fields, seasonal ponds, permanent lakes, emergent marshes, and herbaceous uplands also would provide foraging areas for wintering waterfowl on the habitat islands.

Results of the modified HEP analysis performed by the HMP team indicated that implementation of the HMP under Alternative 2 would offset impacts of Project operations on low- to moderate-quality wintering waterfowl foraging habitats through creation of high-quality foraging habitats on the habitat islands. Therefore, this impact is considered less than significant.

Mitigation
No mitigation is required.

Impact W-9: Increase in Suitable Breeding Habitats for Waterfowl

The primary factors limiting duck production are the availability of nesting habitat and availability of suitable brood water for ducklings. Implementation of the final HMP under Alternative 2 would include establishment of duck nesting habitats, creation of waterfowl brood ponds, and construction of wood duck nest boxes and goose nesting platforms on the habitat islands. Therefore, this impact is considered beneficial and less than significant.

Mitigation
No mitigation is required.

Impact W-10: Loss of Habitats for Upland Game Species

As a result of habitat loss associated with operation of the Reservoir Islands, there would be a substantial decline in the populations of ring-necked pheasant, the most common upland game species. Implementation of the final HMP would provide higher-quality habitats on the habitat islands than under existing conditions. Portions of these habitats would be unavailable to pheasants during fall and winter flood periods; however, habitat suitability would be improved during the breeding season, when agricultural lands typically provide unsuitable habitat. Few pheasant hunters currently hunt on the Project islands, and the hunting program under the HMP is expected to focus on waterfowl hunting and to have less emphasis on hunting for upland game species, including pheasant.

Other upland game species (mourning dove, California quail, and desert cottontail) are present in low numbers and occupy primarily island levees. Desert cottontail may become extirpated from Bacon Island (cottontails are not found on Webb Tract [Swanson pers. comm.]) because maximum storage events would completely inundate island interiors, except for riprapped portions of upper levee slopes. With implementation of the final HMP, an additional 60 acres of riparian habitat (some of which would be willow scrub) would be created on the habitat islands (Table 4.7-10), which would benefit mourning dove and California quail. Higher quality herbaceous upland habitat on the habitat islands also could benefit mourning dove and desert cottontail. Therefore, this impact is considered less than significant.

Mitigation
No mitigation is required.

Impact W-11: Loss of Suitable Foraging Habitat for Greater Sandhill Crane

Greater sandhill cranes forage in corn and grain fields, wetlands, pastures, and herbaceous uplands. Under Alternative 2 and using 2008 conditions, approximately 10,071 acres of suitable greater sandhill crane foraging habitat would be lost on the Reservoir Islands. Crop production varies annually, and median corn production from 1988 and 2002 to 2008 was approximately 2,000 acres less than 2008 conditions. The draft HMP requires 7,673 acres of foraging habitat (corn/wheat, small grains, mixed agriculture/seasonal wetland, seasonal managed wetland, seasonal pond, pasture/hay, and herbaceous upland) to be preserved/managed for greater sandhill crane. As outlined in the environmental commitments to be included in the final HMP, between 7,673 and 10,071 acres of suitable foraging habitat would be preserved or created on the habitat islands to compensate for the loss of habitat on the Reservoir Islands (using previous HMP estimates and 2008 data, respectively). In addition, the final HMP will require that the habitat preserved/created will be higher quality than the foraging habitat that would be lost on the Reservoir Islands. Preservation/creation of this acreage of habitat would ensure that the quality and quantity of foraging habitat on the Project islands for sandhill crane would remain high. With the implementation of this commitment in the final HMP, this impact is less than significant.

Mitigation

No mitigation is required.

Impact W-12: Increase in Suitable Roosting Habitat for Greater Sandhill Crane

Information from 2002–2003 surveys suggests that sandhill cranes roosted on Webb Tract during the winter of 2002–2003 (California Department of Water Resources 2003), and they also have roosted on Holland Tract. Suitable roosting sites are a key habitat requirement for wintering greater sandhill cranes, and such sites are limited in the Delta. Implementation of the HMP under Alternative 2 would include creation of wetlands managed specifically to provide roosting habitat for greater sandhill cranes. The value of crane foraging habitats that would be created on the habitat islands also would be enhanced with development of roosting habitat because cranes typically forage near roosts. Therefore, this impact is considered beneficial and less than significant.

Mitigation

No mitigation is required.

Impact W-13: Loss of Suitable Foraging Habitat for Swainson's Hawk

Under Alternative 2, approximately 9,978 acres of suitable Swainson's hawk foraging habitat (agricultural lands, fallow fields, herbaceous upland, and exotic marsh) would be lost on the Reservoir Islands. The draft HMP requires 7,539 acres of foraging habitat (corn/wheat, small grains, mixed agriculture/seasonal wetland, seasonal managed wetland, pasture/hay, and herbaceous upland) to be preserved/managed for Swainson's hawk. As outlined in the environmental commitments to be included in the final HMP, a minimum of 6,929 acres of suitable foraging habitat would be preserved or created on the habitat islands to compensate for the loss of habitat on the Reservoir Islands. The acreage to be preserved/created was based on providing an equivalent acreage of foraging habitat for losses of fallow fields, herbaceous upland, exotic marsh, and agricultural lands other than corn and half the equivalent acreage for the loss of corn because it has a lower value as foraging habitat for Swainson's hawk. . In addition, the final HMP will require that the habitat preserved/created will be higher quality than the foraging habitat that would be lost on the Reservoir Islands. With implementation of these commitments in the final HMP, this impact is less than significant.

Mitigation
No mitigation is required.

Impact W-14: Loss of Suitable Nesting Habitat for Swainson's Hawk, Cooper's Hawk, and White-Tailed Kite

Mature cottonwood and willow trees provide suitable nesting habitat for Swainson's hawk, Cooper's hawk, and white-tailed kite. Under Alternative 2, approximately 113 acres of riparian woodland that may provide suitable nesting habitat for Swainson's hawk, Cooper's hawk, and white-tailed kite could be lost during construction on the Reservoir Islands. However, as part of the final HMP (and as described in the draft HMP), 387 acres of riparian habitat would be created on the habitat islands, which would compensate for the loss of suitable nesting habitat for these species. With implementation of the final HMP, this impact is less than significant.

Mitigation
No mitigation is required.

Impact W-15: Loss of Suitable Breeding/Wintering Habitat for Western Burrowing Owl

Under Alternative 2, approximately 747 acres of suitable breeding/wintering habitat (herbaceous upland) for western burrowing owl would be lost from the Reservoir Islands. The habitat islands currently contain approximately 1,014 acres of herbaceous upland. As outlined in the environmental commitments to be included in the final HMP, a minimum of 747 acres of suitable nesting/wintering habitat would be preserved or created on the habitat islands to compensate for the loss of habitat on the Reservoir Islands. The draft HMP included 732 acres of herbaceous upland that would be preserved/managed on the habitat islands. Therefore, the final HMP would require a slight increase in the acreage of herbaceous upland to be preserved as nesting/wintering habitat for burrowing owls. With the implementation of this commitment in the final HMP, this impact is less than significant.

Mitigation
No mitigation is required.

Impact W-16: Loss of Suitable Foraging Habitat for Cooper's Hawk, White-Tailed Kite, Western Burrowing Owl, and Loggerhead Shrike

Suitable foraging habitat for Cooper's hawk consists of riparian woodland and scrub. Suitable foraging habitat for white-tailed kite, western burrowing owl, and loggerhead shrike consists of agricultural lands, fallow fields, and herbaceous upland. Under Alternative 2, approximately 113 acres of riparian woodland and 75 acres of riparian scrub would be lost during construction on the Reservoir Islands. In addition, 9,912 acres of foraging habitat for white-tailed kite, western burrowing owl, and loggerhead shrike also would be lost from implementation of Alternative 2.

As part of the final HMP (and as described in the draft HMP), 387 acres of riparian habitat would be created on the habitat islands, which would compensate for the loss of suitable foraging habitat for Cooper's hawk. In addition, 5,423 acres of agricultural lands, mixed agriculture/seasonal wetland, pasture/hay, and herbaceous upland would be created/managed as part of the final HMP (and as described in the draft HMP) and would compensate for the loss of suitable foraging habitat for white-tailed kite, western burrowing owl, and loggerhead shrike. Although there still would be a loss of habitat, the final HMP will require that the habitat preserved/created will be higher quality than the foraging habitat that would be lost on the Reservoir Islands. With implementation of the final HMP, this impact is less than significant.

Mitigation
No mitigation is required.

Impact W-17: Loss of Foraging Habitat for Cackling (Aleutian Canada) Goose

Cackling (Aleutian Canada) geese could occur irregularly in agricultural and herbaceous habitats on all four Project islands. Because this species no longer is listed under the ESA and is expected to occur infrequently on Reservoir Islands, the loss of suitable habitat caused by water storage on Reservoir Islands would not adversely affect the species. In addition, the final HMP that will be prepared as mitigation for other special-status species would benefit cackling goose through creation of suitable habitat on the habitat islands. Therefore, this impact is considered less than significant.

Mitigation
No mitigation is required.

Impact W-18: Loss of Suitable Nesting and Foraging Habitat for Northern Harrier and Short-Eared Owl

Suitable nesting and foraging habitat for northern harrier and short-eared owl is present on all Project islands. Under Alternative 2, approximately 975 acres of suitable northern harrier and short-eared owl nesting and foraging habitat (fallow, herbaceous upland, and marsh) and 10,071 acres of foraging habitat (agricultural lands, fallow, herbaceous upland, and marsh) would be lost on the Reservoir Islands. As part of the final HMP (and as described in the draft HMP), 3,250 acres of nesting habitat (seasonal managed wetland, emergent marsh, and herbaceous upland) and 7,941 acres of foraging habitat (agricultural lands, mixed agriculture/seasonal wetlands, seasonal managed wetland, emergent marsh, and herbaceous upland) would be created on the habitat islands, which would compensate for the loss of suitable nesting and foraging habitat for northern harrier and short-eared owl. Although there still would be a loss of habitat, the final HMP will require that the habitat preserved/created will be higher quality than the foraging habitat that would be lost on the Reservoir Islands. With implementation of the final HMP, this impact is less than significant.

Mitigation
No mitigation is required.

Impact W-19: Loss of Winter Foraging Habitat for Tricolored Blackbird

Suitable foraging habitat (agricultural lands, fallow fields, herbaceous upland, and marsh) for tricolored blackbirds is present on all four islands, and tricolored blackbirds were observed on Bacon Island and Webb Tract during 2002–2003 surveys (California Department of Water Resources 2003). Under Alternative 2, approximately 10,071 acres of suitable tricolored blackbird foraging habitat would be lost on the Reservoir Islands. As part of the final HMP (and as described in the draft HMP), 7,941 acres of foraging habitat (agricultural lands, mixed agriculture/seasonal wetland, seasonal managed wetland, pasture/hay, emergent marsh, and herbaceous upland) would be created on the habitat islands, which would compensate for the loss of suitable foraging habitat for tricolored blackbirds. Although there still would be a loss of habitat, the final HMP will require that the habitat preserved/created will be higher quality than the foraging habitat that would be lost on the Reservoir Islands. With implementation of the final HMP, this impact is less than significant.

Mitigation
No mitigation is required.

Impact W-20: Change in Acreage of Suitable Nesting Habitat for Tricolored Blackbird

Nesting colonies of tricolored blackbirds have not been observed, but suitable nesting habitat is present on all Project islands. Under Alternative 2, approximately 234 acres of suitable tricolored blackbird nesting habitat (marsh and permanent pond) would be lost on the Reservoir Islands. As part of the final HMP (and as described in the draft HMP), 635 acres of suitable nesting habitat (emergent marsh, lake, and borrow pond) would be maintained/created on the habitat islands, which would compensate for the loss of suitable nesting habitat for tricolored blackbirds. This impact is less than significant.

Mitigation
No mitigation is required.

Impact W-21: Increase in Suitable Habitats for Special-Status Bird Species

Project impacts are not assessed for six special-status species (golden eagle, bald eagle, ferruginous hawk, American peregrine falcon, mountain plover, and bank swallow) (Table 4.7-2) because these species would not nest on the islands and are not known to occur or only forage occasionally on the islands. With implementation of the final HMP, agricultural, herbaceous upland, wetland, and riparian habitats for wildlife would be created and managed, resulting in increases in the quantity and quality of suitable habitat for these six special-status species. Therefore, this impact is considered beneficial and less than significant.

Mitigation
No mitigation is required.

Impact W-22: Potential Injury or Mortality of Northern Harrier, Cooper's Hawk, Swainson's Hawk, White-Tailed Kite, California Black Rail, Greater Sandhill Crane, Western Burrowing Owl, Short-Eared Owl, Loggerhead Shrike, and Non–Special-Status Migratory Birds

Construction activities associated with refurbishing and enlarging levees, installing Project infrastructure, and grading to establish habitat island habitats could result in temporary impacts on special-status bird species and other migratory birds. Construction disturbance during the breeding season could result in the incidental loss of fertile eggs or nestlings of northern harriers, Cooper's hawks, Swainson's hawks, white-tailed kites, western burrowing owls, short-eared owls, and loggerhead shrikes or otherwise lead to nest abandonment. Construction activities also could disturb roosting greater sandhill cranes, or disturb California black rails nesting in Delta channels adjacent to Project islands. However, as outlined in the environmental commitments, avoidance and minimization measures on the Habitat and Reservoir Islands, such as preconstruction nest surveys and protective buffers around active nests, would avoid or reduce the potential for injury or mortality of northern harrier, Cooper's hawk, Swainson's hawk, white-tailed kite, California black rail, greater sandhill crane, western burrowing owl, short-eared owl, loggerhead shrike, and non–special-status migratory birds. With the implementation of the environmental commitments, this impact is less than significant.

Mitigation
No mitigation is required.

Impact W-23: Disturbance to Greater Sandhill Cranes and Wintering Waterfowl from Aircraft Operations

The Bouldin Island airstrip may be used to ferry hunters to the island or for other recreation uses. Up to 100 takeoffs and landings of fixed-wing aircraft related to such uses are permitted on hunt and nonhunt days during waterfowl hunting season. Use of the airstrip on hunt days would be allowed only between 12:00 p.m. and 2:00 p.m. This estimate of aircraft operations is based on full buildout of the recreation facilities. However, as described in Chapter 2, the Project applicant has removed construction of the recreation facilities from its CWA applications. Nevertheless, the analysis of aircraft operations assumes that the facilities would be constructed and operated.

The airstrip is located in the east Bouldin Island closed hunting zone. Closed hunting zones were established on the habitat islands to provide resting and foraging areas for greater sandhill cranes and wintering waterfowl that would be free from hunter disturbance on days when other portions of the habitat islands are hunted. Use of the airstrip on hunt days therefore could result in additional disturbance of these species on hunt days and could reduce habitat values provided by the closed hunting zone. Therefore, this impact is considered significant. Implementing Mitigation Measure W-MM-1 would reduce Impact W-23 to a less-than-significant level.

Mitigation Measure W-MM-1: Monitor Effects of Aircraft Flights on Greater Sandhill Cranes and Wintering Waterfowl and Implement Actions to Reduce Aircraft Disturbances of Wildlife

The Project applicant will develop a monitoring program in consultation with DFG and the Habitat Management Advisory Committee (HMAC) and implement the program to determine whether airstrip use on hunt days has a deleterious impact on greater sandhill cranes or waterfowl. The plan will be submitted to the State Water Board’s Chief of the Division of Water Rights within 1 year of issuance of Project operation permits.

The following will be the major elements of the monitoring plan:

- criteria for evaluating monitoring data that would be used to determine whether use of the airstrip on hunt days is having a significant impact on greater sandhill cranes and waterfowl (i.e., more than 1 greater sandhill crane collision per year and greater than 5 waterfowl collisions per year),
- criteria for determining appropriate mitigation requirements for offsetting significant impacts based on the level of impact airstrip use has on these species (i.e., restricting flights to day-time hours and clear conditions),
- a detailed description of monitoring protocols, and
- a monitoring schedule that estimates when data would be sufficient to determine whether airstrip use on hunt days has significant impacts on greater sandhill cranes or waterfowl.

If, based on monitoring results, airstrip use on hunt days is found to have a significant impact on greater sandhill cranes or waterfowl, DFG, in consultation with the HMAC, may recommend to the State Water Board’s Chief of the Division of Water Rights that airstrip use be modified to ensure that the goals for establishment of the closed hunting zone are met. Depending on the level of impact, recommendations could include closing hunting on Bouldin Island during the landing and takeoff period, restricting the number of flights permitted per day, changing the landing and takeoff period to reduce impacts, or closing the use of the airstrip on hunt days. Conversely, if monitoring indicates that there is no significant impact on greater sandhill cranes or wintering waterfowl, DFG, in consultation with the HMAC, could recommend that the proposed initial aircraft use restrictions remain in place or be reduced.

Impact W-24: Potential for Increased Incidence of Waterfowl Diseases

Diseases kill substantial numbers of waterfowl in the Central Valley every year (Tiche 1988). Habitat management changes under Alternative 2 could increase the incidence of disease if habitat conditions are created that favor disease organisms or concentrate birds so that diseases were more easily transmitted. Two important diseases that affect waterfowl in the Delta are botulism and avian cholera. Expected habitat conditions and bird use on the Project islands with implementation of Alternative 2 were analyzed to assess the potential for increases in waterfowl mortality resulting from disease in the Delta.

Botulism develops in waters subject to anaerobic conditions, generally when rotting vegetation depletes oxygen from water. These conditions occur most often in warm, shallow waters and especially in areas with alkaline soils. In general, waterfowl mortality resulting from botulism is minimal in the Delta (Fredrickson et al. 1988). However, the proposed deep flooding of abundant wetland vegetation on the Reservoir Islands raises concerns regarding botulism potential.

Botulism is not likely to become a problem on the Reservoir Islands for several reasons. During November–May water storage periods, temperatures are low enough for the water to remain highly oxygenated and vegetation decomposition to occur slowly. June and July are windy months in the Delta, and they are the warmest months during water storage periods. Winds would aerate the water, thereby reducing the likelihood that the anaerobic conditions necessary for botulism to develop would occur during this period (Miller pers. comm.). During periods when Reservoir Islands are managed as shallow-water wetlands, the Project applicant would circulate water through wetlands, reducing the likelihood that anaerobic conditions would develop, and would have the capability to drain wetlands rapidly if an outbreak of botulism were to occur.

Peat soils exposed during water storage drawdown periods on the Reservoir Islands would quickly dry out and absorb oxygen; this absorption would prevent creation of anaerobic conditions during periods when water is diverted onto the islands. During wetland management periods on both the reservoir and habitat islands, circulation of water through wetland cells would oxygenate the water and reduce the potential for development of botulism (Fredrickson et al. 1988). The incidence of botulism would be expected to be minimal under anticipated Project conditions.

Avian cholera is a contagious disease that kills substantial numbers of waterfowl in the Delta annually (Tiche 1988; Gifford pers. comm.). Cholera is more likely to spread when birds concentrate in high numbers and densities in shallow-water areas. Thus, actions that change waterfowl distribution and density patterns may affect the incidence of cholera.

Waterfowl on the Reservoir Islands would be distributed during shallow-water wetland periods over a large acreage of shallowly flooded area. Hunting during these periods would disturb birds periodically and prevent them from congregating in large numbers. Waterfowl would not make intensive, concentrated use of the deep-water habitats during water storage periods; moderate use by the canvasback and other diving ducks would be expected.

Cholera could become a problem in permanent lakes on Bouldin Island with implementation of the HMP. The risk would be no greater, however, than that currently existing at blowout ponds on Webb and Holland Tracts or in shallow pools in agricultural lands created by the accumulation of rainwater or seepage.

Cholera also could become a problem in corn fields and wheat fields, mixed agriculture/seasonal wetlands, and seasonal managed wetlands on the habitat islands because large numbers of birds would be attracted to the abundant and concentrated foods. Hunting would disturb waterfowl species in hunting zones during October–January and prevent them from concentrating in large numbers on days when hunting is permitted. Large numbers of waterfowl, however, would be expected to concentrate in closed hunting zones.

Waterfowl habitat conditions created on the habitat islands and, during some periods, on the Reservoir Islands under Alternative 2 would concentrate waterfowl in numbers that could be large enough to increase the incidence of avian cholera. Therefore, this impact is considered significant. Implementing Mitigation Measure W-MM-2 would reduce Impact W-24 to a less-than-significant level.

Mitigation Measure W-MM-2: Monitor Waterfowl Populations for Incidence of Disease and Implement Actions to Reduce Waterfowl Mortality
The Project applicant will retain a qualified biologist to monitor waterfowl use areas on the Project islands to locate incidences of waterfowl disease mortalities. The Project applicant, in cooperation with DFG and USFWS, will develop management strategies to be employed in the event of disease outbreaks. On identification of a disease outbreak, the Project applicant will notify DFG and, in cooperation with DFG biologists, implement management strategies to reduce waterfowl mortality. Management actions may include removing carcasses from the Project islands, hazing waterfowl from the islands, or draining waterfowl habitats.

Management strategies will include descriptions of:

- methods used to monitor waterfowl to detect disease outbreaks,
- protocols for determining when and what types of management actions to reduce the incidence of disease would be implemented,
- methods for collecting carcasses and removing them from affected areas,
- potential locations and methods for disposal of collected carcasses, and
- methods to haze waterfowl from Reservoir Islands.

Impact W-25: Potential Disruption of Waterfowl Use as a Result of Increased Hunting

Most species of waterfowl quickly learn to identify and avoid hunted areas (Bellrose 1976; Sacramento Valley Waterfowl Habitat Management Committee n.d.). Hunting disturbance can reduce waterfowl use of foraging areas to levels below the areas potential as determined by foraging habitat quality. During their searches for feeding and resting areas, waterfowl also quickly recognize and use areas that are not being hunted and will use hunting areas that are “rested” regularly from shooting activity. Existing levels of waterfowl hunting are low on the Project islands and do not substantially affect use of the islands by waterfowl.

No waterfowl hunting restrictions are proposed by the Project applicant or are required to offset Project impacts on the Reservoir Islands. The Project applicant, however, may limit hunting on the Reservoir Islands to Wednesdays, Saturdays, and Sundays during the hunting season to preserve hunting quality and reduce bird disturbance. On shooting days, birds would disperse to unhunted portions of the islands or other protected areas. Many birds likely would congregate in closed hunting zones on the habitat islands, Franks Tract, or other unhunted areas elsewhere in the Delta. If the Project applicant allows hunting only on specified days, the hunting schedule would permit waterfowl to return to feed on the Project islands on nonshooting days.

The Project applicant's proposed hunting program for the habitat islands is described in the HMP. The hunting program would reduce hunter disturbance to levels that would not substantially disturb waterfowl; elements include allowing hunting only 3 days each week (the Project applicant would also select a total of 2 additional hunting days during waterfowl season), establishing more than 2,000 acres of closed hunting zones to provide undisturbed waterfowl use areas, restricting the numbers of hunters permitted on islands, and permitting only spaced-blind hunting adjacent to closed hunting zones to reduce disturbance to birds in closed zones. Potential impacts of the hunting program under Alternative 2 were incorporated into the modified HEP analysis conducted for HMP development. The analysis indicated that implementation of the HMP and the hunting program would ensure that waterfowl would use the habitat islands at levels that would offset impacts of Alternative 2 on wintering waterfowl. Therefore, this impact is considered less than significant.

Mitigation
No mitigation is required.

Impact W-26: Potential Disruption of Greater Sandhill Crane Use of the Habitat Islands as a Result of Increased Hunting

Greater sandhill cranes react to hunting disturbance in much the same way as described for waterfowl under Impact W-24 (Schlorff pers. comm.). Little or no suitable foraging habitat for greater sandhill cranes would exist on the Reservoir Islands, and therefore, hunting on these islands would not affect greater sandhill crane foraging activities. Waterfowl and upland game hunting would occur on the habitat islands under Alternative 2. Implementation of the HMP, however, would restrict the number of hunting days per week and the number of hunters. One 810-acre closed hunting zone would be established on Bouldin Island that would offset the impact of hunting on crane use of foraging habitat. Two other closed hunting zones, totaling 1,198 acres, would be established to enhance waterfowl use of the habitat islands and also would provide large, undisturbed areas of crane foraging and loafing habitat. This impact therefore considered is less than significant.

Mitigation
No mitigation is required.

Impact W-27: Increase in Waterfowl Harvest Mortality

Existing levels of hunting on the Project islands and numbers of waterfowl harvested in the Delta are low. Because of this low harvest rate, the Delta provides an unofficial sanctuary area, which has been suggested to be important to maintaining populations of waterfowl, especially the white-fronted goose (Fleskes pers. comm.). The population of white-fronted goose declined in the 1970s but has recovered in recent years (Deuel pers. comm.). A substantial proportion of the entire population winters in the Delta region.

Existing harvest rates on the Project islands, as derived from known hunting use, are low (Table 4.7-10). Implementation of Alternative 2 would result in a substantial increase in waterfowl harvest over existing conditions on the four Project islands (Table 4.7-11). The harvest would increase because more hunters would be present and larger waterfowl populations would be attracted to the islands. Projected harvest levels on the Project islands would represent 1.2% (approximately 1,612 birds) of the average statewide goose harvest (138,500 birds) and 1.6% (approximately 24,195 birds) of the average statewide duck harvest (1,493,500 birds) during 1984–1987 (Deuel pers. comm.). This estimated harvest level also reflects addition of hunters who would be attracted to the Project islands but currently hunt other areas. Harvest increases projected under Alternative 2, however, are expected to be partially offset by increased duck production that would occur on the habitat islands with implementation of the HMP. Therefore, this impact is considered less than significant.

Mitigation

No mitigation is required.

Table 4.7-9. Estimated Annual Waterfowl Harvest under Existing Use and Alternative 2

Island	Existing Use			Alternative 2		
	Number of Hunter Use-Days	Number of Birds Harvested[a]		Maximum Number of Hunter Use-Days[b]	Number of Birds Harvested[c]	
		Geese	Ducks		Geese	Ducks
Bacon	0	0	0	2,592	259	3,888
Webb	320	50	350	2,664	266	3,996
Bouldin	150	15	175	7,424	742	11,136
Holland	60	5	25	3,449	345	5,174
Total	530	70	550	16,129	1,612	24,194

[a] See Table H2-12 in Appendix H2, "Wildlife Inventory Methods and Results," of the 2001 FEIS for sources of harvest rates.

[b] See Chapter 3J, "Recreation and Visual Resources," of the 2001 FEIS for methods used in calculating estimated numbers of annual hunter use-days.

[c] Average harvest rates are assumed to be 1.5 ducks/hunter/day and 0.1 goose/hunter/day, respectively, under the Project.

Impact W-28: Potential Changes in Local and Regional Waterfowl Use Patterns

Under Alternative 2, the quality of foraging habitat for swans and white-fronted geese on the habitat islands would be similar to or greater than habitat quality provided on all four Project islands under existing conditions. Duck use of all the Project islands, however, is expected to be substantially greater under Alternative 2. This level of increase is not likely to cause a noticeable change in waterfowl populations and harvest in other parts of the Delta, in the Central Valley, or at Suisun Marsh because the Project islands would be hunted and agricultural and seasonal wetland habitats would be flooded on staggered schedules through winter, thereby reducing habitat availability in some periods. Therefore, this impact is considered less than significant.

Mitigation
No mitigation is required.

Impact W-29: Potential Impacts on Wildlife and Wildlife Habitats Resulting from Delta Outflow Changes

Compliance with existing water quality objectives and other requirements would ensure that changes in Delta outflow do not cause salinity changes that would be detrimental to the management of wetlands for wildlife (Wernette pers. comm.). No substantial impacts on wildlife habitats or populations are expected to occur. Therefore, this impact is considered less than significant.

Mitigation
No mitigation is required.

Impact W-30: Loss of Roost Sites and Foraging Habitat for and Potential Injury or Mortality of Bats

Implementation of Alternative 2 would result in the loss of suitable roost sites and foraging habitat for special-status (i.e., western red bat and pallid bat) and non–special-status bats. In addition, both of these islands contain suitable foraging habitat for bats. On Bacon Island and Webb Tract, suitable roost sites consist of various structures and trees. Although none of the structures were occupied during 2002 surveys (California Department of Water Resources 2003), they could become occupied prior to Project construction. Conversion of Bacon Island and Webb Tract to reservoirs would result in the removal of structures and flooding of vegetation (hollow trees, snags, and other mature trees) that provide suitable roosting sites for bats. Inundation of the islands also would remove foraging habitat for bats (riparian and other vegetation associated with ponds, lakes, and canals). As part of the final HMP (and as described in the draft HMP), 387 acres of riparian habitat and 224 acres of permanent ponds would be created or preserved on the habitat islands, which would compensate for the loss of suitable roosting and foraging habitat for bats. With implementation of the final HMP, this impact is less than significant.

Implementation of Alternative 2 could result in the injury or mortality of special-status and non–special-status bats. Removal of structures or trees that contain roosting bats could cause injury or mortality if bats are present. Injury or mortality of pallid or western red bat, two special-status bats that have potential to roost on the islands, during building or tree removal would be considered an adverse impact. Based on available information on distribution, status, ecology, and known threats, pallid bat and western red bat have been rated in the category of highest priority by the Western Bat Working Group and are considered imperiled or are at high risk of imperilment in California (Western Bat Working Group 2007). However, as outlined in the environmental commitments to be included in the final HMP, avoidance and minimization measures on the Habitat and Reservoir Islands would avoid or reduce the potential for injury or mortality of special-status and non–special-status bats. With the implementation of the environmental commitments, this impact is less than significant.

Mitigation
No mitigation is required.

Alternative 1

Because only the diversion and discharge rates of Alternatives 1 and 2 are different, the impacts and mitigation measures of Alternative 1 are the same as those of Alternative 2.

Alternative 3

Alternative 3 involves storage of water on Bacon Island, Webb Tract, Bouldin Island south of SR 12, and Holland Tract, with secondary uses for wildlife habitat and recreation. Reservoir islands could be managed in fall, winter, and spring as shallow-water wetlands during some nonstorage periods. The portion of Bouldin Island north of SR 12 would be managed as the North Bouldin Habitat Area (NBHA). However, in contrast to their use under Alternatives 1 and 2, Bouldin Island and Holland Tract would not be devoted entirely to providing wildlife habitat under Alternative 3.

Changes in Wildlife Habitat Conditions and Use

Bacon Island, Webb Tract, Holland Tract, and Bouldin Island South of SR 12

All wildlife habitat conditions on the Reservoir Islands under Alternative 3 would be similar to conditions described above under Impacts and Mitigation Measures of Alternative 2, except that the frequency of these conditions would differ (see Appendix G4 of the 1995 EIR/EIS, “Prediction of Vegetation on the Delta Wetlands Reservoir Islands”).

Impacts on wildlife under Alternative 3 on Bacon Island and Webb Tract (the Reservoir Islands) would be the same as those described above for Reservoir Islands under Impacts and Mitigation Measures of Alternative 2. The magnitude of adverse impacts, however, would be greater because Bouldin Island south of SR12 and all of Holland Tract would be used for water storage. Consequently, losses of wildlife habitat would be greater than under Alternatives 1 and 2. Table 4.7-10 compares changes in habitat types and acreage under existing conditions and conditions that would occur under Alternative 3.

North Bouldin Habitat Area

The portion of Bouldin Island north of SR 12 would be managed as the NBHA. Approximately 50 acres of perennial ponds, 330 acres of seasonal managed wetlands, 170 acres of corn and wheat, 200 acres of riparian woodland, and 125 acres of herbaceous upland would be established and managed for wildlife in the NBHA (Table 4.7-10).

Wildlife habitat conditions associated with each of the NBHA habitats are the same as those described above for habitat island habitats under Impacts and Mitigation Measures of Alternative 2. Detailed descriptions of how these habitats would be managed and the wildlife values they provide are presented in Appendix G3 of the 1995 DEIR/EIS, “Habitat Management Plan for the Delta Wetlands Habitat Islands.”

Impacts on wildlife resulting from development of the NBHA would be similar to those described above for the habitat islands under Impacts and Mitigation Measures of Alternative 2 for each of the habitat types that would be established.

Table 4.7-10. Changes in Habitat Acreages from Existing Conditions to Conditions under Alternative 3

Existing Habitat	Corresponding Habitat at Habitat Area	Existing Conditions	Alternative 3		Change from Existing to Alternative 3 Conditions (acres)[a]
		All Islands (acres)	Reservoir Islands (acres)	North Bouldin Habitat Area (acres)	
Corn, wheat, small grains	Corn and wheat	11,031	0	170	-10,861
Other crops/fallow	N/A	4,353	0	0	-4,353
Exotic marsh	Seasonal managed wetland	1,620	0[b]	330	-1,290
Herbaceous upland	Herbaceous upland	2,058	0[b]	125	-1,933
Freshwater marsh	N/A	249	0[b]	0	-249
Riparian	Riparian	326	0	200	-126
Canals and ditches	N/A	130	0	0	-130
Ponds	Perennial ponds	101	0[b]	50	-51
Total		19,868		875	-18,993

[a] See "Summary of Project Impacts and Recommended Mitigation Measures" for Alternative 3 for a description of how habitat losses would be mitigated.

[b] These habitats would exist on the Reservoir Islands during some operating years; however, because the areal extent of these habitat types and the frequency with which they would appear are unpredictable, no habitat acreage is credited.

Summary of Project Impacts and Recommended Mitigation Measures

Impact W-1: Potential Injury or Mortality of, and Loss of Suitable Habitat for, Valley Elderberry Longhorn Beetle

Conversion of Holland Tract to a Reservoir Island could result in the loss of elderberry shrubs that provide suitable habitat for VELB. The removal or flooding of elderberry shrubs could result in the injury or mortality of VELB. Because VELB is a federally listed species, this impact would be considered significant. Implementing Mitigation Measure W-MM-3 would reduce Impact W-1 to a less-than-significant level.

Mitigation Measure W-MM-3: Avoid or Compensate for the Loss of Habitat for the Valley Elderberry Longhorn Beetle

The Project applicant will avoid removal of and maintain a 100-foot buffer around the cluster of elderberry shrubs on Holland Tract, or if this is not possible, The Project applicant will compensate for the loss of elderberry shrubs in accordance with USFWS guidelines through the Section 7 or 10 processes.

Impact W-2: Potential Injury or Mortality of Western Pond Turtle.

The potential for injury or mortality of western pond turtles under Alternative 3 would be similar to Alternative 2. The magnitude of the impact could be greater because more of the islands would be affected. Implementing Mitigation Measure W-MM-4 would reduce Impact W-2 to a less-than-significant level.

Mitigation Measure W-MM-4: Avoid and Minimize Injury and Mortality of Western Pond Turtle

To avoid and minimize injury and mortality of western pond turtles during construction activities associated with reservoir construction, and habitat creation and modification, the following measures will be implemented:

The construction area will be clearly defined using orange barrier fencing to minimize disturbance to riparian vegetation and western pond turtle habitat.

A preconstruction survey for western pond turtles will be conducted by a qualified biologist within 24 hours of the start of construction activities in suitable aquatic habitat. If a turtle is located within the construction area, the turtle will be relocated out of this area, and exclusion fence will be installed to prevent the movement of turtles back into the construction area. If construction will occur in suitable upland habitat between April 1 and September 1, a survey for nests sites will be conducted within 24 hours prior to ground-disturbing activities in suitable upland habitat.

Grading and construction activities along ponds, borrow pits, ditches, and canals and within 1,000 feet of these areas will be minimized between October 15 and April 15 to reduce potential mortality to hibernating turtles.

If a turtle becomes trapped during construction activities within aquatic habitat, the turtle will be removed from the work area by a qualified biologist with a valid scientific collecting permit and an MOU from DFG and placed downstream from the construction area or in adjacent suitable aquatic habitat outside of the construction area.

Impact W-3: Loss of Suitable Aquatic and Upland Habitat for Western Pond Turtle

According to information gathered by DWR (2003), a total of 549 acres of suitable aquatic habitat will be lost from the interior and exterior of the four islands from implementation of Alternative 3. Approximately 737 acres of suitable upland (herbaceous upland and riparian) habitat will be lost from the interior of the four islands from implementation of Alternative 3. Actual acreage lost would be less because a part of Bouldin Island would not be inundated. The loss of these large quantities of aquatic and upland habitats would be a significant impact. Implementing Mitigation Measure W-MM-5 would reduce Impact W-3 to a less-than-significant level.

Mitigation Measure W-MM-5: Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan

The Project applicant, in consultation with the Corps, DFG, and USFWS, will implement an off-site mitigation plan for mitigating impacts on habitats for special-status and other wildlife (western pond turtle, giant garter snake, greater sandhill crane, Swainson's hawk, northern harrier, Cooper's hawk, white-tailed kite, western burrowing owl, short-eared owl, loggerhead shrike, tricolored blackbird, bats, waterfowl, and upland game species). The mitigation area(s) will be located in San Joaquin or Contra Costa County, preferably in the Delta, unless otherwise approved by DFG and USFWS. Selection of the mitigation site and details of the mitigation plan will be determined through consultation with the Corps, DFG, and USFWS. The plan will include long-term monitoring of the habitat mitigation areas to determine species' use of the of the mitigation area and to ensure that habitats are being managed appropriately for species included in the plan. Monitoring reports will be prepared and submitted to DFG and USFWS on a schedule to be determined in consultation with the agencies. No water diversion/storage will be permitted until ESA and CESA consultations have been completed, no-jeopardy opinions have been issued by USFWS and DFG, and a mitigation plan and mitigation implementation schedule have been developed. The plan will include the following specifications and measures; however, mitigation ratios may be modified during consultation with DFG and USFWS:

- A minimum of 549 acres of suitable aquatic habitat and 737 acres of suitable upland habitat (1:1 ratios) will be preserved and managed for western pond turtle. Aquatic habitat will be surrounded by or immediately adjacent to suitable upland (grassland and/or riparian habitat). Management of aquatic habitat may include placement of basking substrate (logs or boards) and maintaining emergent vegetation for cover.
- A minimum of 966 acres of suitable aquatic habitat and 769 acres of suitable upland habitat (1:1 ratios) will be preserved and managed for giant garter snake. Aquatic habitat will be surrounded by or immediately adjacent to suitable upland (grassland and/or riparian habitat). Habitat management specifications may include conducting maintenance in upland habitat during the active period for the snake (May 1 through October 1), avoiding or minimizing activities within 200 feet of the banks of suitable aquatic habitat, confining vehicle movement to existing roadways, and confining wetland vegetation clearing to the minimal area necessary.
- The mitigation area(s) will contain high-quality herbaceous and agricultural habitats for wintering raptors and resident and migrant songbirds to compensate for the loss of 18,437 acres of herbaceous upland, exotic marsh, and agricultural habitats.
- The mitigation area(s) will contain high-quality agricultural, herbaceous upland, freshwater marsh, and perennial pond habitats for wintering waterfowl to compensate for the loss of 18,737 acres of agricultural, herbaceous upland, exotic marsh, freshwater marsh, and permanent ponds. Management of habitat may include periodic mowing of densely vegetated wetlands before flooding to provide open areas, harvesting only a portion of

corn and wheat crops to increase food abundance, and flooding harvested fields and wetlands sequentially to increase the length of time during which foraging habitat is available.

- The mitigation area(s) will contain high-quality agricultural, herbaceous upland, and riparian woodland and scrub habitats for upland game species to compensate for the loss of 18,563 acres of agricultural, herbaceous upland, exotic marsh, and riparian woodland and scrub.
- A minimum of 18,437 acres of suitable foraging habitat would be preserved and managed for greater sandhill crane (1:1 ratio). Suitable habitat will consist of high-quality agricultural lands, seasonal managed wetland, pasture or herbaceous upland. Management of habitat may include leaving unharvested strips of corn in corn fields and periodically mowing densely vegetated habitats to improve access for foraging cranes.
- A minimum of 14,017 acres of suitable foraging habitat would be preserved and managed for Swainson's hawk to compensate for the loss of 18,437 acres of foraging habitat. This acreage was determined by using a 0.5: 1 ratio for the loss of corn and a 1:1 ratio for the loss of other habitat types. A smaller ratio was used for compensating for the loss of corn, because it has lower value as foraging habitat for Swainson's hawk. Management of habitat may include mowing densely vegetated habitat to increase access to prey and maintaining upland borders around seasonal and perennial wetlands and ponds to provide refugia for prey species (e.g., mice and voles).
- The mitigation area(s) will contain a minimum of 126 acres of high-quality riparian woodland that would provide suitable nesting habitat for Swainson's hawk, Cooper's hawk, and white-tailed kite to compensate for the loss of 126 acres of riparian woodland (1:1 ratio).
- A minimum of 1,933 acres of suitable nesting/wintering habitat would be preserved and managed for western burrowing owl to compensate for the loss of approximately 1,933 acres of suitable nesting/wintering habitat (herbaceous upland) (1:1 ratio). Management of habitat may include mowing densely vegetated habitat to increase the suitability of burrow nest sites and prey accessibility, prohibiting the use of rodenticides, and allowing colonization by ground squirrels to maintain and expand burrow sites.
- The mitigation area(s) will contain a minimum of 126 acres of high-quality riparian woodland that would provide suitable foraging habitat for Cooper's hawk and will contain high-quality foraging habitats (agricultural and herbaceous upland) for white-tailed kite, western burrowing owl, and loggerhead shrike to compensate for the loss of 17,147 acres of agricultural lands and herbaceous upland.
- The mitigation area(s) will contain high-quality agricultural, herbaceous upland, and freshwater marsh habitats for northern harrier and short-eared owl to compensate for the loss of 3,472 acres of suitable nesting and foraging habitat and 15,214 acres of foraging habitat only (i.e., agricultural lands).
- The mitigation area(s) will contain high-quality agricultural and herbaceous upland foraging habitats for tricolored blackbird to compensate for the loss of

approximately 17,147 acres of suitable foraging habitat (agricultural lands and herbaceous upland).

- The mitigation area(s) will contain high-quality freshwater marsh and perennial pond nesting habitats for tricolored blackbird to compensate for the loss of 1,590 acres of suitable nesting habitat (exotic and freshwater marsh and permanent pond). If perennial ponds are constructed, the shoreline contours will be designed to allow riparian, emergent wetland, and herbaceous vegetation to become established.
- The mitigation area(s) will contain high-quality foraging habitat (riparian and perennial ponds) for bats to compensate for the loss of suitable foraging habitat (riparian and other vegetation associated with ponds, lakes, and canals) from inundation of the four islands.

Impact W-4: Potential Injury or Mortality of Giant Garter Snake

The potential for injury or mortality of giant garter snakes from Alternative 3 would be similar to Alternative 2. The magnitude of the impact could be significant because more of the islands would be affected. Implementing Mitigation Measure W-MM-6 would reduce Impact W-4 to a less-than-significant level.

Mitigation Measure W-MM-6: Avoid and Minimize Injury and Mortality of Giant Garter Snake

To avoid and minimize injury and mortality of giant garter snakes during construction activities associated with reservoir construction and habitat creation and modification, the following measures will be implemented:

- Minimize or avoid the take of giant garter snake by limiting construction activities in and adjacent to suitable habitat during the active period for the species (May 1–October 1) in accordance with USFWS (1997b) guidelines.
- Within 24 hours of construction, a qualified biologist approved by USFWS will conduct a survey for giant garter snakes in suitable habitat in the Project area. Results of this survey will be submitted to USFWS within 24-hours of commencement of construction activities.
- To identify and protect any giant garter snake encountered, the qualified biologist will be present during any construction in or near suitable aquatic habitat. Any snake found during construction will be avoided and allowed to move away from construction activities on its own. Capture and relocation may be attempted only by individuals with a valid 10(a)(1)(A) recovery permit from USFWS.
- Avoid or minimize construction activities within 200 feet of the banks of suitable aquatic habitat (e.g., canals, ditches, borrow pits, ponds) and confine the movement of heavy equipment to existing roadways.
- Clearing of wetland vegetation will be confined to the minimal area necessary.

Impact W-5: Loss of Suitable Aquatic and Upland Habitat for Giant Garter Snake

According to information gathered by DWR in 2002 and 2003 (California Department of Water Resources 2003, 2006, and unpublished information), a total of 966 acres of suitable aquatic habitat could be lost from the four islands from implementation of Alternative 3. Approximately 769 acres of suitable upland habitat could be lost from the four islands from implementation of Alternative 3. Actual acreage lost would be less because a part of Bouldin Island would not be inundated and would become the Bouldin Island Habitat Area. The loss of these large quantities of aquatic and upland habitats would be a significant impact. Implementing Mitigation Measure W-MM-5 would reduce Impact W-5 to a less-than-significant level.

Mitigation Measure W-MM-5: Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan

This measure is described above under Alternative 2.

Impact W-6: Loss of Upland Habitats

Water storage operations on the Reservoir Islands under Alternative 3 would result in the loss of approximately 18,437 acres of herbaceous upland, exotic marsh, and agricultural habitats (Tables 4.7-10 and 4.7-11). These habitats provide foraging areas for wintering raptors and resident and migrant songbirds associated with herbaceous and agricultural habitats. Therefore, this impact is considered significant. Implementing Mitigation Measure W-MM-5 would reduce Impact W-6 to a less-than-significant level.

Mitigation Measure W-MM-5: Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan

This measure is described above.

Impact W-8: Loss of Foraging Habitats for Wintering Waterfowl

Implementation of Alternative 3 would result in the loss of approximately 18,737 acres of low- to moderate-quality foraging habitats for wintering waterfowl (Table 4.7-12). The loss of this large quantity of habitat is considered significant. Implementing Mitigation Measure W-MM-5 would reduce Impact W-8 to a less-than-significant level.

Mitigation Measure W-MM-5: Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan

This measure is described above.

Table 4.7-11. Comparison of Impacts of Alternatives 1, 2, and 3 on Acreages of Suitable Foraging Habitat for Swainson's Hawk, Wintering Raptors, Greater Sandhill Crane, and Wintering Waterfowl

	Increase (+) or Decrease (-) in Foraging Habitat Acres from Existing Conditions					
	Swainson's Hawk and Wintering Raptors		Greater Sandhill Crane		Wintering Waterfowl	
Habitat Type	Alternatives 1 and 2	Alternative 3	Alternatives 1 and 2	Alternative 3	Alternatives 1 and 2	Alternative 3
Agriculture	-12,542	-15,214	-12,542	-15,214	-12,542	-15,214
Exotic marsh	+2,275	-1,290	+2,275	-1,290	+2,275	-1,290
Herbaceous upland	-1,326	-1,933	-1,326	-1,933	-1,326	-1,933
Freshwater marsh	N/A	N/A	N/A	N/A	+153	-249
Ponds	N/A	N/A	N/A	N/A	+133	-51
Total	-11,593	-18,437	-11,593	-18,437	-11,307	-18,737

Note: N/A = not applicable.

Impact W-9: Increase in Suitable Breeding Habitats for Waterfowl

Development of the NBHA under Alternative 3 would include establishment of duck nesting habitats, creation of waterfowl brood ponds, and construction of wood duck nest boxes and goose nesting platforms. Because there is limited breeding habitat for waterfowl on the four islands, these actions would increase the suitability of the Project islands as waterfowl breeding habitat. Therefore, this impact is considered beneficial and less than significant.

Mitigation

No mitigation is required.

Impact W-10: Loss of Habitats for Upland Game Species

The impacts of water storage operations on upland game species and their habitats are described above under Impacts and Mitigation Measures of Alternative 2. Implementation of Alternative 3 would result in the loss of approximately 18,563 acres of suitable upland game habitat (i.e., agricultural areas, riparian woodland and scrub, exotic marsh, and herbaceous upland). The loss of this large quantity of habitat is impact is considered significant. Implementing Mitigation Measure W-MM-5 would reduce Impact W-10 to a less-than-significant level.

Mitigation Measure W-MM-5: Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan

This measure is described above.

Impact W-11: Loss of Foraging Habitat for Greater Sandhill Crane

Implementation of Alternative 3 would result in the loss of approximately 18,437 acres of foraging habitat (agricultural lands, herbaceous upland, and exotic marsh) for greater sandhill crane (Table 4.7-11). The loss of this large quantity of habitat is considered significant. Implementing Mitigation Measure W-MM-5 would reduce Impact W-11 to a less-than-significant level.

Mitigation Measure W-MM-5: Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan

This measure is described above.

Impact W-13: Loss of Suitable Foraging Habitat for Swainson's Hawk

Implementation of Alternative 3 would result in the loss of approximately 18,437 acres of foraging habitat for Swainson's hawk (Table 4.7-11). The loss of this large quantity of habitat is impact is considered significant. Implementing Mitigation Measure W-MM-5 would reduce Impact W-13 to a less-than-significant level.

Mitigation Measure W-MM-5: Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan

This measure is described above.

Impact W-14: Loss of Suitable Nesting Habitat for Swainson's Hawk, Cooper's Hawk, and White-Tailed Kite

Implementation of Alternative 3 would result in the loss of approximately 126 acres of riparian woodland that may provide suitable nesting habitat for Swainson's hawk, Cooper's hawk, and white-tailed kite. The loss of this habitat would be considered a significant impact. Implementing Mitigation Measure W-MM-5 would reduce Impact W-14 to a less-than-significant level.

Mitigation Measure W-MM-5: Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan

This measure is described above.

Impact W-15. Loss of Suitable Nesting/Wintering Habitat for Western Burrowing Owl

Implementation of Alternative 3 would result in the loss of approximately 1,933 acres of suitable nesting/wintering habitat (herbaceous upland) for western burrowing owl. The loss of this habitat would be considered a significant impact. Implementing Mitigation Measure W-MM-5 would reduce Impact W-15 to a less-than-significant level.

Mitigation Measure W-MM-5: Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan

This measure is described above.

Impact W-16: Loss of Suitable Foraging Habitat for Cooper's Hawk, White-Tailed Kite, Western Burrowing Owl, and Loggerhead Shrike

Suitable foraging habitat for Cooper's hawk consists of riparian woodland and scrub. Suitable foraging habitat for white-tailed kite, western burrowing owl, and loggerhead shrike consists of agricultural lands, fallow fields, and herbaceous upland. Implementation of Alternative 3 would result in the loss of approximately 126 acres of riparian woodland and scrub from the four islands. In addition, 17,147 acres of foraging habitat for white-tailed kite, western burrowing owl, and loggerhead shrike also would be lost from implementation of Alternative 3. The loss of these habitats would be considered a significant impact. Implementing Mitigation Measure W-MM-5 would reduce Impact W-16 to a less-than-significant level.

Mitigation Measure W-MM-5: Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan

This measure is described above.

Impact W-17: Loss of Foraging Habitat for Cackling (Aleutian Canada) Goose

Cackling (Aleutian Canada) geese could occur irregularly in agricultural and herbaceous habitats on all four Project islands. Because this species no longer is listed under the ESA and is expected to occur infrequently on Reservoir Islands, the loss of suitable habitat caused by Alternative 3 would not adversely affect the species. Therefore, this impact is considered less than significant.

Mitigation

No mitigation is required.

Impact W-18: Loss of Suitable Nesting and Foraging Habitat for Northern Harrier and Short-Eared Owl

Under Alternative 3, approximately 3,472 acres of suitable northern harrier and short-eared owl nesting and foraging habitat and 15,214 acres of foraging habitat only (i.e., agricultural lands) would be lost. The loss of these habitats would be considered a significant impact. Implementing Mitigation Measure W-MM-5 would reduce Impact W-18 to a less-than-significant level.

Mitigation Measure W-MM-5: Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan

This measure is described above.

Impact W-19: Loss of Winter Foraging Habitat for Tricolored Blackbird

Under Alternative 3, approximately 17,147 acres of suitable tricolored blackbird foraging habitat (agricultural lands and herbaceous upland) would be lost. The loss of this large quantity of foraging habitat would be considered a significant impact. Implementing Mitigation Measure W-MM-5 would reduce Impact W-19 to a less-than-significant level.

Mitigation Measure W-MM-5: Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan

This measure is described above.

Impact W-20: Change in Acreage of Suitable Nesting Habitat for Tricolored Blackbird

Under Alternative 3, approximately 1,590 acres of suitable tricolored blackbird nesting habitat (exotic and freshwater marsh and permanent pond) would be lost. The loss of this large amount of suitable nesting habitat would be considered a significant impact. Implementing Mitigation Measure W-MM-5 would reduce Impact W-31 to a less-than-significant level.

Mitigation Measure W-MM-5: Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan

This measure is described above.

Impact W-22: Potential Injury or Mortality of Northern Harrier, Cooper's Hawk, Swainson's Hawk, White-Tailed Kite, California Black Rail, Greater Sandhill Crane, Western Burrowing Owl, Short-Eared Owl, Loggerhead Shrike, and Non–Special-Status Migratory Birds

Potential impacts on northern harrier, Cooper's hawk, Swainson's hawk, white-tailed kite, western burrowing owl, short-eared owl, loggerhead shrike, greater sandhill crane, and California black rail under Alternative 3 would be similar to Alternative 2. This impact is considered significant. Implementing Mitigation Measure W-MM-7 would reduce Impact W-22 to a less-than-significant level.

Mitigation Measure W-MM-7: Prepare a Construction Implementation Plan to Avoid Impacts on Roosting and Nesting Birds

The Project applicant will develop a Construction Implementation Plan for the Reservoir Islands following development of detailed Project construction schedules, specifications, and plan drawings for construction of Project infrastructure, pumps and siphons, enlarged levees, and recreation and other facilities. The plan will be submitted to the State Water Board and DFG for approval. Disagreements between the Project applicant and DFG during the plan approval process may be submitted to the State Water Board Chief of the Division of Water Rights for resolution.

The Construction Implementation Plan will identify methods to avoid impacts on roosting greater sandhill cranes and on nesting northern harriers, Cooper's hawks, Swainson's hawks, white-tailed kites, western burrowing owls, short-eared owls, loggerhead shrikes, and California black rails. These methods will include conducting preconstruction surveys to locate nesting and roosting sites of these species and may include measures such as avoiding construction during sensitive use periods.

Elements of the plan will identify:

- preconstruction survey protocols to locate Swainson's hawk nest sites and greater sandhill crane roosts on Reservoir Islands and nesting California black rails on the water side of perimeter levees;
- preconstruction survey protocols to locate nests of northern harriers, Cooper's hawks, white-tailed kites, western burrowing owl, short-eared owls, loggerhead shrikes, and other migratory birds;
- measures that would be instituted to avoid affecting state-listed wildlife species, including restriction of construction activities to areas at least 600 feet from nesting California black rails;
- construction monitoring methods and schedule to be implemented to ensure compliance with the construction mitigation plan; and
- potential remedial measures to compensate for impacts incurred during construction.

Following construction, the Project applicant will submit a report describing success of construction impact avoidance measures to the State Water Board Chief of the Division of Water Rights and DFG.

Impact W-24: Potential for Increased Incidence of Waterfowl Diseases

The potential for increased incidence of waterfowl diseases from implementation of Alternative 3 would be similar to that described above under Impact W-24 for Alternative 2. This impact is considered significant. Implementing Mitigation Measure W-MM-2 would reduce Impact W-24 to a less-than-significant level.

Mitigation Measure W-MM-2: Monitor Waterfowl Populations for Incidence of Disease and Implement Actions to Reduce Waterfowl Mortality

This mitigation measure is described above under Alternative 2.

Impact W-25: Potential Disruption of Waterfowl Use as a Result of Increased Hunting

The potential for disruption of waterfowl use from implementation of Alternative 3 would be similar to that described above under Impact W-25 for Alternative 2. This impact is considered less than significant.

Mitigation

No mitigation is required.

Impact W-27: Increase in Waterfowl Harvest Mortality

The potential for increased waterfowl harvest mortality under Alternative 3 would be similar to that described above under Impact W-27 for Alternative 2. Waterfowl harvest would be approximately 65% of the harvest predicted under Alternative 2. This impact is considered less than significant.

Mitigation

No mitigation is required.

Impact W-28: Potential Changes in Local and Regional Waterfowl Use Patterns

The potential for changes in local and regional waterfowl use patterns under Alternative 3 would be similar to that described above under Impact W-28 for Alternative 2. This impact is considered less than significant.

Mitigation

No mitigation is required.

Impact W-29: Potential Impacts on Wildlife and Wildlife Habitats Resulting from Delta Outflow Changes

The potential for impacts on wildlife and wildlife habitats from Delta outflow changes under Alternative 3 would be similar to that described above under Impact W-29 for Alternative 2. This impact is considered less than significant.

Mitigation

No mitigation is required.

Impact W-30: Loss of Roost Sites and Foraging Habitat for and Potential Injury or Mortality of Bats

The loss of roost sites and foraging habitat and the potential for injury or mortality of bats under Alternative 3 would be similar to Alternative 2, except that a larger area of foraging habitat would be lost. This impact is considered significant. Implementing Mitigation Measures W-5 and W-8 would reduce Impact W-30 to a less-than-significant level.

Mitigation Measure W-MM-5: Compensate for Loss of Habitats for Special-Status and Other Species through an Off-Site Wildlife Habitat Mitigation Plan

This measure is described above.

Mitigation Measure W-MM-8: Conduct Preconstruction Surveys for Roosting Bats and Compensate for Loss of Roosting Habitat If Bats Are Found

A qualified biologist will conduct surveys to examine structures and trees that provide suitable roosting habitat for bats prior to their demolition or removal. If no bats are detected during the preconstruction survey, structure and tree removal will be conducted during the month of September to ensure that breeding and hibernating bats are avoided. If bats are observed, demolition and tree removal will be delayed until the bats leave the roosting sites or until DFG authorizes building demolition/tree removal. In addition, bat boxes or other suitable roosting habitat will be constructed, per DFG recommendations, to mitigate the loss of roosting habitat on the Reservoir Islands.

No-Project Alternative

Changes in Wildlife Habitat Conditions and Use

Under Section 404(f)(1) of the CWA, normal farming activities such as plowing, seeding, cultivating, and maintaining drainage ditches are exempt from Section 404 permit requirements as long as surface materials are not redistributed by blading or grading to fill a Section 404 jurisdictional wetland area. The No-Project Alternative thus is limited to those farming activities to increase cropping intensity that could be implemented without a Section 404 permit (i.e., no jurisdictional wetlands would be converted to crops). Therefore, because wetlands would not be converted to crops, wetlands that provide habitat for wildlife would not be removed.

Implementation of the No-Project Alternative would result in changes of existing annual grain crops to perennial crops such as vineyards and asparagus. In general, the impacts would result primarily from conversion of pasture, herbaceous upland, and corn and wheat to perennial crops (Table 4.7-12). Conversion of annual grain crops to perennial crops would greatly reduce the amount of foraging habitat for waterfowl and other birds.

Table 4.7-12. Predicted Changes in Acreages of Habitat Types under the No-Project Alternative

Habitat Type Conditions	Acreage										Change in Acres from 2008 to No Project
	Bacon Island		Webb Tract		Bouldin Island		Holland Tract		Total		
	2008	No Project	2008	No Project	2008	No Project	2008	No Project	2008	No Project	
Riparian woodland and scrub	6	3	183	56	11	7	127	46	327	112	-215
Freshwater marsh	41	0	51	16	74	0	82	2	248	18	-230
Exotic marsh	11	0	55	40	47	0	1,507	0	1,620	40	-1,580
Herbaceous upland	406	261	796	220	691	349	165	113	2,058	943	-1,115
Subtotal	464	264	1,085	332	823	356	1,881	161	4,253	1,113	-3,140
Annual grain crops	4,918	3,126	4,178	4,961	5,058	3,329	0	1,912	14,154	13,328	-826
Perennial crops orchards/vineyards	0	1,969	0	0	0	2,097	0	610	0	4,676	+4,676
Pasture	0	0	0	0	0	0	0	256	0	256	+256
Fallow	0	0	69	0	0	0	1,161	0	1,230	0	-1,230
Subtotal	4,918	5,095	4,247	4,961	5,058	5,426	1,161	2,778	15,384	18,260	+2,876
Sloughs and ditches	42	92	27	50	39	118	21	45	129	305	+176
Ponds	0	3	76	106	10	9	15	23	101	141	+40
Developed	155	86	38	20	80	75	0	71	273	252	-21
Subtotal	197	181	141	176	129	202	36	139	503	698	+195
Total	**5,579**	**5,540**	**5,473**	**5,469**	**6,010**	**5,984**	**3,078**	**3,078**	**20,140**	**20,171**	

Note: Minor inconsistencies in totals result from rounding.

Use by Waterfowl and Other Bird Species

Conversion of pasture, herbaceous upland, and annual grain crops to perennial crops (e.g., asparagus, vineyards) on the four Project islands under the No-Project Alternative would reduce the abundance of many bird species that rely on these habitats. Overall habitat values for wintering waterfowl under the No-Project Alternative would be similar or lower than those found under existing conditions. Habitat values may decrease because of the decrease in acreage of corn, but flooding of crops for weed control may balance this loss. The increase in acreage of perennial crops would increase wintering habitat for those birds that prefer areas that are bare or that support low vegetation. Abundance of prey species and foraging habitats for raptors would decrease, causing a reduction in use of the islands by wintering raptors. The increase in the acreage flooded for weed control would provide additional habitat for wading birds, shorebirds, and other waterbirds.

Use by Upland Game

Habitat values for ring-necked pheasant and desert cottontail would decrease with conversion of fallow fields to crops. Assuming that riparian habitats would not be removed, use by mourning dove and quail would remain the same under the No-Project Alternative.

Use by Special-Status Species

Many special-status species could be affected by the removal of pasture, herbaceous upland, and annual grain crops through implementation of the No-Project Alternative. Upland habitat for western pond turtle and giant garter snake on Holland and Webb Tracts would be lost. Individual turtles or snakes also could be injured or killed during the conversion process.

Nesting and foraging habitat for northern harrier, Swainson's hawk, Cooper's hawk, white-tailed kite, burrowing owl, short-eared owl, loggerhead shrike, and tricolored blackbird would be lost from the conversion of more natural lands to crops of potatoes, onions, asparagus, and vineyards. The conversion of corn, which provides foraging habitat for greater sandhill cranes, to other crops would reduce the amount of foraging habitat for this species. Ground-nesting species such as northern harrier, burrowing owl, and short-eared owl also could be injured or killed during conversion activities.

Increase in Waterfowl Harvest Mortality

Under the No-Project Alternative, an intensive for-fee hunting program would be operated on the Project islands. This program would result in additional hunting over existing conditions, resulting in additional waterfowl harvest mortality. This program would need to be consistent with state hunting regulations to ensure a sustainable harvest is achieved.

Section 4.8
Land Use and Agriculture

Introduction

This section describes recent changes to the existing environmental conditions and regulatory setting of the Project area, summarizes the unchanged affected environment, and describes changed environmental effects related to land use and agriculture for the Project. This section contains a review and update of the1995 DEIR/EIS land use and agriculture impact assessment, incorporated by reference in the 2001 FEIR. The land use and agriculture impacts of the Project were most recently analyzed in the 2001 FEIS, which also served as a basis for this analysis.

The 2001 FEIR and 2001 FEIS concluded that the Project alternatives would impact land use and agriculture on the four Project islands. Potential significant and unavoidable impacts included inconsistency with general plan policies for agricultural lands and inconsistency with the Delta Protection Commission's (DPC's) land use plans and policies, and direct and cumulative conversion of agricultural land to nonagricultural uses. Less-than-significant impacts included displacement of residences and structures on the Reservoir Islands, and displacement of property owners on the Habitat Islands.

Since the 2001 FEIR and 2001 FEIS, there have been changes in property ownership and in the number of residences, agricultural structures, and occupants on the Project islands. As a result of these changes, it has been concluded in this impact analysis that the Alternatives 1 and 2 of the Project would not impact residences and structures on the Reservoir Islands or property owners on the Habitat Islands.

Furthermore, there have been additional studies that call into question the long-term viability of agriculture in the Delta. Sea level rise, seismic risk, continued land subsidence, and increased levee vulnerability in the Delta are all factors that threaten the sustainability of agriculture in the Delta over the long term unless major interventions are made. Project impacts on agriculture were reanalyzed in this Place of Use EIR in light of this more recent information as well as in light of changes in the Project, which include agricultural conservation easements on the Habitat Islands and identification of designated places of use where Project water would benefit agriculture. Although these changes were considered in this analysis, the conclusions reflected in the 2001 FEIR and 2001 FEIS that the direct conversion of agricultural land to nonagricultural uses under Alternatives 1 and 2 would result in a significant impact has not changed.

There have been no changes in the Project that result in new significant environmental effects or a substantial increase in the severity of previously identified significant effects on land use and agricultural resources.

There have been minor changes in the affected environmental and regulatory setting since the 2001 FEIR and 2001 FEIS, but these changes do not alter the conclusions in the 2001 FEIR and 2001 FEIS regarding environmental effects on land use and agricultural resources.

The Project will not have any direct effects on land use and agriculture in the Places of Use; the effects on land use and agriculture, if any, associated with the provision of Project water to the Places of Use are addressed in Chapter 5, "Cumulative Impacts," and Chapter 6, "Growth-Inducing Impacts."

Summary of Impacts

Table 4.8-1 provides a summary and comparison of the impacts and mitigation measures for land use and agriculture from the 2001 FEIR, 2001 FEIS, and this Place of Use EIR.

Table 4.8-1. Comparison between Delta Wetlands Project 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures for Land Use and Agriculture

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
ALTERNATIVES 1 AND 2	
Impact I-1: Displacement of Residences and Structures on Reservoir Islands (LTS) **Mitigation:** No mitigation is required.	No impact. Bacon Island and Webb Tract are owned by the Project applicant, as are all buildings, structures, and residences on these islands. Property on these islands is leased for farming; however, the leases are all short-term and contemplate eventual conversion to water storage. Therefore, displacement of residences and structures on the Reservoir Islands as a result of implementation of Alternatives 1 or 2 is not considered an impact.
Impact I-2: Displacement of Property Owners on Habitat Islands (LTS) **Mitigation:** No mitigation is required.	No impact. The Project applicant owns all property on Bouldin Island and all property within the Project area on Holland Tract. Therefore, no property owners on the Habitat Islands would be displaced as a result of implementation of Alternatives 1 or 2.
Impact I-3: Inconsistency with Contra Costa County General Plan Policy for Agricultural Lands and Delta Protection Commission Land Use Plan Principles for Agriculture and Recreation (SU) **Mitigation:** No mitigation is available to reduce this impact to a less-than-significant level.	**Impact LU-1:** Inconsistency with Contra Costa County General Plan Policy for Agricultural Lands and Delta Protection Commission Land Use Plan Principles for Agriculture and Recreation (SU) **Mitigation:** This impact has not changed. No mitigation is available to reduce this impact to a less-than-significant level; however, changes have been incorporated into the Project to reduce the severity of the impact.

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
Impact I-4: Direct Conversion of Agricultural Land (SU) **Mitigation:** No mitigation is available to reduce this impact to a less-than-significant level	**Impact LU-2:** Direct Conversion of Agricultural Land (SU) **Mitigation:** This impact has not changed. No mitigation is available to reduce this impact to a less-than-significant level; however, changes have been incorporated into the Project to reduce the severity of the impact.
ALTERNATIVE 3	
Impact I-5: Displacement of Residences and Structures on Reservoir Islands (LTS) **Mitigation:** No mitigation is required.	**Impact LU-3:** Displacement of Residences and Structures on Reservoir Islands (LTS) **Mitigation:** This impact has not changed. No mitigation is required. All residences and structures on Bacon Island, Webb Tract, and Bouldin Island are owned by the Project applicant. Therefore, this impact only applies to displacement of residences and structures on Holland Tract. Prior to the implementation of Alternative 3, land and property not presently owned by the Project applicant would be purchased. Housing opportunities in the local area are considered sufficient for those affected to be housed.
Impact I-6: Inconsistency with Contra Costa County General Plan Policy for Agricultural Lands and Delta Protection Commission Land Use Plan Principles for Agriculture and Recreation (SU) **Mitigation:** No mitigation is available to reduce this impact to a less-than-significant level	**Impact LU-1:** Inconsistency with Contra Costa County General Plan Policy for Agricultural Lands and Delta Protection Commission Land Use Plan Principles for Agriculture and Recreation (SU) **Mitigation:** This impact has not changed. No mitigation is available to reduce this impact to a less-than-significant level; however, changes have been incorporated into the Project to reduce the severity of the impact.
Impact I-7: Direct Conversion of Agricultural Land (SU) **Mitigation:** No mitigation is available to reduce this impact to a less-than-significant level.	**Impact LU-2:** Direct Conversion of Agricultural Land (SU) **Mitigation:** This impact has not changed. No mitigation is available to reduce this impact to a less-than-significant level; however, changes have been incorporated into the Project to reduce the severity of the impact.
Note: SU = Significant and unavoidable; LTS = Less than significant; LTS-M = Less than significant with mitigation; B = Beneficial.	

Summary of Changes, New Circumstances, and New Information

Changes that may potentially affect the environment, regulatory setting, or environmental effects of the Project on land use and agriculture are described in the Existing Conditions section below. The following is a summary of findings based on that consideration.

Substantial Changes in the Project

Since the 2001 FEIR and 2001 FEIS, there have been no substantial changes to the Project resulting in new significant effects or substantial increase in the severity of effects on land use and agriculture. However, several changes in the Project, in addition to new information, would result in the reduction of the severity of the agricultural land conversion impact relative to the 2001 FEIR and 2001 FEIS conclusion. These Project changes include:

- An environmental commitment to place agricultural conservation easements on Bouldin Island and Holland Tract;
- The Project applicant has entered into agreements to provide water to designated places of use including Semitropic, Golden State, and Metropolitan. Other likely places of use include Valley District, Western, and member agencies within Metropolitan;
- Project water not needed for designated place of use demands would be stored within the Semitropic Groundwater Storage Bank and/or the Antelope Valley Water Bank for later delivery to the designated places of use.
- Project water will be provided to Semitropic to improve the reliability of the existing supplies of water for agricultural irrigation; and

Project water provided to Semitropic, Valley District, Western, and Metropolitan ultimately would benefit agriculture in those service areas by supplementing existing water supplies.

New Circumstances

Since the 2001 FEIR and 2001 FEIS there have been many additional studies in the Delta and several events that call into question the long-term viability of agriculture in the Delta. The 2001 FEIR and 2001 FEIS assumed that the current infrastructure generally could support the No-Project Alternative (intensive agriculture) through the life of the Project (50 years). However, threats to continued agriculture in the Delta include continued land subsidence, levee instability, sea level rise, seismic risk, and urban encroachment, calling into question whether agricultural activities are sustainable within the projected Project life.

Agricultural cultivation of peat soils in the Delta has contributed to the subsidence of the majority of Delta islands, especially in the western and central Delta, where the Project islands are located. Recent studies confirm that as subsidence continues over time, increased hydrostatic pressure is placed on the surrounding levees, increasing the cost of levee maintenance, water table management, and land loss from seepage and increasing salinity (Trott 2007). Levee failure on deeply subsided islands would damage or destroy agriculture and infrastructure on these islands, as well as threaten water conveyance to agricultural and urban water users in the Bay Area, San Joaquin Valley and southern California. Funding for local levees in the Delta comes primarily from agricultural reclamation district fees and this funding has been insufficient for levee improvements that would meet current standards, leading to a higher risk of levee failure than assumed in the 2001 FEIR and 2001 FEIS (Trott 2007).

DWR's Delta Risk Management Strategy (DRMS) evaluated the potential for catastrophic levee failure and subsequent effects on water supply and concluded that agriculture within the Delta is unsustainable over the long-term if current land and levee management practices continue for the baseline conditions currently existing in the Delta. According to the DRMS Phase 1 report (California Department of Water Resources 2009), a seismic event is the single greatest risk to levee integrity in the Delta. Levees would fail and as many as 20 islands could flood simultaneously. If this were to occur during a time of low-to-moderate fresh water Delta inflow, brackish water from Suisun Marsh would enter the Delta and would compromise local water supplies, as well as State and federal water project exports, and water could not be used for in-Delta agricultural irrigation (California Department of Water Resources 2009).

A recent paper by Mount and Twiss (2005) estimated that there is a two-in-three chance that 100-year recurrence interval floods or earthquakes will cause catastrophic flooding and significant change in the Delta by 2050. Continued subsidence on the islands has reduced the stability of Delta levees, increasing the risk of levee failure. Ongoing subsidence coupled with the expected sea level rise over the next 50 years associated with climate change is expected to significantly increase the instability of the current Delta levee network over the baseline conditions assumed in the 2001 FEIR and 2001 FEIS, and will result in increased potential for and consequence of island flooding (Mount and Twiss 2005). The central and west Delta are the zones at highest risk of seismic-induced levee failure (Mount and Twiss 2005).

New Information

There is no new information of substantial importance that would result in an increase in severity of effects on land use and agriculture. The key sources of new information pertaining to land use and agriculture reviewed or used to prepare this section include:

- Development Title of San Joaquin County, adopted July 1992, published 1995 (updated monthly);
- Contra Costa County General Plan 2005-2020, January 2005;
- Contra Costa County Community Development Department 2006 Agricultural Preserves Map;
- California Department of Conservation, Division of Land Resource Protection: 2008 Contra Costa County important farmland series map;
- California Department of Conservation, Division of Land Resource Protection: 2006 San Joaquin County important farmland series map;

- California Department of Conservation, Division of Land Resource Protection: San Joaquin County Williamson Act Lands 2006; and
- San Joaquin County Multi Species Habitat Conservation and Open Space Plan, November 14, 2000.
- 2006 soil surveys for Contra Costa and San Joaquin Counties, prepared by U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS);
- California Department of Conservation's 2006 important farmland mapping system data;
- crop history (2002–2008) for Project islands; and
- current property ownership on the Project islands.

Existing Conditions

This section discusses changes in the existing conditions or regulatory setting since the 2001 FEIR and 2001 FEIS.

Regulatory Environment

Several changes in the regulatory setting were considered as follows. These changes in regulations do not alter the impact analysis conclusion or mitigation measures in the 2001 FEIR and 2001 FEIS.

- Update of the Contra Costa County General Plan.
- Update of the San Joaquin County Development Title.
- Adoption of the San Joaquin County Multi Species Habitat Conservation and Open Space Plan.
- Update of Delta Protection Commission's Draft Land Use and Resource Management Plan for the Primary Zone of the Delta.

The following section describes new regulations affecting land use and agriculture and summarizes previously identified regulations.

State

California Department of Conservation Important Farmland Mapping and Monitoring Program

The California Department of Conservation administers the Important Farmland Mapping and Monitoring Program (FMMP), which evaluates the quality of farmlands throughout the State of California.

The California Land Conservation (Williamson) Act

The California Land Conservation Act (California Government Code, beginning at Section 51200), also known as the Williamson Act, was adopted in 1965. The Williamson Act allows for the preservation of agricultural and open space lands through property tax incentives and voluntary restrictive use contracts. This program allows property owners to have their property assessed on the basis of its agricultural production rather than at the current market value. The contract may be cancelled if the land is being converted to an incompatible use.

1992 Delta Protection Act

The State's 1992 Delta Protection Act designates the Delta Primary Zone as an area for protection from intrusion of nonagricultural uses (Section 29703a) and establishes the DPC. The DPC is a State entity that plans for and guides the conservation and enhancement of the natural resources in the Delta, while sustaining agriculture and meeting increased recreational demand.

In 1995, the DPC adopted its regional plan, *Land Use and Resource Management Plan for the Primary Zone of the Delta* (LURMP), which outlines findings, policies, and recommendations to guide land use and resource management decisions in the Primary Zone of the Delta. The LURMP was updated in 2009 and adopted in February 2010. As stated in the act, the goals of this regional plan are to "protect, maintain and, where possible, enhance and restore the overall quality of the Delta environment, including, but not limited to, agriculture, wildlife habitat, and recreational activities." The entire Project area is located within the Delta Primary Zone.

Local

Bacon and Bouldin Islands are located within San Joaquin County and Webb and Holland Tracts are located in Contra Costa County. The local regulations established by San Joaquin and Contra Costa Counties that pertain to the islands that fall within their respective boundaries are described below.

Contra Costa County General Plan

The Contra Costa County General Plan was updated in 2005; however, changes do not pertain to land use or agriculture.

San Joaquin County Development Title

The Development Title of San Joaquin County has been updated since the 2001 FEIR and 2001 FEIS. Two pertinent changes were made to the Development Title:

- In 2002, San Joaquin County adopted a land use ordinance (Chapter 9-100) as part of its zoning codes. Under this ordinance project proponents are required to obtain a use permit before constructing a water storage project. The ordinance adds Section 9-115.582 to the Use Classification System of San Joaquin County as follows:

  > Section 9-115.582 Water Storage. The intentional use of any area of five hundred (500) acres or more for the containment of water which will at any time exceed an average of six (6) feet in depth for thirty (30) days or more in any calendar year. This section does not apply to containment by a levee of an island adjacent to tidal waters in the Sacramento-San Joaquin Delta as defined in California Water Code Section 12220 if the maximum possible water storage elevation exceeds four feet above mean sea level as established by the United States Geological Survey 1929 datum. This section does not apply to dams and reservoirs under the jurisdiction of the Federal Government or the State of California exercising jurisdiction under Division 3 of the California Water Code.

- In 2006, San Joaquin County adopted an agricultural mitigation ordinance (Chapter 9-1080). Section 9-1080.3 of that ordinance requires mitigation for: 1) a General Plan Amendment that changes the designation of any land from an agricultural use to a non-agricultural use; and 2) a zoning reclassification that changes the permitted uses from agricultural to nonagricultural, regardless of the General Plan designation. Mitigation, in a 1:1 ratio, shall be required for land that will no longer be designated as or zoned for agricultural land. This ordinance does not apply to the Project because the Project would not require an amendment to the general plan or a zoning reclassification.

Water storage on Bacon Island is consistent with uses conditionally permitted (i.e., requiring a use permit) by San Joaquin County in the General Agriculture (AG) zone. In addition, because water storage is a permitted use in an AG zone, mitigation, as set forth under San Joaquin County's agricultural mitigation ordinance, would not be required (Swanson pers. comm., July 30, 2008).

San Joaquin County Multi Species Habitat Conservation and Open Space Plan

The San Joaquin County Multi Species Habitat Conservation and Open Space Plan (SJMSCP) was adopted in 2001 and covers all of San Joaquin County. The SJMSCP is designed to provide a regional approach to mitigating development impacts on the 97 listed and non-listed plant, fish, and wildlife species covered by the SJMSCP and compensating for the conversion of open space to non–open space uses. The plan provides compensation for habitat losses through collection of fees that are used to preserve habitats elsewhere. The Project is not considered a covered activity by the SJMSCP. Therefore, mitigation to offset the Project's impacts to agricultural lands would not be required pursuant to the SJMSCP.

Affected Environment

Existing conditions on the Project islands have been reconsidered in light of updated soil surveys and land production capability assessments, new data on current crop patterns, changes in property ownership, as well as revisions or updates to the San Joaquin County Development Title and the Contra Costa County General Plan as they pertain to new (since 2001) land use ordinances and policies.

Existing land use conditions and agricultural conditions are, for the most part, as they were presented in the 2001 FEIR and 2001 FEIS and are hereby incorporated by reference. Land uses in areas adjacent to the Project islands are discussed briefly in the following section. Changes in the affected environment since the 2001 FEIR and 2001 FEIS are presented in the land use and agricultural conditions sections.

Adjacent Land Uses

Land Uses near Bacon Island

Land on islands surrounding Bacon Island is used primarily for agriculture. Scattered agricultural structures, equipment complexes, and a few rural residences are interspersed throughout the vicinity. San Joaquin County has designated land north, south, and east of Bacon Island on Mandeville Island, Woodward Island, and Lower Jones Tract as AG. These islands are under Williamson Act contracts.

Land Uses near Webb Tract

Webb Tract is bordered by the San Joaquin River to the north and east, False River and the flooded Franks Tract to the south, and Fishermans Cut to the west. Land use west of Webb Tract on Bradford Island is mainly agriculture with associated farmsteads and structures related to agricultural production. Boating facilities are located on the eastern shoreline of Bradford Island, facing toward Webb Tract. The Contra Costa County General Plan designation for all of Bradford Island is Delta Recreation and Resources. Bradford Island has two parcels under Williamson Act contract.

Franks Tract, south of Webb Tract across False River, is a state recreation area. The flooded portion of Franks Tract is designated as Water and the designation for land areas is Parks and Recreational. Franks Tract is used primarily for boating and other water-oriented recreation and has no extensively developed areas.

Land north of Webb Tract across the San Joaquin River is located in Sacramento County. This area has some shoreline development, but most land is in agricultural use with scattered farmsteads and other agriculture-related structures. Land use designations for this area are Recreational and Agricultural Cropland.

Land Uses near Bouldin Island

The Mokelumne River bounds Bouldin Island to the north and west, and Potato Slough bounds the island to the east and south. Land on islands surrounding Bouldin Island is used primarily for agricultural production. Scattered agricultural structures, equipment complexes, and a few rural residences are interspersed throughout the vicinity.

In San Joaquin County, islands surrounding Bouldin Island have been designated AG. Staten and Venice Islands, located north and south of Bouldin Island, respectively, are under Williamson Act contracts. Andrus and Tyler Islands, west of Bouldin Island, have been designated as Agricultural Cropland by Sacramento County. Most of the parcels on these islands are under Williamson Act contracts. Most parcels east of Bouldin Island on Terminous and Empire Tracts are also under Williamson Act contracts.

Land Uses near Holland Tract

Bethel Island northwest of Holland Tract has extensive shoreline development, consisting mainly of boat docks, marinas, single-family residences, and some retail businesses. General plan designations for this developed area are mainly Single-Family Residential High-Density, with some Commercial and Multifamily Residential uses permitted. Similar shoreline land uses exist on Hotchkiss Tract, on the western shore of Sand Mound Slough west of Holland Tract. Inland use of these adjacent islands is primarily for agriculture, with a limited amount of rural residential development.

Franks Tract State Recreation Area is north of Holland Tract. Land uses and designations on Franks Tract are described above.

Land uses south of Holland Tract on Veale and Palm Tracts are generally agricultural with some farmsteads and agricultural structures. Veale Tract is designated as Delta Recreation and Resources with land uses such as agriculture, wildlife habitat, and low-intensity recreational use.

Approximately half of Palm Tract, east of Veale Tract, is designated Delta Recreation and Resources, and this land is under Williamson Act contract. The remainder of Palm Tract is designated Public/Semi-Public.

Land Use Conditions

The four Project islands are used primarily for agricultural production, with some hunting and fishing recreational uses. In general, conditions remain as they were at the time the 2001 FEIR and 2001 FEIS was issued. However, there have been some changes in property ownership and in the number of residences, agricultural structures, and occupants on the islands. These changes are presented in the following section.

Bacon Island

Several farmsteads or rural residences are located on the island near the perimeter levees. In total, there are approximately 20 occupants on the island. Agricultural structures and equipment complexes are located in the northern, central, and southern portions of the island. An airstrip for crop dusting flights is located on the eastern portion of the island. Bacon Island, as well as all structures and residences, is entirely owned by the Project applicant. Property on Bacon Island is leased out for farming; however, the leases are all short-term and contemplate eventual conversion to water storage.

All of Bacon Island is currently under Williamson Act contracts. These contracts are in nonrenewal and expire December 2012.

Webb Tract

A small number of agricultural structures and equipment complexes are located on the island, mainly near the perimeter levees. A clubhouse and caretaker's trailer are located on high ground at the extreme eastern tip of the island. There are two occupants on Webb Tract. Webb Tract, as well as all structures and residences, is entirely owned by the Project applicant. Property on Webb Tract is leased out for farming; however, the leases are all short-term and contemplate eventual conversion to water storage.

Webb Tract has a 139.2-acre parcel under Williamson Act contract. This contract is in nonrenewal and expires November, 2012 (Contra Costa County 2007).

Bouldin Island

Scattered agricultural structures and equipment complexes are located in the northern, central, and southern portions of the island. Several residences and associated farmstead structures are located north of SR 12. Two residences, one of which is currently occupied, are located south of SR 12 on the eastern side of the island. There are approximately 40 occupants in total on Bouldin Island. On the eastern portion of the island, just south of SR 12, there is an airstrip used by crop-dusting operators. An oil drilling pad is located on the western portion of the island. Bouldin Island is entirely owned by the Project applicant. Property on Bouldin Island is leased for farming; however, the leases are all short-term and eventual conversion to habitat management is contemplated.

The entire land area of Bouldin Island is under Williamson Act contracts; these contracts are in nonrenewal and expire December 2012.

Holland Tract

Agricultural structures and equipment complexes are scattered along the southern and western perimeter levees. Onsite residences include a trailer located in the northeast portion of the island near the levee bordering Holland Cut and two residences in the western portion of the island. An abandoned hog feeding area is located east of these two residences. This area includes several structures ancillary to hog farming and untilled open space. There are two occupants currently residing on Holland Tract.

Two marinas are located at the southern boundary of Holland Tract on Rock Slough. The Lindquist Landing Marina on the southern boundary features boat docks and other structures ancillary to marina uses. The Holland Riverside Marina, at the southeastern corner of the island, is a large facility with numerous boat docks, covered slips, and ancillary marina uses.

The Project applicant owns all land on Holland Tract except several small parcels in the southwestern corner of the island, the two marina parcels along the southeastern perimeter of the island, and the 263-acre Wildlands, Inc. parcel directly north of the Lindquist Landing Marina. Wildlands intends to convert this property to a habitat mitigation bank. The marina parcels, 857 acres in the southwestern corner of Holland Tract, the Wildlands property, and other small parcels would be excluded from Alternatives 1 and 2 (estimated 1,120 acres total). The remaining property on Holland Tract is leased out for grazing; however, the leases are all short-term and eventual conversion to habitat management is contemplated.

Holland Tract has no parcels under Williamson Act contract (Contra Costa County 2007).

Agricultural Conditions

Crops and Production Levels

Crops and planted acreages on the Project islands have changed. While the analysis for this document was based on updated (2008) baseline conditions, the 2001 FEIR and 2001 FEIS used 1988 conditions to describe pre-Project agricultural land use as a result of the Project's effects on land use during the intervening years.

Between 1990 and 2001, some land management decisions that changed agricultural land use on the Project islands were made in anticipation of Project implementation. Land management decisions made since 2001 have resulted in further changes in agricultural land use on the Project islands. Current cropping patterns on the islands in many cases are substantially different from 1988 patterns (Table 4.8-2). For example, in 1988, the production of seed potatoes on Bacon Island accounted for 52.5% of San Joaquin County's production of the crop. However, seed potatoes have not been produced on Bacon Island since 2003.

Table 4.8-2. Agricultural Crop Changes on Project Islands between 1988 and 2008 (Acres)

	Bacon Island			Webb Tract			Bouldin Island			Holland Tract		
Crop	1988	2008	% Change	1988	2008	% Change	1988	2008	% Change	1988	2008	% Change
Alfalfa	0	1,787	100									
Asparagus	1,043		-100							402		-100
Corn	757	1,914	153	2,128	4,000	88	2,368	4,002	69	226		-100
Fallow	347	14	-96	611	87	-86	685		-100	745		-100
Milo	82		-100									
Oats		207.4	100									
Pasture				58		-100	33		-100	542	2,884	432
Potatoes	1,836		-100									
Rice								623	100			
Sunflower	186	373.6	101				855		-100			
Tomatoes								308	100			
Unknown Crops	155		-100	26		-100						
Vineyard	272		-100									
Wheat		577.5	100	426		-100	1,139		-100	835		-100
Total	**4,678**	**4,873**	**4**	**3,249**	**4,087**	**26**	**5,080**	**4,933**	**-3**	**2,750**	**2,884**	**5**

Source: Delta Wetlands Properties. 2008. Crop history for 2002–08 (unpublished data).

Typically in an EIR, environmental baseline conditions are those that exist at the time the NOP is published or, if no NOP is published, at the time the environmental analysis is begun. Because agricultural land use conditions have changed considerably in 20 years, a baseline defined by 1988 conditions is no longer appropriate or relevant. A baseline based on 2008 conditions provides the most reliable description of pre-Project agricultural land use on the Project islands for assessing the impacts of the Project alternatives; however, it should be noted that a static baseline is only a snapshot of current conditions as cropping patterns will continue to change based on market demand for crops and farmers' choices. The Project applicant provided crop history and crop acreages for 2002–2008 for the Project islands. Cropping patterns for 2009 are likely to change because of changing commodity prices. Crop yields were estimated using 2007 countywide yield data from Contra Costa and San Joaquin Counties.

Bacon Island

Yield and production levels for the crops grown on Bacon Island, based on planted acreage in 2008, are shown in Table 4.8-3. Crop acreages vary from year to year, depending on market conditions, the status of federal "set aside" programs, and pest management concerns. Similarly, per-acre yields vary from season to season based on management practices and weather and pest conditions. The production estimates shown in Table 4.8-3 indicate that Bacon Island produced the following percentages of the crops produced in San Joaquin County, based on 2007 countywide production levels in tons: wheat, 4%; corn, 2.3%; and alfalfa, 2.6%; (San Joaquin County Office of the Agricultural Commissioner 2008). Although oats and sunflower were also grown on Bacon Island in 2008, production estimates are not presented here because these crops were not included in the 2007 crop report for San Joaquin County.

Webb Tract

In 2008, an estimated 73% (4,064 acres) of the Webb Tract's total acreage was planted in corn, the only crop grown on Webb Tract in that year (Table 4.8-2). Approximately 87 acres of land were fallowed. Corn and wheat were the two crops grown in recent years (2002–2008) on Webb Tract (Delta Wetlands Properties 2008a).

The production estimates shown in Table 4.8-3 indicate that Webb Tract produced approximately 55% of the corn crop in Contra Costa County, based on 2007 countywide production levels in tons (Contra Costa County Department of Agriculture 2008).

Bouldin Island

As shown in Table 4.8-2, corn and rice were the dominant crops grown on Bouldin Island in 2008; these two crops accounted for nearly 94% of the island's agricultural acreage and 77% of the island's total acreage. Tomatoes accounted for approximately 6% of the island's agricultural acreage in 2008.

Table 4.8-3 shows yields and production levels for the primary crops grown on Bouldin Island based on planted acreage in 2008. The production estimates shown in Table 4.8-3 indicate that Bouldin Island produced the following percentages of the crops produced in San Joaquin County, based on 2007 countywide production levels in tons: corn, 5.0%; rice, 11.7%; and tomatoes, 0.6% (San Joaquin County Office of the Agricultural Commissioner 2008).

Holland Tract

Holland Tract is the least intensively farmed island of the four Project islands. During the period of 2002–2008, 2,884 acres of Holland Tract were used for pasture each year, an equivalent of approximately 69% of the island's total acreage; none of the island was used for crop production during this period (Delta Wetlands Properties 2008a).

Table 4.8-3. Estimated Crop Production on the Project Islands in 2008

	Bacon Island			Webb Tract			Bouldin Island			Holland Tract[a]			All Islands	
Crops	Acres Planted in 2008	Yield (tons per acre)	Total Yield (tons)	Acres Planted in 2008	Yield (tons per acre)	Total Yield (tons)	Acres Planted in 2008	Yield (tons per acre)	Total Yield (tons)	Acres Planted in 2008	Yield (tons per acre)	Total Yield (tons)	Acres Planted in 2008	Total Yield (tons)
Wheat	578	3.3	1,906										578	1,906
Corn (grain)	1,914	4.73	9,053	4,064	3.88	15,768	4,002	4.73	18,929				9,980	43,751
Alfalfa	1,787	7.5	13,403										1,787	13,403
Rice							623	4.35	2,710				623	2,710
Tomatoes							308	33.97	10,463				308	10,463
Oats	207[b]												207	0
Sunflower	374[b]												374	0
Pasture										2,884	N/A	N/A	2,884	N/A
Total	**4,860**			**4,064**			**4,933**			**2,884**			**16,741**	

Sources: Acreages of planted crops were obtained from Delta Wetlands Properties 2008a.

Notes: N/A = not applicable.

Average yields: Average yield data were obtained from San Joaquin County and Contra Costa County 2007 crop reports; San Joaquin County Office of the Agricultural Commissioner 2008; Contra Costa County Department of Agriculture 2008.

[a] Acreage and yield includes production of acreage excluded from the Project under Alternatives 1 and 2.

[b] Although oats and sunflower were also grown on Bacon Island in 2008, production estimates are not presented here because these crops were not included in the 2007 crop report for San Joaquin County.

Soils and Land Production Capabilities

Information on soil and agricultural land production capabilities has been updated relative to the 2001 FEIR and 2001 FEIS. In general, the soil types and land production capabilities have not changed significantly. As such, there have been no significant changes made to the impact analysis or conclusions based on this update.

Soil data was obtained from 2006 soil surveys prepared by the NRCS. Acreages by soil units on each island were estimated based on GIS measurements made by ICF Jones & Stokes of NRCS soil survey maps. Information on agricultural land production capabilities on the Project islands was updated using the California Department of Conservation's (CDC's) Integrated Farm Management (IFM) system; specifically, updates were made to the total acreages on the islands comprising prime farmland, farmland of statewide importance, and unique farmland based on 2006 CDC IFM maps for San Joaquin and Contra Costa Counties.

Bacon Island

Bacon Island soil types, as identified by the 2006 NRCS soil survey for San Joaquin County, are presented in Table 4.8-4. Two soil types compose an estimated 73% of Bacon Island, according to GIS measurements of NRCS soils maps. Rindge muck, partially drained with 0–2% slopes, is the dominant soil on Bacon Island, accounting for an estimated 2,360 acres, or 47% of total acreage. Kingile muck, partially drained with 0–2% slopes, accounts for an estimated 1,455 acres, or 26% of total acreage. Both soils have NRCS land capability classifications of III, as do all soils on Bacon Island.

Major limitations of Bacon Island soils include subsidence, a high water table, and slow permeability. Drainage and careful irrigation practices are required for the production of irrigated row and field crops on Bacon Island soils. Fields are irrigated through application of water through siphon pipes from sloughs and channels to a network of canals and ditches on the island. Drainage water must be pumped out continually to prevent flooding by the rising water table that is caused by the constant hydrostatic pressure of the water outside the island levees. The shallow water table, in combination with the organic peat soils, creates a soil condition favorable to the outbreak of plant pathogens and destructive nematodes.

CDC's IFM map for San Joaquin County indicates that virtually all soils on Bacon Island have been classified as prime farmland, approximately 102 acres have been designated farmland of statewide importance, and 10 acres have been designated as farmland of local importance (Table 4.8-5). The soils on Bacon Island have been categorized by NRCS as Class III soils because of the limitations imposed by subsidence and high water table. Class III soils can be categorized by NRCS as prime if the soil limitations are easily solved by agricultural practices, as if often the case with drainage systems for Delta soils (Jones & Stokes 2001b). Virtually all of Bacon Island's soils have been classified as prime because of drainage practices implemented on the island. An estimated 135 acres of Itano silty clay loam have not been classified as prime.

Webb Tract

According to the NRCS 2006 soil survey of Contra Costa County (U.S. Department of Agriculture, Natural Resources Conservation Service 2007a), Rindge muck is the dominant soil on Webb Tract, accounting for an estimated 4,379 acres (81%) of the island's 5,415 soil acres (Table 4.8-4); Ryde silt loam is the second most common soil found on Webb Tract, accounting for 438 acres. NRCS considers these two soils to be prime. All but an estimated 275 acres (5%) of the island's soils are categorized as Class III soils. Major limitations of the Webb Tract soils include a high water table, rapid permeability, and a moderate soil-blowing hazard. As on the other Project islands, careful drainage and irrigation practices are required for the production of irrigated row and field crops.

The CDC IFM system has designated an estimated 4,374 acres on Webb Tract as prime farmland, 127 acres as farmland of statewide importance, 86 acres as unique farmland, and 735 acres as farmland of local importance (Table 4.8-5).

Bouldin Island

Three soils account for an estimated 73% of the soils on Bouldin Island. Similar to Bacon Island, Rindge muck, partially drained, 0–2% slopes, is the dominant soil on Bouldin Island, accounting for an estimated 2,360 acres (39%) of the total acreage of Bouldin Island (Table 4.8-4). Rindge mucky silt loam (0–2% slopes) and Retryde Peltier complex (0–2% slopes) account for an estimated 18% and 16% of total acreage, respectively. All three soils have NRCS land capability classifications of III.

Major limitations of the Bouldin Island soils are similar to those found on Bacon Island, including subsidence, a high water table, and slow permeability. The discussion of Bacon Island soils describes necessary drainage practices for crop production on Bouldin Island.

All but 30 acres of Bouldin Island have been classified by NRCS as Class III soils. Class III soils are usually not considered prime by NRCS or CDC; however, appropriate drainage and irrigation practices may significantly reduce the limitations of the soil and lead to prime designations for some Class III soils. CDC has classified all but 54 acres of Bouldin Island's farmlands as prime; an estimated 50 acres are classified as farmland of statewide importance, and 4 acres as unique farmland (Table 4.8-5).

Holland Tract

Three soils account for an estimated 83% of Holland Tract's 3,066 soil acres: Rindge muck (47%), Piper loamy sand (15%), and Shima muck (21%) (Table 4.8-4). Unlike Bacon Island, Webb Tract, and Bouldin Island, Holland Tract has large areas of Class IV soils, including an estimated 455 acres of Piper loamy sand and 320 acres of Piper fine sandy loam. The remaining soils on Holland Tract are categorized as Class III soils. Major limitations of Holland

Tract soils include a high water table, low available water capacity, rapid permeability, and moderate soil blowing.

All farmland on Holland Tract has been designated by CDC as farmland of local importance (Table 4.8-5).

Table 4.8-4. Estimated Acreages of Soil Types on the Project Islands

Soils	Land Capability Classes[a]	Soil Limitations	Typical Uses	Bacon Island		Bouldin Island		All Islands	
				Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total
SAN JOAQUIN COUNTY SOILS									
Peltier mucky clay loam, partially drained, 0 to 2 percent slopes	IIIw-5	Subsidence, high water table, slow permeability	Irrigated row and field crops	0	0.0	14	0.2	14	0.1%
Retryde-Peltier complex, 0 to 2 percent slopes	IIIw-2	Subsidence, high water table, slow permeability	Irrigated row and field crops	65	1.1	944	15.7	1,009	5.0%
Venice mucky silt loam, overwash, 0 to 2 percent slopes	IIIw-10	Subsidence, high water table	Irrigated row and field crops	0	0.0	210	3.5	210	1.0%
Piper sandy loam, partially drained, 0 to 2 percent slopes	IVw-4	Subsidence, low available water capacity, high water table, weakly cemented substratum	Irrigated row and field crops	0	0.0	30	0.5	30	0.1%
Shima muck, partially drained, 0 to 2 percent slopes	IIIw-10	Subsidence, high water table	Irrigated row and field crops	0	0.0	21	0.4	21	0.1%
Dello loamy sand, partially drained, 0 to 2 percent slopes	IIIw-4	Low available water capacity, severe hazard of soil blowing, high water table	Irrigated row and field crops	0	0.0	20	0.3	20	0.1%
Rindge muck, partially drained, 0 to 2 percent slopes	IIIw-10	Subsidence, high water table	Irrigated row and field crops	2,619	47.0	2,360	39.4	4,979	24.8%
Kingile muck, partially drained, 0 to 2 percent slopes	IIIw-10	Subsidence, high water table, slow permeability	Irrigated row and field crops	1,455	26.1	153	2.6	1,608	8.0%
Kingile-Retryde complex, partially drained, 0 to 2 percent slopes	IIIw-10	Subsidence, high water table, slow permeability	Irrigated row and field crops	480	8.6	0	0.0	480	2.4%
Retryde clay loam, partially drained, 0 to 2 percent slopes	IIIw-2	Subsidence, high water table	Irrigated row and field crops	396	7.1	87	1.5	483	2.4%
Valdez silt loam, partially drained, 0 to 2 percent slopes	IIIw-2	Subsidence, high water table	Irrigated row and field crops	0	0.0	466	7.8	466	2.3%
Rindge mucky silt loam, overwash, 0 to 2 percent slopes	IIIw-10	Subsidence, high water table	Irrigated row and field crops	93	1.7	1,076	17.9	1,169	5.8%
Venice muck, partially drained, 0 to 2 percent slopes	IIIw-10	Subsidence, high water table	Irrigated row and field crops	59	1.0	271	4.5	330	1.6%

Soils	Land Capability Classes[a]	Soil Limitations	Typical Uses	Bacon Island		Bouldin Island		All Islands	
				Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total
Retryde silty clay loam, organic substratum, 0 to 2 percent slopes	IIIw-2	Subsidence, high water table	Irrigated row and field crops	268	4.8	343	5.7	611	3.0%
Itano silty clay loam, partially drained, 0 to 2 percent slopes	IIIw-2	Subsidence, high water table, acidity	Irrigated row and field crops	135	2.4	0	0.0	135	0.7%
Subtotal for Bacon and Bouldin Islands				**5,570**	**100.0**	**5,995**	**100.0**	**11,565**	**57.7**

Soils	Land Capability Classes[a]	Soil Limitations	Typical Uses	Holland Tract[b]		Webb Tract		All Islands	
				Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total
CONTRA COSTA COUNTY SOILS									
Rindge muck	IIIw-10	High water table, rapid permeability, moderate soil blowing hazard	Irrigated row crops	1,454	47.4%	4,379	80.9%	5,833	28.8%
Piper fine sandy loam	Ive-9	High water table, low available water capacity, rapid permeability, moderate soil blowing hazard	Dryland pasture, small grains, volunteer hay	320	10.4%	264	4.9%	584	2.9%
Piper loamy sand	Ivw-4	High water table, low available water capacity, rapid permeability, moderate soil blowing hazard	Irrigated pasture, alfalfa, row crops	455	14.8%	11	0.2%	466	2.3%
Ryde silt loam	IIIw-2	High water table	Irrigated row and field crops	62	2.0%	483	8.9%	545	2.7%
Egbert mucky clay loam	IIIw-2	High water table	Irrigated field crops and wildlife habitat	15	0.5%	0	0.0%	15	0.1%
Shima muck	IIIw-10	High water table, moderate soil blowing hazard	Irrigated row and field crops	644	21.0%	99	1.8%	743	3.7%
Kingile muck	IIIw-10	High water table, moderate soil blowing hazard	Irrigated row and field crops	0	0.0%	37	0.7%	37	0.2%

Soils	Land Capability Classes[a]	Soil Limitations	Typical Uses	Holland Tract[b]		Webb Tract		All Islands	
				Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total
Webile muck	IIIw-10	High water table, moderate soil blowing hazard	Irrigated row and field crops	116	3.8%	0	0.0%	116	0.6%
Merritt loam	IIIw-2	High water table	Irrigated row and field crops	0	0.0%	142	2.6%	142	0.7%
Subtotal for Holland and Webb Tracts				**3,066**	**100.0**	**5,415**	**100.0**	**8,481**	**41.9**
Total								**20,046**	**100.0**

Source: U.S. Department of Agriculture, Natural Resources Conservation Service 2007a and 2007b.

Note: Acreage totals may not correspond with acreages shown elsewhere in this report because of measurement error, rounding error, and water bodies not surveyed on the islands. Acreages do not include non-farmable acres (e.g., ditches, roads, equipment yards, levees). Acreages by soil units were estimated based on GIS measurements performed by ICF Jones & Stokes.

[a] Soils are categorized by NRCS according to eight classes (I–VIII) depending on the limitations to agricultural use imposed by specific soil and climatic criteria. The higher the class, the more restrictive the limitation. Soils in Class III have more limitations and hazards than those in Classes I and II. They require more difficult or complex conservation practices when cultivated. Soils in Class IV have greater limitations and hazards than those in Class III and require more difficult or complex measures when cultivated. Capability classes are divided into subclasses and capability units. Subclass symbols include "w" for wetness and "e" for erosion problems. Capability unit symbols include "2" for wetness problems; "4" for coarse texture, low water-holding capacity; "5" for fine textures, tillage problems; "9" for low fertility, acidity, or toxics problems; and "10" for very coarse textured substratum.

[b] Acreages for Holland Tract exclude the 1,120 nonproject acres (under Alternatives 1 and 2).

Table 4.8-5. Estimated Acreages of Soils in Important Farmland Mapping Categories on the Project Islands

	Bacon Island		Webb Tract		Bouldin Island		Holland Tract[a]		All Islands	
	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total
SAN JOAQUIN COUNTY SOILS										
Prime farmland	5,151	97.9			5,812	99.1			10,963	56.3
Farmland of statewide importance	102	1.9			50	0.8			152	0.8
Unique farmland	0	0.0			4	0.1			4	0.02
Farmland of local importance	10	0.2			0	0.0			10	0.05
CONTRA COSTA COUNTY SOILS										
Prime farmland			4,374	82.2					4,374	22.5
Farmland of statewide importance			127	2.4					127	0.7
Unique farmland			86	1.6					86	0.4
Farmland of local importance			735	13.8			3,020	100	2,464	19.3
Total	**5,263**	**100.0**	**5,322**	**100.0**	**5,866**	**100.0**	**3,020**	**100.0**	**19,471**	**100.0**

Source: California Department of Conservation 2006, 2008. Acreages were estimated based on GIS measurements performed by ICF Jones & Stokes.

[a] Acreages for Holland Tract exclude the 1,120 nonproject acres (under Alternatives 1 and 2).

Farmland Conversion

Under the Farmland Mapping and Monitoring Program, an analysis of agricultural land use and changes in land use throughout California is conducted every other year. Between the years of 1998 and 2006, the amount of prime farmland has steadily decreased primarily due to land use conversions. Table 4.8-6 identifies the acreages of Important Farmland in Contra Costa and San Joaquin Counties from 2002 through 2006. Prime farmland and farmland of statewide importance demonstrate the greatest declines in acreages from 2002 to 2006. Designation of new areas as unique farmland and farmland of statewide importance has resulted in net increases for these categories for San Joaquin County during this timeframe.

Table 4.8-6. Important Farmland Acreage in San Joaquin and Contra Costa Counties

Land Use Category	2002	2004	2006	2008
San Joaquin County				
Prime Farmland	416,307	412,548	407,609	n/a
Farmland of Statewide Importance	92,559	91,225	89,273	n/a
Unique Farmland	61,030	62,534	63,231	n/a
Farmland of Local Importance	56,506	57,808	59,957	n/a
Contra Costa County				
Prime Farmland	33,731	32,024	29,938	26,788
Farmland of Statewide Importance	9,733	8,547	8,092	7,555
Unique Farmland	4,450	3,929	3,589	3,123
Farmland of Local Importance	53,136	52,257	52,071	53,449

Note: 2006 farmland acreage is the most recent data for San Joaquin County.
Source: California Department of Conservation, Division of Land Resource Protection 2006, 2008.

Environmental Commitments

To ensure continued habitat management and agricultural production on the Habitat Islands, the Project applicant will record conservation easements over Bouldin Island and Holland Tract lands controlled by DW Properties. The easements will be developed to be consistent with the HMP and will be recorded in San Joaquin County and Contra Costa County, respectively.

Environmental Effects

Methods

Land Use impacts were assessed based on how construction and operation of the Project alternatives would benefit or adversely affect existing residences and structures, adjacent land uses, and existing land uses. The Project alternatives also were evaluated for their consistency with land use designations and policies of the county general plans and zoning ordinances, DPC regional policies, and Williamson Act contracts.

Agricultural resources impact analysis focuses on the conversion of agricultural land and related changes in agricultural production. Agricultural land conversion impacts were evaluated through comparison between conditions under the Project alternatives and point-of-reference conditions described in the Affected Environment section.

Significance Criteria

The land use and agriculture impact analysis considered several criteria for determining the significance of impacts related to this resource. The analysis took into account both relevant criteria contained in Appendix G of the State CEQA Guidelines (Association of Environmental Professionals 2009) and Project-specific criteria developed by the lead agency to address potential impacts unique to the Project's location and elements.

A Project alternative is considered to have a significant impact on land use if it would:

- displace existing residences and structures in areas where replacement housing is unavailable and landowners are not willing sellers;
- be incompatible with existing adjacent land uses;
- convert existing land use that involves an extreme change from one land use to a more intensive use;
- cause incompatibilities with existing Williamson Act contracts; or
- conflict with adopted and proposed plans and policies in the Project area.
- Impacts on agricultural lands would be considered significant if the Project would result in the conversion of prime farmland as classified by the California Department of Conservation to other uses.

In the 2001 FEIR and 2001 FEIS, changes in agriculture-related employment and farm income were evaluated in a separate chapter, "Economic Conditions and Effects," along with other economic effects potentially associated with implementation of the Project alternatives. In that evaluation, employment and income effects generated by the loss of agricultural use of the Project islands were assessed to help determine the significance of the loss of agricultural land. Under CEQA, agencies are not required to evaluate economic or social effects. An assessment of the potential economic and social effects is not included in this Place of Use EIR. As such, an assessment of the changes in employment and income potentially resulting from changes in agricultural uses of the Project islands was not used to inform the agriculture impact analysis.

Impacts and Mitigation Measures

The impacts to land use and agriculture resulting from implementation of the Project were described in detail in the 2001 FEIR and 2001 FEIS and are briefly summarized in Table 4.8-1. Where there have been no changes to the impact analysis, the 2001 FEIR and 2001 FEIS is incorporated by reference. Certain changes in the affected environment, such as crop changes, and changes in land ownership and occupancy, necessitate updating the impact analysis. None of these changes has resulted in new significant environmental effects or a substantial increase in the severity of previously identified significant effects on land use and agricultural resources.

As indicated in Table 4.8-1, the impacts previously identified in the 2001 FEIR and 2001 FEIS as Impact-1, “Displacement of Residences and Structures on Reservoir Islands” and Impact-2, “Displacement of Property Owners on Habitat Islands”, are no longer considered impacts. Property on the Bacon Island and Webb Tract is leased out for farming, but these leases are short-term and contemplate eventual conversion to water storage. As such, there would be no impact to residences, structures, or other property on the Reservoir Islands. Implementation of Alternative 1 would not require removal or relocation of existing structures on Bouldin Island or Holland Tract. Occupants currently residing on the four Project islands would need to relocate; however, housing opportunities in the local area are considered sufficient for those affected to be housed.

Proposed Project (Alternative 2)

Alternative 2 involves storage of water on Bacon Island and Webb Tract (Reservoir Islands) and management of Bouldin Island and Holland Tract (Habitat Islands) primarily for wetlands and wildlife habitat. The Reservoir Islands would be managed primarily for water storage, with wildlife habitat and recreation constituting secondary uses.

Conflicts with Adjacent Land Uses

Bacon Island and Webb Tract

As discussed in the 2001 FEIR and 2001 FEIS, storage of water and associated recreational uses on Bacon Island and Webb Tract would not adversely affect adjacent land uses because the islands are buffered by levees and surrounding waterways (see Section 4.3, Flood Control and Levee Stability, for more detail on levee structure). Thus, implementation of Alternative 2 is not expected to create nuisances that could affect or impair off-site agricultural or nonagricultural land uses.

Implementation of Alternative 2 without appropriate remedial measures could result in flooding of adjacent lands from seepage from Bacon Island onto surrounding islands. However, the Project applicant proposes seepage control measures as part of Alternative 2.

Bouldin Island and Holland Tract

Habitat management on Bouldin Island and Holland Tract and associated recreational uses would not adversely affect adjacent land uses because the island is buffered by levees and surrounding waterways. Thus, Alternative 2 is not expected to create nuisances that could affect or impair off-site agricultural or urban land uses.

Consistency with Zoning and General Plan Designations

Bacon Island

In an AG zone, water storage is a permitted land use with a use permit. As noted previously, San Joaquin County requires a use permit for water storage projects of greater than six feet in depth, for storage of 30 days or more in any calendar year, on 500 acres or more of agricultural land in San Joaquin County. A use permit will be obtained if this ordinance applies to the Project.

All of Bacon Island is currently under Williamson Act contracts. These contracts are in nonrenewal and expire December 2012. San Joaquin County has preliminarily determined that Alternative 2 is consistent with the goals of the Williamson Act; submerged areas are considered “agricultural lands” in San Joaquin County under the Williamson Act (Jones & Stokes 2001b).

Webb Tract

Water storage on Webb Tract would require rezoning to P-1, planned unit (Roche pers. comm.) and would require a development plan. According to Division 84, Chapter 84-66 of the County’s Code of Ordinances, “the P-1 district is intended to allow diversification in the relationship of various uses, buildings, structures, lot sizes and open space while insuring substantial compliance with the general plan and the intent of the county code in requiring adequate standards necessary to satisfy the requirements of the public health, safety and general welfare.” P-1 zoning would be consistent with the general plan and with the uses proposed under Alternative 2 (Roche pers. comm.).

As discussed in the 2001 FEIR and 2001 FEIS, Alternative 2 would be consistent with the Contra Costa County General Plan Delta Recreation and Resource land use designation, which allows for wildlife habitat and limited recreation. Conditional uses allowed under the Delta Recreation and Resources designation are limited to low- to medium-intensity establishments that do not rely on urban levels of service or infrastructure (i.e., a public water or sewer system, and which will not draw large concentrations of people to flood-prone areas. Because, as part of the Project, the Project applicant would increase bottled-water delivery service, drill new wells, and incorporate water purification techniques to increase water supply at the recreation facilities, as well as install a new sewage disposal system at each facility consistent with Contra Costa County requirements, the recreational uses proposed under Alternative 2 could be considered low- to medium-intensity. As such, a conditional use permit would be required. Rezoning to P-1 and a development plan would be required for higher-intensity recreational uses (Roche pers. comm.).

Lands zoned A-4 would remain in this district as Williamson Act lands. However, the parcel currently under Williamson Act contract is in nonrenewal and the contract expires November, 2012 (Contra Costa County 2007). Contra Costa County has preliminarily determined that the water component of Alternative 2 is consistent with the current Williamson Act contract and the existing agricultural use (Jones & Stokes 2001b). Water storage is a compatible use under the Williamson Act. Therefore, Alternative 2 would be compatible with the existing Williamson Act contract on Webb Tract.

Bouldin Island

As discussed in the 2001 FEIR and 2001 FEIS, Alternative 2 is considered consistent with San Joaquin County zoning and general plan designations because it retains open space values and encourages the multiple uses of open space (Jones & Stokes 2001b). The entire land area of Bouldin Island is under Williamson Act contracts; these contracts are in nonrenewal and expire December 2012. Based on a preliminary evaluation by San Joaquin County, Alternative 2 would be consistent with the open space preservation goals of the Williamson Act and is consistent with the SJCGP open space/conservation element and AG land use designation (Jones & Stokes 2001b). Therefore, Alternative 2 would have no effect on Williamson Act contracts.

Holland Tract

As discussed in the 2001 FEIR and 2001 FEIS, the habitat management component of Alternative 2 is consistent with the Contra Costa County General Plan Delta Recreation and Resources land use designation and with the agricultural zoning on Holland Tract because the Project would provide uses compatible with agriculture. As discussed for Webb Tract, a conditional use permit would be required for the proposed recreational facilities on Holland Tract. Holland Tract has no parcels under Williamson Act contract (Contra Costa County 2007).

Consistency with General Plan Policies and Delta Protection Commission Land Use Plan Principles

A detailed discussion of the consistency of Alternative 2 with pertinent general plan policies of Contra Costa County or San Joaquin County and land use plan principles of the Delta Protection Commission was provided in the 2001 FEIR. Because the Delta Protection Commission recently has revised and updated the LURMP, the Project's consistency with the LURMP was reexamined in light of policy revisions. However, the impact (Impact LU-1) has not changed. The consistency conclusions are briefly presented here in Table 4.8-7.

Table 4.8-7. Consistency of the Proposed Project with Relevant General Plan and Delta Protection Commission Objectives, Goals, and Policies

Goal/Objective/Policy	Consistency
SAN JOAQUIN COUNTY GENERAL PLAN	
Agriculture Principles	
Objective 1 To protect agricultural lands needed for the continuation of commercial agricultural enterprises, small-scale farming operations, and the preservation of open space.	Consistent The Proposed Project would protect agricultural lands for the preservation of open space. Both water storage and habitat management are open space uses.
Policy 1 The following agricultural land use categories shall be established to promote a range of agricultural activities and preserve open space: General Agriculture, Limited Agriculture, and Agriculture-Urban Reserve.	Consistent The Proposed Project would be consistent with the General Agriculture designation on Bouldin and Bacon Islands.
Policy 5 Agricultural areas shall be used principally for crop production, ranching, and grazing. All agricultural support activities and nonfarm uses shall be compatible with agricultural operations and shall satisfy the following criteria: (a) The use requires a location in an agricultural area because of unusual site area requirements, operational characteristics, resource orientation, or because it is providing a service to the surrounding agricultural area; (b) The operational characteristics of the use will not have a detrimental impact on the management or use of surrounding agricultural properties; (c) The use will be sited to minimize any disruption to the surrounding agricultural operations; and (d) The use will not significantly impact transportation facilities, increase air pollution, or increase fuel consumption.	Consistent Water storage and habitat management are both compatible nonfarm uses. Both proposed uses require location in the Delta area, and neither would have a detrimental effect on surrounding agricultural properties or would result in significant air and transportation impacts (see Sections 4.4, Utilities and Highways; 4.10, Traffic; and 4.13, Air Quality).
Policy 6 All lands designated for agricultural uses and those lands designated for nonagricultural use but not needed for development for 10 years shall be placed in an agricultural preserve and shall be eligible for Williamson Act contracts. Parcels eligible for Williamson Act contracts shall be 20 or more acres in size in the case of prime land or 40 or more acres in the case of nonprime land.	Consistent The Proposed Project would be consistent with existing Williamson Act contracts in San Joaquin County.

Goal/Objective/Policy	Consistency
Policy 7 There shall be no further fragmentation of land designated for agricultural use, except in the following cases: (a) Parcels for homesites may be created, provided that the General Plan density is not exceeded. (b) A parcel may be created for the purpose of separating existing dwellings on a lot, provided the Development Title regulations are met. (c) A parcel may be created for a use granted by a permit in the AG zone, provided that conflicts with surrounding agricultural operations are mitigated.	Consistent The Proposed Project would not lead to fragmentation of existing parcels.
Open Space Principles	
Objective 1 To preserve open space land for the continuation of commercial agricultural and productive uses, the enjoyment of scenic beauty and recreation, the protection and use of natural resources, and for protection from natural hazards.	Consistent The Proposed Project would provide recreation opportunities, flood control, and protection of natural resources in the Delta.
Policy 4 Areas with serious development constraints, such as the Delta, should be predominantly maintained as open space.	Consistent The Proposed Project would maintain the islands in water storage and habitat management, consistent with the county's open space definition.
Policy 6 The County shall consider waterways, levees, and utility corridors as major elements of the open space network and shall encourage their use for recreation and trails in appropriate areas.	Consistent The Proposed Project would promote recreational use along levees.
Recreation Principles	
Objective 2 To protect the diverse resources upon which recreation is based, such as waterways, marsh lands, wildlife habitats, unique land and scenic features, and historical and cultural sites.	Consistent The Proposed Project would involve management of the Habitat Islands to protect and restore wildlife habitat.
Objective 3 To ensure the preservation of the Delta and the opportunity for the public to learn about and enjoy this unique recreation resource.	Consistent The Proposed Project would provide new recreation opportunities in the Delta. Recreation facilities on the Project islands may or may not be publicly accessible; however, the proposed Project would provide opportunities and improve the setting for waterfowl hunting, bird watching, and other recreation activities in the Delta by enhancing the regional habitat value for wildlife in the Delta (see Section 4.6, Wildlife).

Goal/Objective/Policy	Consistency
Policy 7 Natural features shall be preserved in recreation areas, and opportunities to experience natural settings shall be provided.	Consistent Implementation of the Proposed Project would provide recreation opportunities in resource management areas in the Delta.
Policy 15 The recreational values of the Delta, the Mokelumne River, and the Stanislaus River shall be protected.	Consistent Same as above.
Policy 19 Development in the Delta islands shall generally be limited to water-dependent uses, recreation, and agricultural uses.	Consistent Under the Proposed Project, the islands would be managed for recreation, wildlife, and water storage.
Vegetation and Wildlife Principles	
Objective 2 To provide undeveloped open space for nature study, protection of Endangered species, and preservation of wildlife habitat.	Consistent Habitat management under the Proposed Project would provide open space for nature study, protection of Endangered species, and preservation of wildlife habitat.
Policy 1 Resources of significant biological and ecological importance in San Joaquin County shall be protected. These include wetlands; riparian areas; rare, threatened, and endangered species and their habitats as well as potentially rare or commercially important species; vernal pools; significant oak groves; and heritage trees.	Consistent Habitat management under the Proposed Project would establish and protect wetlands, riparian areas, and habitats for listed species.
Policy 7 The County shall support feeding areas and winter habitat for migratory waterfowl.	Consistent Same as above.
Policy 14 The County shall support the establishment and maintenance of ecological preserves and accessibility to areas for nature study.	Consistent Same as above.

Goal/Objective/Policy	Consistency
CONTRA COSTA COUNTY GENERAL PLAN	
Conservation Principles	
Policy 8-2 Areas that are highly suited to prime agricultural production shall be protected and preserved for agriculture, and standards for protecting the viability of agricultural land shall be established.	Inconsistent Implementation of the Proposed Project would remove agricultural land in Contra Costa County from production. The inherent agricultural productivity of the islands would not change because of the use of prime agricultural land for water storage and habitat management. Project implementation would not be consistent with the county’s policy of preserving lands for agricultural production.
Policy 8-3 Watersheds, natural waterways, and areas important for the maintenance of natural vegetation and wildlife populations shall be preserved and enhanced.	Consistent The Proposed Project would enhance and preserve habitat values on Holland Tract.
Agriculture Principles	
Goal 8-G To encourage and enhance agriculture, and to maintain and promote a healthy and competitive agricultural economy.	Inconsistent Implementation of the Proposed Project would remove agricultural land in Contra Costa County from production; this is not consistent with the county's goal to promote a competitive agricultural economy.
Goal 8-H To conserve prime productive agricultural land outside the Urban Limit Line exclusively for agriculture.	Consistent Implementation of the Proposed Project would remove agricultural land in Contra Costa County from production; however, Contra Costa County does not consider the Class III and IV soils in Holland and Webb Tracts to represent prime farmland. Therefore, the conversion of farmlands on these islands is not considered inconsistent with the county’s policy of preserving prime agricultural lands for agricultural production.
Policy 8-38 Agricultural operations shall be protected and enhanced through encouragement of Williamson Act contracts to retain designated areas in agricultural use.	Consistent The Proposed Project would not affect existing Williamson Act contracts on Project islands.
Policy 8-39 A full range of agriculturally related uses shall be allowed and encouraged in agricultural areas.	Consistent Water storage and habitat management are considered agriculture-related uses.
Policy 8-45 Efforts to assure an adequate, high quality and fairly priced water supply to irrigated agricultural areas shall be supported.	Consistent A purpose of the Proposed Project is to increase the availability of high-quality water through the Delta.

Goal/Objective/Policy	Consistency
Policy 8-46 Maintenance and reconstruction of Delta levees shall be encouraged to assure the continued availability of valuable agricultural land protected by the existing network of levees and related facilities.	Consistent The Proposed Project would enhance the existing levee system on the water storage islands.
Vegetation and Wildlife Principles	
Goal 8-D To protect ecologically significant lands, wetlands, and plant and wildlife habitats.	Consistent A purpose of the Proposed Project is to increase the extent and value of wildlife habitat in the Delta.
Goal 8-F To encourage the preservation and restoration of the natural characteristics of the San Francisco Bay/Delta estuary and adjacent lands, and recognize the role of Bay vegetation and water area in maintaining favorable climate, air and water quality, and fisheries and migratory waterfowl.	Consistent Same as above.
Policy 8-17 The ecological value of wetland areas, especially the salt marshes and tidelands of the bay and Delta, shall be recognized. Existing wetlands in the county shall be identified and regulated. Restoration of degraded wetland areas shall be encouraged and supported whenever possible.	Consistent Same as above.
Open Space Principles	
Policy 9-2 Historic and scenic features, watersheds, natural waterways, and areas important for the maintenance of natural vegetation and wildlife populations shall be preserved and enhanced.	Partially Inconsistent The Proposed Project would affect scenic waterways along the Project islands. In other areas, however, the proposed Project would enhance wildlife habitat. See Sections 4.9, Recreation and Visual Resources, and 4.6, Vegetation and Wetlands, for more information on these effects of the Proposed Project.
Policy 9-28 Maintenance of the scenic waterways of the county shall be ensured through public protection of the marshes and riparian vegetation along the shorelines and Delta levees, as otherwise specified in this plan.	Inconsistent Riparian habitat on Delta levees will be affected by the Proposed Project. See Section 4.9, Recreation and Visual Resources, for an analysis of impacts on scenic waterways.
Policy 9-44 As a unique resource of statewide importance, the Delta shall be developed for recreation use in accordance with the state environmental goals and policies. The recreational value of the Delta shall be protected and enhanced.	Consistent A purpose of the Proposed Project is to provide regional recreation opportunities.

Goal/Objective/Policy	Consistency
DELTA PROTECTION COMMISSION—LAND USE AND RESOURCE MANAGEMENT PLAN FOR THE PRIMARY ZONE OF THE DELTA	
Natural Resources	
Policy P-3 Lands managed primarily for wildlife habitat shall be managed to maximize ecological values. Appropriate programs, such as "Coordinated Resource Management and Planning" (Public Resources Code Section 9408[c]) should ensure full participation by local government and property owner representatives.	Consistent Habitat management under the Proposed Project would provide open space, protection of Endangered species, and preservation of wildlife habitat. Bouldin Island and Holland Tract would be managed to provide breeding and foraging habitat for several wildlife species groups.
Policy P-5 Preserve and protect the viability of agricultural areas by including an adequate financial mechanism in any planned conversion of agricultural lands to wildlife habitat for conservation purposes. The financial mechanism shall specifically offset the loss of local government and special district revenues necessary to support public services and infrastructure.	Consistent The conversion of land under the Proposed Project would not change the land use characterization of the land, and thus would not result in loss of local government and special district revenues.
Policy P-6 Support the implementation of appropriate buffers, management plans and/or good neighbor policies (e.g., safe harbor agreements) that among other things, limit liability for incidental take associated with adjacent agricultural and recreational activities within lands converted to wildlife habitat to ensure the ongoing agricultural and recreational operations adjacent to the converted lands are not negatively affected.	Consistent Conversion of agricultural lands to wildlife habitat on Bouldin Island and Holland Tract would not negatively affect adjacent land uses because the islands are buffered by levees and surrounding waterways. As such, the Proposed Project is not expected to create nuisances that could affect or impair off-site agricultural or urban land uses.
Policy P-10 Ensure that design, construction, and management of any flooding program to provide seasonal wildlife and aquatic habitat on agricultural lands, duck club lands and additional seasonal and tidal wetlands, shall incorporate "best management practices" to minimize vectors including mosquito breeding opportunities, and shall be coordinated with the local vector control districts, (each of four vector control districts in the Delta provides specific wetland/mosquito management criteria to landowners within their district.)	Consistent The Project applicant, California Department of Fish and Game, and the Habitat Management Advisory Council would consult and coordinate with the appropriate vector control districts during all phases of the Proposed Project, including design, implementation, and operations, and the Habitat Management Plan would be updated in accordance with the best management practices identified in the Central Valley Joint Venture's Technical guide to Best Management Practices for Mosquito Control in Managed Wetlands design and management of constructed wetlands published by the Central Valley Joint Venture, California Department of Health Services, and Sacramento-Yolo Mosquito and Vector Control District.

Goal/Objective/Policy	Consistency
Utilities and Infrastructure Policies	
Policy P-2 Ensure that new houses built in the Delta agricultural areas but outside of the Delta's unincorporated towns continue to be served by independent potable water and wastewater treatment facilities and/or septic systems. Agricultural uses that require wastewater treatment shall provide adequate infrastructure improvements or pay to expand existing facilities, and not overburden the existing limited community resources. The appropriate governing body shall ensure that new or expanded construction of agriculturally-oriented wastewater disposal systems meet the appropriate standards/conditions and are not residentially growth inducing. Independent treatment facilities should be monitored to ensure no cumulative adverse impact to groundwater supplies.	Consistent Drinking water for recreation facilities would be imported as needed or supplied using onsite treatment subject to county and state standards. Sewer disposal would comply with the requirements of the CVRWQCB. A private solid waste collection agency certified to operate in Contra Costa and San Joaquin Counties would be contracted to serve the recreation facilities.
Land Use Policies	
Policy P-6 Subsidence control shall be a key factor in evaluating land use proposals. Encourage agricultural, land management, recreational, and wildlife management practices that minimize subsidence of peat soils. Local governments should utilize studies of agricultural and land management methods that minimize subsidence and should assist in educating landowners and managers as to the value of utilizing these methods.	Consistent Implementation of the Proposed Project would diminish current subsidence rates.
Policy P-7 New structures shall be set back from levees and areas that may be needed for future levee expansion consistent with local reclamation district regulations and, upon adoption, with the requirements to be identified in the California Department of Water Resources Central Valley Flood Control Plan.	Consistent The Proposed Project would improve levees on all four Project islands. Although recreational facilities would be located adjacent to the levee crest, they would not interfere with future levee expansion.
Policy P-14 The conversion of an agricultural parcel, parcels, and/or agricultural island for water impoundment, including reservoirs, water conveyance or wetland development may no result in the seepage of water onto or under the adjacent parcel, parcels, and/or island. These conversions shall mitigate the risks and adverse effects associated with seepage, levee stability, subsidence, and levee erosion, and shall be consistent with the goals of this Plan.	Consistent The Proposed Project would improve levees on all four Project islands. As described in Section 4.3, Flood Control and Levee Stability, Reservoir Island levees will be designed to include a core trench and interceptor well system to provide a levee seepage barrier. In addition, the Project applicant would implement a seepage monitoring program to provide early detection of seepage problems caused by Project operations.

Goal/Objective/Policy	Consistency
Agriculture Policies	
Policy P-1 Support and encourage agriculture in the Delta as a key element in the State's economy and in providing the food supply needed to sustain the increasing population of the State, the Nation, and the world.	Inconsistent Implementation of the Proposed Project would result in land being removed from agricultural production.
Policy P-2 Conversion of land to non-agriculturally-oriented uses should occur first where productivity and agricultural values are lowest.	Inconsistent Implementation of the Proposed Project would convert a substantial number of acres of prime farmland in the Delta to non-agricultural use and would result in productive agricultural land being removed from production in the long term (50 years).
Policy P-6 Encourage acquisition of agricultural conservation easements from willing sellers as mitigation for projects within each county. Promote use of environmental mitigation in agricultural areas only when it is consistent and compatible with ongoing agricultural operations and when developed in appropriate locations designated on a countywide or Delta-wide habitat management plan.	Consistent Agricultural conservation easements would be placed on Bouldin Island and Holland Tract.
Policy P-7 Encourage management of agricultural lands which maximize wildlife habitat seasonally and year-round, through techniques such as sequential flooding in fall and winter, leaving crop residue, creation of mosaic of small grains and flooded areas, controlling predators, controlling poaching, controlling public access, and others.	Consistent Agricultural fields on the Habitat Islands will be managed to maximize wildlife habitat values. Requirements specified in the Habitat Management Plan call for the provision of high-value foraging habitat for wintering waterfowl through creation of fields of corn rotated with wheat, mixed agriculture/seasonal wetland, seasonal managed wetland, and pasture/hay fields.
Policy P-8 Encourage the protection of agricultural areas, recreational resources and sensitive biological habitats, and the reclamation of those areas from the destruction caused by inundation.	Partially Inconsistent Although the Proposed Project would inundate agricultural land in the Delta during periods of storage, the Project would provide a net benefit to overall flood protection in the Delta.
Water Policies	
Policy P-1 State, federal and local agencies shall be strongly encouraged to preserve and protect the water quality of the Delta both for in-stream purposes and for human use and consumption.	Consistent Implementation of the Proposed Project would require ongoing consultation with water agencies at the state, federal, and local levels. The final operations criteria and other reasonable prudent measures adopted as part of the Endangered Species Act consultation process include restrictions on Project operations to minimize effects on aquatic habitat and fish. Project effects on drinking water quality would be reduced to a less-than-significant level through the implementation of the mitigation measures.

Goal/Objective/Policy	Consistency
Policy P-2 Ensure that Delta water rights and water contracts are respected and protected, including area of origin water rights and riparian water rights.	Consistent The four Project islands have existing riparian and appropriative water rights to use a reasonable quantity of water from Delta channels for agricultural and other beneficial purposes of about 44 taf.
Recreation and Access Policies	
Policy P-2 Encourage expansion of existing privately-owned, water-oriented recreation and access facilities that are consistent with local General Plans, zoning regulations and standards.	Inconsistent Implementation of the Proposed Project would include the construction of new private recreation facilities in the Delta.
Levee Policies	
Policy P-9 Support a minimum Delta-specific levee design standard as established by state and federal regulation.	Consistent Reservoir and Habitat Island levees would be designed to meet or exceed PL84-99 standards. CALFED and the California Department of Water Resources have adopted PL84-99 as the preferred design standard for Delta levees.
Sources: San Joaquin County Community Development Department 1992; Contra Costa County Community Development Department 2005; Delta Protection Commission 2010.	

Impact LU-1: Inconsistency with Contra Costa County General Plan Policy for Agricultural Lands and Delta Protection Commission Land Use Plan Principles for Agriculture and Recreation

Implementation of Alternative 2 would convert a total of 6,534 acres of farmland (prime and unique farmland, and farmland of statewide and local importance) on Webb and Holland Tracts to water storage and habitat uses, respectively (Table 4.8-8). This conversion, and subsequent loss of agricultural production, is not consistent with the county's agricultural principles to maintain and promote a healthy and competitive agricultural economy or to protect and preserve areas suited to prime agricultural production (Table 4.8-7). Although the inherent agricultural productivity of the islands would not be significantly changed by the use of agricultural land for water storage or habitat management, the proposed use is not consistent with these general plan principles.

Removing land from agricultural production is inconsistent with the DPC's agricultural policy to support and encourage agriculture in the Delta as a key element in the state's economy. It is partially inconsistent with DPC's agricultural policy to protect agricultural areas from inundation as the Project would flood agricultural land in the Delta during periods of storage; however, the Project also would provide a net benefit to the overall flood protection in the Delta. In addition, because a substantial number of acres of prime farmland would be converted to non-agricultural use, it is inconsistent with the DPC's agricultural policy that indicates that conversion of land to non-agriculture-oriented uses should occur where productivity and agricultural values are lowest. Additionally, the construction of the new recreation facilities on the Project islands is inconsistent with the DPC's recreation principle for private, water-oriented commercial recreational facilities, which encourages the expansion of existing private water-oriented facilities over construction of new recreations facilities. This impact is considered significant and unavoidable.

Mitigation

No mitigation is available to reduce this impact to a less-than-significant level.

Long-Term Conversion of Agricultural Land

Bacon Island

Implementation of Alternative 2 would remove an estimated 5,570 acres of Class III soils on Bacon Island from agricultural uses on a long-term basis (for the life of the Project) (Table 4.8-4). Under the CDC IFM classification system, an estimated 5,151 acres on Bacon Island have been designated prime farmland, 102 acres have been designated farmland of statewide importance, and 10 acres have been designated farmland of local importance (Table 4.8-5). Implementation of Alternative 2 would remove these lands from agricultural use for the life of the Project.

An estimated 4,859 acres, excluding 14 acres of fallow land, were in agricultural use on Bacon Island in 2008 (Table 4.8-2). This land represented an estimated

0.64% of harvested acreage in San Joaquin County in 2007 (San Joaquin County Office of the Agricultural Commissioner 2008).

As discussed in the “Affected Environment” section, Bacon Island produced the following percentages of the crops produced in San Joaquin County, based on 2007 countywide production levels in tons: wheat, 4%; corn, 2.3%; and alfalfa, 2.6%; (San Joaquin County Office of the Agricultural Commissioner 2008). Although oats and sunflower were also grown on Bacon Island in 2008, production estimates are not presented here because these crops were not included in the 2007 crop report for San Joaquin County. The removal of land on Bacon Island from agricultural uses would reduce the countywide production of these crops. Over the long term, agricultural production on the island may become infeasible even without Project implementation because of subsidence and increased likelihood of levee failure (Mount and Twiss 2005; Lund et al. 2007).

Webb Tract

Implementation of Alternative 2 would remove an estimated 5,140 acres of Class III soils and 275 acres of Class IV soils on Webb Tract from agricultural uses on a long term basis (for the life of the Project). The CDC has designated an estimated 4,374 acres on Webb Tract as prime farmland, 127 acres as farmland of statewide importance, 86 acres as unique farmland, and 735 acres as farmland of local importance. Implementation of Alternative 2 would remove these lands from agricultural uses for the life of the Project.

An estimated 4,000 acres, excluding 87 acres of fallow land, were in agricultural use on Webb Tract in 2008. This land represented an estimated 2% of acreage harvested in Contra Costa County in 2007 (Contra Costa County Department of Agriculture 2008).

Removing the land from agricultural use would result in the loss of agricultural production on Webb Tract for the life of the Project. In 2008, Webb Tract produced approximately 55% of Contra Costa County’s field corn crop, based on estimated total yield (tons). The loss of Webb Tract’s agricultural production would substantially reduce the countywide production of this crop.

Bouldin Island

Implementation of Alternative 2 would convert much of Bouldin Island to nonagricultural uses (i.e., wildlife habitat). Approximately 2,831 acres of prime farmland and 8 acres of farmland of statewide importance would remain in use as agriculture (grains and pasture) for wildlife habitat, as described below, as part of the HMP. Because it has not yet been determined precisely where each crop would be planted on Bouldin Island, these acreage values as they apply to important farmland types are preliminary. In total, approximately 2,981 acres of prime farmland, 42 acres of farmland of statewide importance, and 4 acres of unique farmland would be converted under Alternative 2 to nonagricultural use (Table 4.8-8).

In 2008, an estimated 4,933 acres were in agricultural use on Bouldin Island (Table 4.8-2). Under Alternative 2 as part of the HMP, some portions of Bouldin

Island would be planted, primarily in grain crops, to enhance wildlife habitat. As shown in Table 4.8-9, an estimated 1,867 acres would be planted in corn, wheat, pasture, and barley; an estimated 1,195 acres would be harvested for sale. Approximately 1,014 acres would be planted as mixed agriculture/seasonal wetland but would not be harvested.

The sale of grain crops planted for wildlife habitat would partially offset the loss of agricultural production on Bouldin Island; however, overall crop production on the island would be reduced by implementation of Alternative 2. The effect of this alternative on crop production on Bouldin Island includes the net loss of an estimated 15,344 tons of corn, 2,697 tons of rice, and 8,492 tons of tomatoes, and the net gain of an estimated 805 tons of wheat, 119 acres of pasture, and 13 acres of barley[1]. The crop reductions (based on 2007 countywide production levels) represent approximately 4% of San Joaquin County's corn crop, 12 % of the county's rice crop, and 0.6% of the county's tomato crop. The crop gains would represent approximately 2% of the county's wheat crop, and an unknown percentage of the county's barley crop[1] and harvested pasture[2] (based on 2007 countywide production levels).

Holland Tract

Under Alternative 2, portions of Holland Tract would be excluded from the Project. Nonproject areas on Holland Tract would include marina properties, the 857 acres of parcels on the southwestern corner of the island, the 263-acre Wildlands parcel, and several small parcels along the levee held by outside interests. Approximately 1,179 acres within the Project area would be planted in grain crops (corn, wheat, and barley) and pasture to enhance wildlife habitat, with an estimated 741 acres harvested for sale (Table 4.8-9). Approximately 631 acres would be planted as mixed agriculture/seasonal wetlands but would not be harvested.

Implementation of Alternative 2 would convert an estimated 1,212 acres of farmland to nonagricultural uses (excluding 1,120 nonproject acres and 1,808 acres planted in grain crops, pasture, and mixed agriculture/seasonal wetlands) (Table 4.8-8). An estimated 1,212 acres of land designated as farmland of local importance by the CDC would be converted to nonagricultural uses on Holland Tract. (Table 4.8-8.)

An estimated 2,884 acres were used for pasture on Holland Tract in 2008, and no crops were planted (Table 4.8-2). Implementation of Alternative 2 would change cropping patterns within the Project area on Holland Tract and would result in a net increase in crop production because no harvested crops are currently grown on Holland Tract. The harvest and sale of grain crops planted for wildlife habitat under Alternative 2 would result in the net gain of 1,862 tons of corn, 281 tons of

[1] San Joaquin County's 2007 Agricultural Report does not provide production data for barley; therefore, an estimate for the barley yield on Bouldin Island and percentage increase in countywide barley production (harvested acreage [tons] resulting from the implementation of Alternative 1 could not be provided.

[2] San Joaquin County's 2006/2007 agricultural report reports pasture production in combination with range land production, not as a separate crop; therefore, a percentage increase in the county's pasture production resulting from the implementation of Alternative 1 could not be provided.

wheat, 19 acres of barley[3], and 184 harvested acres of pasture in Contra Costa County. The crop gains (based on 2007 countywide harvested acreage) would represent approximately 7% of the county's corn crop, 14% of the county's wheat crop, 3% of the county's pasture, and an unknown percentage of the county's barley crop[3].

Table 4.8-8. Estimated Acreage of Farmland Converted under Alternatives 1 or 2

	Bacon Island	Webb Tract	Bouldin Island[a]	Holland Tract[b]	All Islands
San Joaquin County					
Prime Farmland	5,151		2,981		8,132
Farmland of Statewide Importance	102		42		144
Unique Farmland	0		4		4
Farmland of Local Importance	10		0		10
Contra Costa County					
Prime Farmland		4,374		0	4,374
Farmland of Statewide Importance		127		0	127
Unique Farmland		86		0	86
Farmland of Local Importance		735		1,212	1,947
Total	**5,263**	**5,322**	**3,027**	**1,212**	**14,824**

Note: Inconsistencies in acreages are the result of rounding and conversion of 1995 and 2000 data (Jones & Stokes 1995 and 2001b) to GIS.

[a] Under Alternative 1 or 2, approximately 2,831 acres of prime farmland, and 8 acres of farmland of statewide importance would be planted in grain crops (corn, wheat, and barley) ,pasture, and mixed agriculture/seasonal wetlands on Bouldin Island. These acreages are excluded here.

[b] Under Alternative 1 or 2, approximately 1,809 acres of farmland of local importance would be planted in grain crops (corn, wheat, and barley), pasture, and mixed agriculture/seasonal wetlands on Holland Tract. These acreages are excluded here.

[3] Contra Costa County's 2006/2007 agricultural report does not provide production data for barley; therefore, an estimate for the yield and percentage increase in barley on Holland Tract resulting from the implementation of Alternative 1 could not be provided.

Table 4.8-9. Projected Crop Production on the Project Islands under Alternatives 1 and 2

Crop	Bouldin Island				Holland Tract[a]				Total		
	Acres Planted	Acres Harvested[b]	Yield (tons per acre)	Total Yield (tons)	Acres Planted	Acres Harvested[b]	Yield (tons per acre)	Total Yield (tons)	Acres Planted	Acres Harvested[b]	Total Yield (tons)
Corn	1,222	819	4.73	3,874	716	480	3.88	1,862	1,938	1,299	5,736
Wheat[c]	487	244	3.3	805	353	177	1.59	281	840	421	1,087
Barley	26	13	N/A	N/A	38	19	N/A	N/A	64	32	N/A
Pasture	132	119	N/A	N/A	72	65	N/A	N/A	204	184	N/A
Mixed agriculture/ seasonal wetlands	1,014	N/A	N/A	N/A	631	N/A	N/A	N/A	1,645	N/A	N/A
Total	**2,881**	**1,195**			**1,810**	**741**			**4,691**	**1,936**	

Sources: Planted acreage projections: Jones & Stokes Assoc. 1995, Appendix G3, "Habitat Management Plan for the Delta Wetlands Habitat Islands." Average yield projections: San Joaquin County Office of the Agricultural Commissioner 2008; Contra Costa County Department of Agriculture 2008.

Note: Represents acreages of crops planted for wildlife habitat. No crops would be planted on Bacon Island and Webb Tract. These acreages are based on the draft HMP and may be revised in the final HMP. Inconsistencies in acreages are the result of rounding and conversion of 1995 and 2000 data (Jones & Stokes 1995 and 2001b) to GIS.

[a] Excludes crops grown on 1,120 acres on nonproject Holland Tract lands.

[b] Represents acreages of crops that would be harvested and sold.

[c] Includes spring and winter wheat.

[d] Acreage devoted to mixed agricultural/seasonal wetland would not be harvested.

Impact LU-2: Direct Conversion of Agricultural Land

Implementation of Alternative 2 would convert an estimated 14,824 acres of farmland (prime and unique farmland, and farmland of statewide and local importance) to nonagricultural uses on the four Project islands (Table 4.8-8). As indicated in Table 4.8-9, an estimated 4,691 acres total on Holland Tract and Bouldin Island would be planted in grain crops, pasture, and mixed agriculture/wetlands to enhance wildlife habitat. This acreage is excluded from the total converted acreage, as is the 1,120 nonproject acres on Holland Tract.

The direct conversion of an estimated 14,824 acres of farmland is considered significant because it is a substantial acreage and includes 12,506 acres of prime farmland.

The impact of converting prime farmland, farmland of statewide importance, unique farmland, and farmland of local importance and resulting losses in agricultural production would be attenuated by some of the Project features and actions. These are:

- enhancing in-Delta recreation opportunities,
- enhancing the sustainability of agriculture within the place of use of water supplied by the Project,
- restoring agricultural production on Project islands used for water storage purposes, and
- contributing to the sustainability of in-Delta agriculture.

One measure of the value of the loss of farmland is the loss of agricultural production and the potential and resulting adverse impact on employment and income. As shown in Table 4.8-2, agricultural production on the Project islands is primarily limited to the production of grain, seed, and forage crops. Removing these lands would result in a reduction in agricultural-related economic activity. Because planting and harvesting grain, seed, and forage crops is highly mechanized, the employment and income losses attributable to no longer producing these crops would be small when compared to agricultural-related employment in San Joaquin and Contra Costa County.

In-Delta Recreation Opportunities

The Project would enhance water-dependent and water-enhanced recreation opportunities occurring within the Delta. The increase in hunting, fishing, and boating activity would benefit the regional economy as recreationists make expenditures for food, fuel, lodging, and equipment that they would not have otherwise made. However, if Mitigation Measure REC-MM-1 is implemented, recreation opportunities would be substantially reduced.

Enhancing Sustainability of Agriculture Occurring in the Place of Use

Agriculture in San Joaquin Valley would benefit under Alternative 2 by providing water to designated places of use (Chapter 2, "Project Description"). For example, through its partnership with Semitropic, the Project would provide benefits to landowners and agricultural production within Semitropic's service areas. Semitropic provides water to irrigate approximately 140,000 acres for agricultural uses in Kern County. Water delivered to Semitropic from the Project would augment Semitropic's groundwater and SWP water supplies. Storage of Project water within the Semitropic groundwater bank would benefit agricultural operations both within and outside of Semitropic's service area by enhancing water supply reliability and in turn increasing the sustainability of agriculture within the San Joaquin Valley.

Restoring Agricultural Production on Project Islands
As discussed in Chapter 2 "Project Description", agricultural production would be eliminated from Project's Reservoir Islands. However, the conversion of these agricultural lands is not considered irreversible. Once the Project ceases operation, the Reservoir Islands would be made available for agricultural production. Use of the Project islands for water storage activities is not expected to have an adverse impact on the productive capabilities of island soils.

Enhancing Sustainability of In-Delta Agriculture
The Project's impact on agricultural land would be further offset by the Project's environmental commitment to place agricultural production easements on Habitat Islands (Chapter 2 "Project Description") and enhancing the stability of levees on Project islands. Enhancing the stability of the Project's levees would help benefit agriculture by reducing the threat of levee failure on the Habitat Islands and other islands within the Delta that also support agriculture.

The direct conversion of agricultural land is considered a significant and unavoidable impact.

Mitigation
No feasible mitigation is available to reduce this impact to a less-than-significant level. Restoring Project lands to agricultural uses at the conclusion of the Project would ensure that permanent conversion of agricultural land and production could be avoided; however, it would not reduce the long-term conversion of prime and other farmlands during the 50-year life of the Project.

Alternative 1

Impacts on land use and agricultural resources of Alternative 1 are the same as those of Alternative 2.

Alternative 3

Alternative 3 involves storage of water on Bacon Island, Webb Tract, Bouldin Island, and Holland Tract, with secondary uses for wildlife habitat and recreation. The portion of Bouldin Island north of SR 12 would be managed as a wildlife habitat area and would not be used for water storage.

Impacts on land use, including displacement of residences and structures, consistency with relevant plans, policies, and zoning designations, and effects on Williamson Act contracts remain as they were presented in the 2001 FEIR and 2001 FEIS and are hereby incorporated by reference, and are briefly summarized in the following section. Because important farmland acreages on the four Project islands have been updated with CDC's 2006 IFM data, values for affected acreages have changed and are incorporated below.

Impact LU-3: Displacement of Residences and Structures on Reservoir Islands

Implementation of Alternative 3 would convert onsite agricultural land uses to water storage operations on all four Project islands. This change would require removal or relocation of existing onsite structures and farmsteads. The affected landowners on Holland Tract would be compensated for their property as willing sellers. Occupants currently residing on all four islands would need to relocate. Housing opportunities in the local area are considered sufficient for those affected to be housed. Therefore, this impact is considered less than significant.

Mitigation

No mitigation is required.

Impact LU-1: Inconsistency with Contra Costa County General Plan Policy for Agricultural Lands and Delta Protection Commission Land Use Plan Principles for Agriculture and Recreation

Implementation of Alternative 3 would convert approximately 9,588 acres of farmland (prime and unique farmland, and farmland of statewide and local importance) on Webb and Holland Tracts to water storage use (Table 4.8-5). Impacts due to agricultural land conversion under Alternative 3 would be greater than under Alternative 2 because under Alternative 3 no crops would be planted on Holland Tract or Bouldin Island, although as part of the Project's environmental commitments (Chapter 2, "Project Description"), agricultural conservation easements would be placed on Bouldin Island and Holland Tract.

Agricultural land conversion is not consistent with Contra Costa County's or the DPC's agricultural principles to preserve agricultural lands for agricultural production and promote a competitive agricultural economy for the reasons discussed under Impact LU-1 and presented in Table 4.8-7. Although the inherent agricultural productivity of the islands would not be significantly changed by use of agricultural land for water storage, the proposed use is not consistent with these general plan principles. Additionally, as discussed above, the construction of the new recreation facilities on the Project islands may be inconsistent with the DPC's recreation principle for private, water-oriented commercial recreational facilities. This impact is considered significant and unavoidable.

Mitigation

No mitigation is available to reduce this impact to a less-than-significant level.

Long-Term Conversion of Agricultural Land

As previously noted, impacts on agricultural resources, including agricultural land conversion and production losses would be greater under this alternative than under Alternative 2. Under Alternative 3, no crops would be planted on Bouldin Island and Holland Tract as part of an HMP; therefore, agricultural resource impacts caused by land conversion on these islands would not be offset by agricultural production associated with habitat management as under Alternative 2 and no conservation easements would apply. Additionally, the 1,120 acres on Holland Tract excluded from the Project under Alternatives 2 and 1 would be converted to water storage uses under Alternative 3.

Agricultural resource impacts of Alternative 3 on Bacon Island and Webb Tract are the same as those described previously for Alternative 1.

Implementation of Alternative 3 would result in conversion to nonagricultural uses of an estimated 5,866 acres of farmland on Bouldin Island, including 5,812 acres designated by CDC as prime farmland (Table 4.8-5). This conversion of agricultural land would result in the loss of agricultural production from an estimated 4,933 acres under cultivation in 2008 (Table 4.8-2). Bouldin Island produces 11.7% of San Joaquin County's rice crop (based on 2007 countywide production levels), 5.0% of the county's corn crop, and 0.56% of the county's tomato crop. All agricultural production on Bouldin Island would be lost under Alternative 3.

Implementation of Alternative 3 would result in conversion to nonagricultural uses an estimated 4,141 acres of agricultural soils on Holland Tract, including 1,095 acres designated by CDC as prime farmland (Table 4.8-5). Conversion of agricultural land would result in the loss of an estimated 2,884 acres of pasture, based on 2008 conditions.

Impact LU-2: Direct Conversion of Agricultural Land

Alternative 3 would convert to nonagricultural uses an estimated 20,718 acres of farmland (prime and unique farmland, and farmland of statewide and local importance) on the four Project islands combined, including an estimated 16,777 acres of currently harvested cropland and pasture. This conversion amounts to approximately 5,769 acres more than would be converted under Alternatives 1 or 2.

The direct conversion of agricultural land on the Project islands includes conversion of an estimated 15,337 acres of land designated as prime farmland by CDC. This acreage represents approximately 3.5 % of the estimated 437,547 acres of prime farmland in the two counties combined in 2006 (California Department of Conservation 2006).

The conversion of 16,777 harvested acres of agricultural land (including pasture) represents conversion of approximately 1.7 % of the 956,021 harvested acres (excluding nonirrigated grazing lands) in Contra Costa and San Joaquin Counties in 2007. Production losses would be similar to, but greater than, the effects described previously for Alternative 1.

The direct conversion of an estimated 16,777 acres of farmland is considered significant because it is a substantial acreage and includes an estimated 15,337 acres of prime farmland.

As discussed under Alternative 2, the Project benefits would attenuate the adverse effects of converting prime and other farmlands to other uses. These would include enhancing in-Delta recreation opportunities, enhancing the sustainability of agriculture occurring in the place of use, enhancing the sustainability of agriculture within the Delta by improving the stability of the Project levees, and eventually restoring agriculture to the Project islands.

The direct conversion of agricultural land is considered a significant and unavoidable impact.

Mitigation
No feasible mitigation is available to reduce this impact to a less-than-significant level. Restoring Project lands to agricultural uses at the conclusion of the Project would ensure that permanent conversion of agricultural land and production could be avoided, however, it would not reduce the long-term conversion of prime and other farmlands during the 50-year life of the Project.

No-Project Alternative

The analysis of the No-Project Alternative, in relation to baseline conditions projected over the life of the Project, has been revised, relative to the 2001 FEIR and 2001 FEIS, in light of the new information calling into question the long-term sustainability of agriculture in the Delta, as discussed above.

Under the No-Project Alternative presented in the 2001 FEIR and 2001 FEIS, more intensive agricultural operations would be implemented on the four Project islands. An agricultural consultant made general recommendations concerning agricultural practices, land improvements, and cropping patterns that would improve the farming efficiency on the four Project islands (Jones & Stokes 2001b). However, given new information and recent conditions in the Delta (e.g., continued subsidence, increased levee vulnerability), it is reasonable to conclude that for the land use and agricultural resource impact analysis, were agriculture to be intensified under the No-Project Alternative, it likely would be short-lived. However, because these estimates cannot predict with confidence when the agricultural activities would cease to function on the Project islands, the 2001 FEIR and 2001 FEIS projections will not change for purposes of analysis in this Place of Use EIR.

In the short term, implementing the No-Project Alternative would increase the amount of land in agricultural production on the Project islands from approximately 16,741 acres (including pasture) (Table 4.8-2) under existing conditions to approximately 18,720 acres (Jones & Stokes 2001b). Increasing crop production would contribute to an increase in agricultural employment in Contra Costa and San Joaquin Counties, but it is likely that this would be a short-term gain. Because these estimates cannot predict with confidence when the agricultural activities would cease to function on the Project islands, the 2001 FEIR and 2001 FEIS projections will not change for purposes of analysis in this Place of Use EIR.

Although irrigation and drainage systems would be improved on the Project islands to provide for long-term agricultural production, implementation of the No-Project Alternative would not provide additional flood control benefit or create additional levee stability; and it may, as compared to baseline conditions, have a long-term deterioration of levee stability and an increase, although unquantifiable, in flood risk. Levee stability on the Project islands would continue to be as vulnerable to flood, seismic risk, and land subsidence as it is under existing conditions. As discussed in Section 4.3, “Flood Control and Levee Stability”, under the No-Project Alternative, maintenance practices would continue at their current levels as the local Reclamation Districts (RDs) strive to achieve the adopted PL84-99 standard as the preferred delta island levee geometry; however, the resources of local RDs are limited and are not always adequate to achieve or maintain compliance on an annual basis. Levee failure on subsided islands would impair or damage the islands’ agriculture as well as affect the salinity balance of the Delta, which in turn would threaten water conveyance to agricultural in the region and beyond (Trott 2007).

Additionally, lands would likely continue to subside, especially in the central and western Delta where the Project islands are located (Mount and Twiss 2005; Lund et al. 2007) and as such would continue to threaten the long-term sustainability of agriculture on the Project islands.

Given these considerations, it is unlikely that increasing agricultural production on the Project islands under the No-Project Alternative would benefit agriculture-related industries for any long-term period.

Section 4.9
Recreation and Visual Resources

Introduction

This section describes recent changes to the existing environmental conditions and regulatory setting of the Project area, summarizes the unchanged affected environment, and describes changed environmental effects related to recreation and visual resources for the Project. This section contains a review and update of the1995 DEIR/EIS air quality impact assessment, incorporated by reference in the 2001 FEIR. The recreation and visual resources impacts of the Project were analyzed most recently in the 2001 FEIS, which also served as a basis for this analysis.

The 2001 FEIR and 2001 FEIS concluded that the Project alternatives would affect recreation and visual resources in the vicinity of the four Project islands. Since that time, there have been no changes in the Project that result in new significant environmental effects or a substantial increase in the severity of previously identified significant effects on recreation and visual resources.

There have been minor changes in the regulatory setting since the 2001 FEIR and 2001 FEIS, but these changes do not alter the conclusions in the 2001 FEIR and 2001 FEIS regarding environmental effects on recreation and visual resources. The 2001 FEIR and 2001 FEIS "Recreation and Visual Resources" analysis has been updated here to update the Regulatory Setting. The additions to the regulatory setting and changes to the Project description as listed below are minor and do not change the impact analysis or mitigation for this Place of Use EIR.

Identification of the Project's specific places of use as part of the affected Project environment does not affect recreation and visual resources in any way that alters the conclusions of the 2001 FEIR and 2001 FEIS. There are no major unanalyzed impacts on these resources at the places of use; although any minor changes in the affected environmental and regulatory setting since the 2001 FEIR and 2001 FEIS do not alter the prior document's conclusions, such changes are addressed by the urban water management plan EIR of each affected place of use. The Project will not have any direct effects on recreation and visual resources in the places of use; the effects on recreation and visual resources, if any, associated with the provision of Project water to the places of use are addressed in Chapter 5, "Cumulative Impacts," and Chapter 6, "Growth-Inducing Impacts."

Summary of Impacts

Table 4.9-1 provides a summary and comparison of the impacts and mitigation measures for recreation and visual resources from the 2001 FEIR, 2001 FEIS, and this Place of Use EIR.

Table 4.9-1. Comparison between Delta Wetlands Project 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures for Recreation and Visual Resources

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
ALTERNATIVES 1 AND 2 *There are no differences between the 2010 Place of Use EIR Impacts and the 2001 FEIR and 2001 FEIS Impacts. The revised numbering is reflected below.*	
Impact J-1: Increase in Recreation Use-Days for Hunting in the Delta (B) **Mitigation:** No mitigation is required.	**Impact REC-1:** Increase in Hunting on the Project Islands (B and LTS) **Mitigation:** No mitigation is required.
Impact J-2: Change in Regional Hunter Success outside the Project Area (LTS) **Mitigation:** No mitigation is required.	**Impact REC-2:** Change in Regional Hunter Success Outside the Project Area (LTS) **Mitigation:** No mitigation is required.
Impact J-3: Increase in Recreation Use-Days for Boating in the Delta (B) **Mitigation:** No mitigation is required.	**Impact REC-3:** Increase in Recreation Use-Days for Boating in the Delta (B and LTS) **Mitigation:** No mitigation is required.
Impact J-4: Change in the Quality of the Recreational Boating Experience in Delta Channels (SU) **Mitigation Measure RJ-1:** Reduce the Number of Outward Boat Slips Located at Recreation Facilities	**Impact REC-4:** Change in the Quality of the Recreational Boating Experience in Delta Channels (LTS-M) **Mitigation Measure REC-MM-1:** Reduce the Size or Number of Recreation Facilities This mitigation measure has changed. It now calls for eliminating all recreation facilities on the Reservoir Islands and reducing the size or number of recreation facilities on the Habitat Islands by 70%.
Impact J-5: Increase in Recreation Use-Days for Other Recreational Uses in the Delta (B) **Mitigation:** No mitigation is required.	**Impact REC-5:** Increase in Recreation Use-Days for Other Recreational Uses in the Delta (B and LTS) **Mitigation:** No mitigation is required.
Impact J-6: Reduction in the Quality of Views of the Reservoir Island Interiors from Island Levees (LTS) **Mitigation:** No mitigation is required.	**Impact REC-6:** Reduction in the Quality of Views of the Bacon Island and Webb Tract Interiors from Island Levees (LTS) **Mitigation:** No mitigation is required.
Impact J-7: Potential Conflict with the Scenic Designation for Bacon Island Road (LTS) **Mitigation:** No mitigation is required.	**Impact REC-7:** Potential Conflict with the Scenic Designation for Bacon Island Road (LTS) **Mitigation:** No mitigation is required.

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
Impact J-8: Reduction in the Quality of Views of the Reservoir Islands from Adjacent Waterways and from the Santa Fe Railways Amtrak Line (SU) **Mitigation Measure RJ-1:** Reduce the Number of Outward Boat Slips Located at Recreation Facilities **Mitigation Measure J-1:** Partially Screen Proposed Recreation Facilities and Pump and Siphon Stations from Important Viewing Areas **Mitigation Measure J-2:** Design Levee Improvements, Siphon and Pump Stations, and Recreation Facilities and Boat Docks to Be Consistent with the Surrounding Landscape	**Impact REC-8:** Reduction in the Quality of Views of Bacon Island and Webb Tract from Adjacent Waterways and from the Santa Fe Railways Amtrak Line (SU) **Mitigation Measure REC-MM-1:** Reduce the Size or Number of Recreation Facilities This mitigation measure has changed. It now calls for eliminating all recreation facilities on the Reservoir Islands and reducing the size or number of recreation facilities on the Habitat Islands by 70%. **Mitigation Measure REC-MM-2:** Partially Screen Proposed Recreation Facilities and Pump and Siphon Stations from Important Viewing Areas **Mitigation Measure REC-MM-3:** Design Levee Improvements, Siphon and Pump Stations, and Recreation Facilities and Boat Docks to Be Consistent with the Surrounding Landscape
Impact J-9: Enhanced Views of Bouldin Island from SR 12 (B) **Mitigation:** No mitigation is required.	**Impact REC-9:** Enhanced Views of Bouldin Island from SR 12 (B and LTS) **Mitigation:** No mitigation is required.
Impact J-10: Reduction in the Quality of Views of the Habitat Islands from Adjacent Waterways (LTS-M) **Mitigation Measure RJ-1:** Reduce the Number of Outward Boat Slips Located at Recreation Facilities **Mitigation Measure J-1:** Partially Screen Proposed Recreation Facilities and Pump and Siphon Stations from Important Viewing Areas **Mitigation Measure J-2:** Design Levee Improvements, Siphon and Pump Stations, and Recreation Facilities and Boat Docks to Be Consistent with the Surrounding Landscape	**Impact REC-10:** Reduction in the Quality of Views of the Habitat Islands from Adjacent Waterways (LTS-M) **Mitigation Measure REC-MM-1:** Reduce the Size or Number of Recreation Facilities This mitigation measure has changed. It now calls for eliminating all recreation facilities on the Reservoir Islands and reducing the size or number of recreation facilities on the Habitat Islands by 70%. **Mitigation Measure REC-MM-2:** Partially Screen Proposed Recreation Facilities and Pump and Siphon Stations from Important Viewing Areas **Mitigation Measure REC-MM-3:** Design Levee Improvements, Siphon and Pump Stations, and Recreation Facilities and Boat Docks to Be Consistent with the Surrounding Landscape
Impact J-11: Increase in Viewing Opportunities and the Quality of Views of Island Interiors and the Project Vicinity for Recreation Facility Members (B) **Mitigation:** No mitigation is required.	**Impact REC-11:** Increase in Opportunities for Recreation Facility Members to View Island Interiors and Other Areas in the Project Vicinity (B and LTS) **Mitigation:** No mitigation is required.
ALTERNATIVE 3	
Impact J-12: Increase in Recreation Use-Days for Hunting in the Delta (B) **Mitigation:** No mitigation is required.	**Impact REC-1:** Increase in Recreation Use-Days for Hunting in the Delta (B and LTS) **Mitigation:** No mitigation is required.
Impact J-13: Increase in Recreation Use-Days for Boating in the Delta (B) **Mitigation:** No mitigation is required.	**Impact REC-3:** Increase in Recreation Use-Days for Boating in the Delta (B and LTS) **Mitigation:** No mitigation is required.

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
Impact J-14: Change in the Quality of the Recreational Boating Experience in Delta Channels (SU) **Mitigation Measure RJ-1:** Reduce the Number of Outward Boat Slips Located at Recreation Facilities	**Impact REC-4:** Change in the Quality of the Recreational Boating Experience in Delta Channels (LTS-M) **Mitigation Measure REC-MM-1:** Reduce the Size or Number of Recreation Facilities This mitigation measure has changed. It now calls for eliminating all recreation facilities on Bacon Island and Webb Tract, and reducing the size or number of recreation facilities on Bouldin Island and Holland Tract by 70%.
Impact J-15: Increase in Recreation Use-Days for Other Recreational Uses in the Delta (B) **Mitigation:** No mitigation is required.	**Impact REC-5:** Increase in Recreation Use-Days for Other Recreational Uses in the Delta (B and LTS) **Mitigation:** No mitigation is required.
Impact J-16: Reduction in the Quality of Views of Bacon Island and Webb Tract Interiors from Island Levees (LTS) **Mitigation:** No mitigation is required.	**Impact REC-6:** Reduction in the Quality of Views of Bacon Island and Webb Tract Interiors from Island Levees (LTS) **Mitigation:** No mitigation is required.
Impact J-17: Potential Conflict with the Scenic Designation for Bacon Island Road (LTS) **Mitigation:** No mitigation is required.	**Impact REC-7:** Potential Conflict with the Scenic Designation for Bacon Island Road (LTS) **Mitigation:** No mitigation is required.
Impact J-18: Reduction in the Quality of Views of Bacon Island and Webb Tract from Adjacent Waterways and from the Santa Fe Railways Amtrak Line (SU) **Mitigation Measure RJ-1:** Reduce the Number of Outward Boat Slips Located at Recreation Facilities **Mitigation Measure J-1:** Partially Screen Proposed Recreation Facilities and Pump and Siphon Stations from Important Viewing Areas **Mitigation Measure J-2:** Design Levee Improvements, Siphon and Pump Stations, and Recreation Facilities and Boat Docks to Be Consistent with the Surrounding Landscape	**Impact REC-8:** Reduction in the Quality of Views of Bacon Island and Webb Tract from Adjacent Waterways and from the Santa Fe Railways Amtrak Line (SU) **Mitigation Measure REC-MM-1:** Reduce the Size or Number of Recreation Facilities This mitigation measure has changed. It now calls for eliminating all recreation facilities on Bacon Island and Webb Tract, and reducing the size or number of recreation facilities on Bouldin Island and Holland Tract by 70%. **Mitigation Measure REC-MM-2:** Partially Screen Proposed Recreation Facilities and Pump and Siphon Stations from Important Viewing Areas **Mitigation Measure REC-MM-3:** Design Levee Improvements, Siphon and Pump Stations, and Recreation Facilities and Boat Docks to Be Consistent with the Surrounding Landscape
Impact J-19: Change in Views Southward from SR 12 (LTS) **Mitigation:** No mitigation is required.	**Impact REC-12:** Change in Views Southward from SR 12 (LTS) **Mitigation:** No mitigation is required.
Impact J-20: Reduction in the Quality of Views of Holland Tract from the Island Levee (LTS) **Mitigation:** No mitigation is required.	**Impact REC-13:** Reduction in the Quality of Views of Holland Tract from the Island Levee (LTS) **Mitigation:** No mitigation is required.

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
Impact J-21: Reduction in the Quality of Views of Bouldin Island and Holland Tract from Adjacent Waterways (SU) **Mitigation Measure RJ-1:** Reduce the Number of Outward Boat Slips Located at Recreation Facilities **Mitigation Measure J-1:** Partially Screen Proposed Recreation Facilities and Pump and Siphon Stations from Important Viewing Areas **Mitigation Measure J-2:** Design Levee Improvements, Siphon and Pump Stations, and Recreation Facilities and Boat Docks to Be Consistent with the Surrounding Landscape	**Impact REC-10:** Reduction in the Quality of Views of Bouldin Island and Holland Tract from Adjacent Waterways (SU) **Mitigation Measure REC-MM-1:** Reduce the Size or Number of Recreation Facilities This mitigation measure has changed. It now calls for eliminating all recreation facilities on Bacon Island and Webb Tract, and reducing the size or number of recreation facilities on Bouldin Island and Holland Tract by 70%. **Mitigation Measure REC-MM-2:** Partially Screen Proposed Recreation Facilities and Pump and Siphon Stations from Important Viewing Areas **Mitigation Measure REC-MM-3:** Design Levee Improvements, Siphon and Pump Stations, and Recreation Facilities and Boat Docks to Be Consistent with the Surrounding Landscape
Impact J-22: Increase in Opportunities for Recreation Facility Members to View Reservoir Island Interiors and Other Areas in the Project Vicinity (B) **Mitigation:** No mitigation is required.	**Impact REC-11:** Increase in Opportunities for Recreation Facility Members to View Island Interiors and Other Areas in the Project Vicinity (B and LTS) **Mitigation:** No mitigation is required.
Note: SU = Significant and unavoidable; LTS = Less than significant; LTS-M = Less than significant with mitigation; B = Beneficial.	

Summary of Changes, New Circumstances, and New Information

Changes that potentially may affect the affected environment, regulatory setting, or environmental effects of the Project on recreation and visual resources are described in the Existing Conditions section below. The following section is a summary of findings based on that consideration.

Substantial Changes in the Project

Since the 2001 FEIR and 2001 FEIS were completed, there have been no substantial changes in the Project resulting in new significant effects or substantial increase in the severity of effects on recreation and visual resources.

As described in Chapter 3, "Project Operations," changes have been made to the Project regarding timing of water diversion and export under Alternatives 1 and 2, which have increased the frequency of anticipated shallow-water wetland conditions on the Reservoir Islands. Shallow-water wetland conditions increase the opportunities for waterfowl hunting, resulting in an increase in available hunter-use days. As shown in Tables 4.9-2 and 4.9-3 (which replace Tables 3J-3 and 3J-4 from the 2001 FEIS, respectively), shallow-water wetland conditions will result in 750 hunter-use days per year on the Reservoir Islands. This represents a 5% increase in total estimated annual hunter-use days on Habitat and Reservoir Islands under Alternatives 1 and 2. This increase in annual hunter-use days does not substantially affect the impact analysis for recreation and visual resources.

New Circumstances

Since the 2001 FEIR and 2001 FEIS, there have been no new circumstances that result in new significant effects or substantial increase in the severity of effects on recreation and visual resources.

New Information

There is no new information that would result in new significant effects or a substantial increase in severity of effects on recreation and visual resources.

None of the mitigation measures or alternatives considered in the 2001 FEIR and 2001 FEIS as infeasible has since been found feasible. Also, there are no new or considerably different mitigation measures or alternatives that would substantially reduce previously identified impacts on recreation and visual resources.

Table 4.9-2. Estimated Maximum Number of Hunter Use-Days for the Shallow-Water Wetland Condition on the Reservoir Islands under Alternative 2

	Acres of Shallow-Water Wetlands[a]	Hunter Density (acres per hunter)[b]	Maximum Number of Hunters	Maximum Allowable Hunting Days[c]	Average Percent Frequency of Shallow-Water Wetland Condition[d]	Estimated Annual Maximum Hunter Use-Days	Estimated Annual Participation as a Percentage of Capacity[e]	Estimated Annual Hunter Use-Days
Bacon Island								
October	3,694	30	123	9	65	720		
November	3,694	30	123	30	100	3,690		
December	3,694	30	123	31	65	2,479		
January	3,694	30	123	16	40	788		
Subtotal						7,677	30	2,203
Webb Tract								
October	3,836	30	128	9	75	864		
November	3,836	30	128	30	100	3,840		
December	3,836	30	128	31	70	2,778		
January	3,836	30	128	16	45	922		
Subtotal						8,404	30	2,521
Total								**4,824**

[a] Jones & Stokes Associates 1993.

[b] Jones & Stokes Associates 1993; Forkel pers. comm. 2010.

[c] California Department of Fish and Game 1993.

[d] Values based on averages of maximum and minimum acreages of available shallow-water wetlands during Project years. Methods used to derive percentages are described in Chapter 3, Project Operations.

[e] Estimate of 30% based on possible marginal quality of waterfowl foraging habitat that would attract low numbers of waterfowl; consequently, hunter attendance would be significantly lower than on habitat islands.

Table 4.9-3. Estimated Maximum Number of Hunter Use-Days for Full--Storage Conditions on the Reservoir Islands under Alternative 2

	Total Island Acreage	Hunter Density (acres per hunter)[a]	Maximum Number of Hunters	Maximum Allowable Hunting Days[b]	Average Percent Frequency of Full-Storage Conditions[c]	Estimated Annual Maximum Hunter Use-Days	Estimated Annual Participation as a Percentage of Capacity[d]	Estimated Annual Hunter Use-Days
Bacon Island								
October	5,539	30	185	9	35	394		
November	5,539	30	185	30	0	0		
December	5,539	30	185	31	35	2,008		
January	5,539	30	185	16	60	1,776		
Subtotal						4,179	15	626
Webb Tract								
October	5,470	30	182	9	25	410		
November	5,470	30	182	30	0	0		
December	5,470	30	182	31	30	1,693		
January	5,470	30	182	16	55	1,602		
Subtotal						3,705	15	556
Total								**1,182**

[a] Jones & Stokes Associates 1993; Forkel pers. comm. 2010.

[b] California Department of Fish and Game 1993.

[c] Values based on averages of maximum and minimum acreages of available shallow-water wetlands during Project years. Methods used to derive percentages are described in Chapter 3, Project Operations.

[d] Participation in hunting is predicted to be half of that estimated for reservoir islands during shallow-water wetland periods. (Forkel pers. comm. 2010.)

Existing Conditions

This section discusses changes in the existing conditions or regulatory setting since the 2001 FEIR and 2001 FEIS. There have been no major changes in the existing conditions and environmental effects since the 2001 FEIR and 2001 FEIS. The only changes that have occurred are regulatory in nature and would not affect the impact analysis or mitigation measures. Such changes include:

- new state regulations,
- new recreation policies in the county general plans, and
- updated information pertaining to visual resources from the county general plan policies.

Regulatory Setting

The following are state and local regulations related to recreation and visual resources.

Federal

Federal Water Project Recreation Act

The Federal Water Project Recreation Act requires federal agencies with authority to approve water projects to include recreation development as a condition of approving permits. Recreation development must be considered along with any navigation, flood control, reclamation, hydroelectric, or multipurpose water resource project. The act states that "consideration should be given to opportunities for outdoor recreation and fish and wildlife enhancement whenever any such project can reasonably serve either or both purposes consistently."

The Project proposes new water-based recreation facilities and features. Recreation effects are discussed under Environmental Effects, below.

State

Land Use and Resource Management Plan for the Primary Zone of the Delta

Recreation

The Environmental section of the Land Use and Resource Management Plan for the Primary Zone of the Delta (LURMP) acknowledges how permanent flooding can have an adverse effect on recreational activities while recreational activities can have an adverse effect on habitat, and includes findings, policies, and recommendations to balance these effects. The Land Use section of the LURMP includes findings, policies, and recommendations to support the promotion of recreation in appropriate locations. The Water section of the LURMP includes findings, policies, and recommendations to protect the long-term water quality in the Delta, in addition to other reasons, for recreation. The Recreation and Access section of the LURMP identifies the Delta as a region that is unique and well noted for its water-oriented recreation. This section includes findings, policies, and recommendations to promote and protect recreational uses in the Delta (Delta Protection Commission 1995).

Visual

The LURMP does not include findings, policies, or recommendations related to protecting or preserving visual resources in the Delta. There are no roadways in the Project vicinity that are designated in state plans as a scenic highway worthy of protection for maintaining and enhancing scenic viewsheds. Accordingly, California Scenic Highway Program guidelines do not apply.

Local

Bacon and Bouldin Islands are located in San Joaquin County, and Webb and Holland Tracts are located in Contra Costa County. The local regulations established by San Joaquin and Contra Costa Counties that pertain to the islands that fall within their respective boundaries are described below.

Contra Costa County General Plan

Recreation

The Land Use Element identifies goals and policies for development and project design that reinforce the aesthetic character of the county, encourage the uniqueness of its communities, and enhance scenic quality. The Project area falls within the Primary Zone of the Delta and Bethel Island Area. The Primary Zone of the Delta is protected under the LURMP, adopted and amended by the DPC. The Bethel Island Area is protected under the goals and policies of the General Plan, Policies for the Primary Zone of the Delta and Policies for the Bethel Island Area, to preserve and enhance the rural and recreational quality of the area. In addition, Project Islands Webb Tract and Holland Tract are identified as having Delta Recreation land use category and are designated as such because of their periodic flooding and potential recreational values due to proximity to Delta waterways and ability to support low intensity uses. These lands are subject to development restrictions set by their designation. (Contra Costa County 2005: 3-37 to 3-39.)

The Transportation and Circulation Element, Scenic Routes section of the general plan requires that scenic routes be planned to access recreational areas, and recreation is encouraged along these routes, where appropriate. In the Project area, Jersey Island and Bethel Island Roads are designated as county scenic routes under the Transportation and Circulation Element. (Contra Costa County 2005: 5-20 to 5-22.)

The Public Facilities and Services Element, Drainage and Flood Control section of the general plan includes goals and policies to enhance recreation on local waterways and ensure that effects on recreation are taken into account when evaluating alternative drainage system improvements. (Contra Costa County 2005: 7-20 to 7-21.)

The Conservation Element, Water Resources section of the general plan includes goals and policies to enhance public accessibility and recreational use of waterways and to retain waterways in their natural state to maintain their recreational values. (Contra Costa County 2005: 8-45.)

The Open Space Element, Parks and Recreation Facilities section of the general plan includes goals and policies to protect recreation resources in the county. It specifies that outdoor public recreation areas can be used for promoting scenic areas. Private recreational facilities, such as marinas in the Delta, also are protected by the plan. The Bethel Island Area is proposed for multi-use recreation development. Franks Tract State Park and Jersey Island Management Area are identified as existing open space areas whose major purpose is to "project the uniqueness of these lands through passive recreational activities and habitat uses that do not require substantial facilities." (Contra Costa County 2005: 9-7 and 9-12 to 9-6.)

Visual

The Land Use Element identifies goals and policies for development and project design that reinforce the aesthetic character of the county, encourage the uniqueness of its communities, and enhance scenic quality. The Project area falls within the Primary Zone of the Delta and Bethel Island Area. The Primary Zone of the Delta is protected under the LURMP, adopted and amended by the Delta Protection Commission. As described above, the Bethel Island Area is protected under the goals and policies of the General Plan, Policies for the Primary Zone of the Delta and Policies for the Bethel Island Area, to preserve and enhance the rural and recreational quality of the area that in turn act to protect the visual resources in the Bethel Island Area. (Contra Costa County 2005: 3-37 to 3-39.)

The Transportation and Circulation Element, Scenic Routes section of the general plan designates scenic routes that have rural and natural scenic qualities that should be protected. In the Project area, Jersey Island and Bethel Island Roads are designated as county scenic routes and are worthy of protection under Transportation and Circulation Element goals and policies. (Contra Costa County 2005: 5-20 to 5-22.)

The Public Facilities and Services Element, Drainage and Flood Control section of the general plan includes goals and policies to ensure that aesthetic effects are taken into account when evaluating alternative drainage system improvements. (Contra Costa County 2005: 7-20 to 7-21.)

The Conservation Element, Vegetation and Wildlife section of the general plan includes goals and policies to protect Rare, Threatened, and Endangered species that, in addition to other parameters, have aesthetic qualities. The Water Resources section of the general plan includes goals and policies to enhance public accessibility of waterways and to retain waterways in their natural state to maintain their aesthetic values. (Contra Costa County 2005: 9-7 and 8-45.)

As detailed in the Open Space Element, Scenic Resources section of the general plan, preserving the scenic resources of Contra Costa County is an important general plan goal. Particular focus is paid to scenic ridges, hillsides, and rock outcroppings and the Bay-Delta estuary system. The scenic vistas are major contributors to the perception that the county is a desirable place to live and work. Preserving the quality of visually sensitive features of the landscape reinforces the rural landscape character and balances the effects of development. The Delta tributaries and Franks Tract are designated as Scenic Waterways in this element. The Open Space Element of the general plan identifies goals and policies for preserving and protecting areas of high scenic value, including scenic qualities of the shorelines and other elements of the Bay and Delta estuary systems, and scenic ridges, hillsides, and rock outcroppings. (Contra Costa County 2005: 9-4 to 9-6.)

San Joaquin County General Plan

Recreation

The Community Development, Public Facilities section identifies waterways of the Delta as an important part of the county's recreational assets and includes goals and policies to protect them. Potato, White, Disappointment, South Spud Island, Light II, Connection, and Latham Sloughs and Middle River are identified in the general plan as significant recreation resource areas, namely for their scenic channel islands and riparian vegetation. (San Joaquin County 1992: IV-113 to IV-118.)

The Resources, Open Space section includes goals and policies for the projection of open space lands for, among other things, the enjoyment of recreation and protection of natural resources (San Joaquin County 1992: VI-1 to VI-8). The Water Resources and Quality section includes goals and policies to ensure water quantity and quality for recreational resources (San Joaquin County 1992: VI-24). In addition, the Vegetation, Fish, and Wildlife Habitat section acknowledges the recreational value of such resources, especially in the Delta, and includes goals and policies to protect these resources from adverse effects of overuse (San Joaquin County 1992: VI-29 to VI-33).

Visual

The river corridors, groves of valley oak trees, wetlands in the Delta, and sloping foothills and ridges of the Diablo Range and the Sierra Nevada are the key visual resources in the San Joaquin County landscape. The Delta waterways and marshlands are considered important visual features because they provide a contrasting visual element to the large tracts of agricultural land that are common in the county (San Joaquin County 1992).

San Joaquin County has designated as scenic routes roads that lead to recreation areas, exhibit scenery with agricultural or rural values or topographic interest, provide access to historical sites, or offer views of waterways (San Joaquin County 1992). In the Project area, these roads include Lower Roberts Island, Bacon Island, Eight Mile, and Empire Tract Roads (San Joaquin County 1992: VI-6). Figure IV-2 in the Public Facilities, Recreation Section of the Community Development chapter of the general plan identifies the following waterways that are adjacent to the Project islands as Significant Recreation Resource Areas: Potato, White, Connection, and Latham Sloughs and Middle River. Protection and maintenance of these areas for high-quality recreation is an important general plan goal (San Joaquin County 1992).

The Land Use Element and Open Space and Recreation Element of the general plan include several policies for protecting, enhancing, and mitigating effects of development on visual resources in the county, including Delta waterways (San Joaquin County 1992).

Affected Environment

Existing recreation and visual resource conditions are largely as they were presented in the 2001 FEIR and 2001 FEIS and are hereby incorporated by reference. Summaries of these conditions are presented below.

Recreation Resources

The primary unit of measurement of recreation use is the recreation use-day, which represents participation by one individual in a recreational activity during any portion of a 24-hour period. Participation in hunting, fishing, or boating by one individual during a 24-hour period represents 1 recreation use-day. Participation in all three activities during a 24-hour period represents 3 recreation use-days.

Recreational Uses in the Region

The Delta is generally bounded by the cities of Sacramento, Stockton, Tracy, and Pittsburg. Delta recreation is supported by these major population centers and the Bay Area in general. Recreation use in the Delta exceeds 12 million user days annually. Boating is the most popular recreation activity in the Delta, followed by fishing (not including boating), and finally, hunting. According to the DPC, the popularity of hunting has continued to decline in California with the number of resident hunting licenses issued down 61% between 1970 and 1998. However, the demand for recreation opportunities in the Delta is expected to increase as a result of increased population, higher incomes, and increased numbers of retirees.

Approximately 120 commercial recreation facilities exist in the Delta, including at least 100 marinas. Delta marinas provide services to regional boaters that include temporary and permanent boat berthing, mooring, and dry storage. Most marinas operate at 50%–90% capacity. Other commercial facilities include resorts, restaurants with guest docks, and recreational vehicle parks. Also in the Delta are public recreation facilities that include areas or facilities for boat launching, camping, fishing access, swimming, and picnicking.

On many privately owned Delta islands, owners and their guests hunt waterfowl on agricultural lands. Most of the private hunting clubs in the Delta are small, accommodating between eight and 16 hunters on a typical shoot day. Landowners manage private hunting clubs on Delta islands that in some cases are no longer in agricultural production.

Recreational Uses on the Project Islands

Bacon Island

No waterfowl hunting takes place on Bacon Island. Pheasant hunting is permitted by invitation only and is limited primarily to on-site workers and their families. The total number of hunting recreation use-days per season is estimated at 100.

Approximately 90% of the fishing on Bacon Island takes place adjacent to the county road, which is the only means of public access. Although there are no designated public access areas along the roadway for fishing, members of the public fish Middle River from the island perimeter levee adjacent to Bacon Island Road. No other areas of Bacon Island are accessible to the public. Therefore, fishing from other parts of the island (i.e., away from the county roadway) is limited to relatives and employees of property owners, and trespassers in those areas are asked to leave. Total fishing activity is estimated at 3,120 recreation use-days per year on Bacon Island.

Although there are no marinas or boat docks on Bacon Island, about 35% of the anglers use boats to gain access to Delta waterways adjacent to Bacon Island. The remaining anglers (approximately 65%) fish from the levee adjacent to the county road.

Webb Tract

No public hunting takes place on Webb Tract; hunting is limited to family and friends of the owners. Waterfowl hunting use is estimated at 320 recreation use-days per season. There is some private pheasant hunting, limited to friends and family of property owners, that amounts to about 320 recreation use-days per season.

Written permission from the property owners is required for fishing on Webb Tract. Anglers occasionally fish the northern blowout pond on Webb Tract. Fishing activity on Webb Tract totals approximately 90 recreation use days per year. No boating activity originates from Webb Tract.

Bouldin Island

Waterfowl hunting on Bouldin Island is limited to invited guests, totaling approximately 150 hunting recreation use-days per year. Hunting facilities on the island consist of a building used to store waterfowl hunting equipment. Pheasant hunting on Bouldin Island also is limited to invited guests and totals about 60 hunting recreation use-days per year.

On-site workers who fish from levees account for most of the fishing on Bouldin Island. Written permission is needed for others visiting the island. Fishing activity averages two anglers per day, for a total of about 360 fishing recreation use-days per season. No boating originates from Bouldin Island.

Holland Tract

One landowner on Holland Tract accommodates for-fee hunting, which constitutes approximately 80% of the waterfowl hunting on this property. The remainder consists of hunting by friends and family of the landowner. Approximately two people hunt per day, for a total of about 50 hunting recreation use-days per season for waterfowl. Other property owners on Holland Tract either do not allow hunting or limit hunting to members of their immediate families. Total waterfowl hunting per season on these properties totals about 10–15 recreation use-days. Pheasant hunting takes place primarily on the west side of Holland Tract. Hunters are charged a fee to visit the island. Approximately 20% of all hunting is non-fee hunting that is limited to friends and family of the landowner. The island generates approximately 30 hunting recreation use-days per season for pheasant. An estimated 80% of the hunters make day trips, and approximately 20% stay overnight in the local area. Approximately half the overnight users stay in hotels, and the other half stay in campgrounds. Hunting facilities on Holland Tract consist of a building used as a clubhouse.

Most fishing on Holland Tract originates from two marinas on the south end of the island. Marina tenants generate an estimated 4,000 fishing recreation use-days per year. Fishing activities associated with the launch ramp (day-use boaters) account for another 4,500–7,700 fishing recreation use-days annually. Fishing from the levees accounts for approximately 200 fishing recreation use-days per year. Total fishing on Holland Tract thus ranges from 8,700 to 11,900 recreation use-days annually.

Two marinas located on Holland Tract presently support recreational boating near the island. The larger marina, located on the southeastern corner of the island, accommodates 235 boats more than 26 feet long and 100 boats less than 20 feet long. Boat slip occupancy at this marina averages approximately 85%, with the summer months being especially busy. Boat slips account for an estimated 24,100 boating recreation use-days per season.

The larger marina also has other facilities, including a fuel dock, a snack shack, a launch ramp, and a 500-foot guest dock. The launch ramp is used by day-use boaters. The launch ramp generates an estimated additional 22,750–38,500 boating recreation use-days per season at Holland Tract. Most launch ramp use is related to waterskiing. Approximately 20% of the launch ramp boating activity is related to fishing.

The other marina on Holland Tract, located on the south shore, has a 21-berth capacity. Total boating generated by this facility is estimated at 1,500 recreation use-days per season.

Visual Resources

The Visual Resources in the Delta Region discussion below describes the current setting of the Project area. The purpose of this information is to establish the existing environmental context against which the reader can understand the environmental changes caused by the Project. The environmental setting information is intended to be directly or indirectly relevant to the subsequent discussion of impacts. For example, the setting identifies groups of people, such as boaters, drivers, and train riders, who have views of the Project area because the action could change their views and experiences.

Concepts and Terminology

Identifying a project area's visual resources and conditions involves three steps:

1. objective identification of the visual features (visual resources) of the landscape;
2. assessment of the character and quality of those resources relative to overall regional visual character; and
3. determination of the importance to people, or *sensitivity*, of views of visual resources in the landscape.

The aesthetic value of an area is a measure of its visual character and quality, combined with the viewer response to the area (Federal Highway Administration 1988). Scenic quality can best be described as the overall impression that an individual viewer retains after driving through, walking through, or flying over an area (U.S. Bureau of Land Management 1980). Viewer response is a combination of viewer exposure and viewer sensitivity. Viewer exposure is a function of the number of viewers, number of views seen, distance of the viewers, and viewing duration. Viewer sensitivity relates to the extent of the public's concern for a particular viewshed. These terms and criteria are described in detail below.

Visual Character

Natural and artificial landscape features contribute to the visual character of an area or view. Visual character is influenced by geologic, hydrologic, botanical, wildlife, recreational, and urban features. Urban features include those associated with landscape settlements and development, including roads, utilities, structures, earthworks, and the results of other human activities. The perception of visual character can vary significantly seasonally, even hourly, as weather, light, shadow, and elements that compose the viewshed change. The basic components used to describe visual character for most visual assessments are the elements of form, line, color, and texture of the landscape features (U.S. Forest Service 1995;

Federal Highway Administration 1988). The appearance of the landscape is described in terms of the dominance of each of these components.

Visual Quality

Visual quality is evaluated using the well-established approach to visual analysis adopted by Federal Highway Administration, employing the concepts of vividness, intactness, and unity (Federal Highway Administration 1988; Jones et al. 1975), which are described below.

- Vividness is the visual power or memorability of landscape components as they combine in striking and distinctive visual patterns.
- Intactness is the visual integrity of the natural and human-built landscape and its freedom from encroaching elements; this factor can be present in well-kept urban and rural landscapes, and in natural settings.
- Unity is the visual coherence and compositional harmony of the landscape considered as a whole; it frequently attests to the careful design of individual components in the landscape.

Visual quality is evaluated based on the relative degree of vividness, intactness, and unity, as modified by its visual sensitivity. High-quality views are highly vivid, relatively intact, and exhibit a high degree of visual unity. Low-quality views lack vividness, are not visually intact, and possess a low degree of visual unity.

Visual Exposure and Sensitivity

The measure of the quality of a view must be tempered by the overall sensitivity of the viewer. Viewer sensitivity or concern is based on the visibility of resources in the landscape, proximity of viewers to the visual resource, elevation of viewers relative to the visual resource, frequency and duration of views, number of viewers, and type and expectations of individuals and viewer groups.

The importance of a view is related in part to the position of the viewer to the resource; therefore, visibility and visual dominance of landscape elements depend on their placement within the viewshed. A viewshed is defined as all of the surface area visible from a particular location (e.g., an overlook) or sequence of locations (e.g., a roadway, trail) (Federal Highway Administration 1988). To identify the importance of views of a resource, a viewshed must be broken into distance zones of foreground, middleground, and background. Generally, the closer a resource is to the viewer, the more dominant it is and the greater its importance to the viewer. Although distance zones in a viewshed may vary between different geographic regions or types of terrain, the standard foreground zone is 0.25–0.5 mile from the viewer, the middleground zone from the foreground zone to 3–5 miles from the viewer, and the background zone from the middleground to infinity (U.S. Forest Service 1995).

Visual sensitivity depends on the number and type of viewers and the frequency and duration of views. Visual sensitivity also is modified by viewer activity, awareness, and visual expectations in relation to the number of viewers and viewing duration. For example, visual sensitivity is generally higher for views seen by people who are driving for pleasure; people engaging in recreational activities such as hiking, biking or camping; and homeowners. Sensitivity tends to be lower for views seen by people driving to and from work or as part of their work (U.S. Forest Service 1995; Federal Highway Administration 1988; U.S. Soil Conservation Service 1978). Commuters and nonrecreational travelers have generally fleeting views and tend to focus on commute traffic, not on surrounding scenery; therefore, they generally are considered to have low visual sensitivity. Residential viewers typically have extended viewing periods and are concerned about changes in the views from their homes; therefore, they generally are considered to have high visual sensitivity. Viewers using recreation trails and areas, scenic highways, and scenic overlooks usually are assessed as having high visual sensitivity.

Judgments of visual quality and viewer response must be made based in a regional frame of reference (U.S. Soil Conservation Service 1978). The same landform or visual resource appearing in different geographic areas could have a different degree of visual quality and sensitivity in each setting. For example, a small hill may be a significant visual element on a flat landscape but have very little significance in mountainous terrain.

Visual Resources in the Delta Region

The Delta is an extensive, largely agricultural region linking the Central Valley and the Bay Area. Views in the Delta are dominated by flat, open agricultural land and sloughs and rivers that are bordered by levees. Scattered trees occasionally break the horizon, but typical views encompass agricultural fields.

The Delta waterways are important visual features because they contribute to the visual character of the region by enhancing the vividness of views in the Delta. Because few roads traverse the Delta islands, the unique Delta landscape is accessible primarily by boat.

The visual resources associated with the four Project islands are typical of the region. Views of the Project islands from levee roads have some variety in form, line, color, and texture but are not unique to the region. The sensitivity of the visual resources of the four islands varies from island to island based on the wide variability in access to and travel patterns on the islands. The character of the views changes with the season, time of day, and weather, but the quality of the views is relatively uniform.

Bacon Island

Bacon Island is accessible only on its eastern side by a local levee road, Bacon Island Road. Views from the road toward the Bacon Island interior are dominated by intensely farmed agricultural open space with scattered woody vegetation, farm buildings, and rural residences. Mt. Diablo can be seen to the west from Bacon Island Road, providing a background visual element that enhances the vividness of the viewshed from Bacon Island Road. Except for the utility lines that run along the perimeter of Bacon Island, the views of the island from the road are generally intact. The views are not vivid, however, and are common for the region. The overall visual quality of the island bottom from Bacon Island Road is considered moderate.

San Joaquin County has designated Bacon Island Road as a scenic route because of its recreational access and use characteristics and its visual relationship to the adjacent waterway. The road carries a low volume of traffic, and the remainder of the island is largely inaccessible to the public. The visual resources on this island as viewed from Bacon Island Road are considered moderately sensitive because of the small number of visitors traveling the designated scenic route and the inaccessibility of the rest of the island interior.

Views of the Bacon Island levees from adjacent waterways consist of a variety of forms and colors created by changing elevations between the water level and the levee and by textural differences among the water, the marsh, and the riparian vegetation along the water side of the levees. The views from the waterways are vivid and relatively intact but are common to the region. The overall visual quality of the island viewsheds from the water is considered moderate.

A portion of Middle River along the east side of Bacon Island and a portion of Connection Slough bordering the island to the north are considered "significant resource areas for recreation" by San Joaquin County and are frequently used by boaters and anglers. Views of the island perimeter levees from these waterways therefore are considered highly sensitive.

The Santa Fe Railways Amtrak line immediately south of Bacon Island runs passenger trains between Stockton and Richmond, California. Views of the Bacon Island southern exterior levee from the train are similar to views of the levee from the adjacent waterway along the south side of Bacon Island (Santa Fe Cut). Views of Bacon Island from the railway are considered highly sensitive.

Webb Tract

Interior views of Webb Tract are dominated by agriculture, but the intensity of agricultural production on this island is low compared with that of Bacon Island. Webb Tract has more natural vegetation and high visual variability because of the scattered woody vegetation and blowout ponds. Views of the island bottom from the levee tops are vivid and intact because the visual resources vary and present a natural setting free from encroaching elements. The overall visual quality of resources on Webb Tract therefore is considered high.

Public access is more limited on Webb Tract than on any of the other Project islands. No bridges provide access to the island; it is accessible only by ferry. The number of visitors to the island is low; thus, the visual sensitivity of the Webb Tract landscape as viewed from perimeter levees and other parts of the island interior is considered low.

Views of Webb Tract from adjacent waterways are similar to those described above for Bacon Island. The views are generally intact and vivid but are common to the region. The overall visual quality of the landscape from the waterways is moderate.

Contra Costa County has designated all the waterways surrounding Webb Tract as scenic waterways. The Webb Tract perimeter levees as viewed from these waterways therefore are considered a highly sensitive visual resource.

Bouldin Island

Public access to the interior of Bouldin Island is limited to travelers crossing the island on SR 12. Views from SR 12 toward the interior of Bouldin Island are dominated by intensely farmed agricultural open space with scattered woody vegetation, farm buildings, and rural residential units. Utility lines cross the highway, detracting from the intactness of views of the island. The overall visual quality of Bouldin Island is considered moderate because the visual resources are somewhat intact but are not especially vivid, and because the views are common to the region.

Because Bouldin Island is visible to people from SR 12 and many of the viewers are recreationists in the Delta, visual sensitivity for part of the viewer group could be high. The duration of views for viewers along SR 12 is brief, however, because there are no vista points or rest areas on Bouldin Island from which to prolong the views. Therefore, the overall visual sensitivity is considered moderate for views of the island along SR 12. The views of Bouldin Island are not especially vivid and are common to the region, and SR 12 across the island is not considered eligible for designation as a scenic route. Therefore, the overall visual quality of Bouldin Island is considered moderate for views from SR 12.

Views of Bouldin Island from adjacent waterways are similar to those described above for Bacon Island. The overall visual quality of the landscape from the waterways is moderate; these views are generally intact and vivid but are common to the region. Potato Slough south of Bouldin Island is considered a resource area for recreation, so the south perimeter levee commonly is viewed by boaters and anglers. The Bouldin Island east perimeter levee is visible from marina facilities across Little Potato Slough on Terminous Tract, both north and south of SR 12. Views of these perimeter levees from the waterways are considered highly sensitive because many recreationists use these waterways.

Holland Tract

Public access to Holland Tract is limited to Holland Tract Road along the south levee. Views of Holland Tract from the road consist of agriculture fields and some fallow areas with established woody vegetation along the levee and toward the center of the island. This vegetation adds somewhat to the variety and texture of views and generally enhances the vividness of views of the island. The overall visual quality of resources on Holland Tract is considered moderate because the views are generally common to the region.

One small bridge at the southwest corner of Holland Tract provides access across Rock Slough to the marinas located on the southern levee; other parts of Holland Tract are inaccessible to the public. Furthermore, Holland Tract Road has no special local or state scenic corridor designation. Visual sensitivity of the Holland Tract landscape from the road therefore is considered moderate.

Views of Holland Tract from adjacent waterways include developed marina facilities on the southern and eastern side of the island and vegetated levees in other areas. The marina facilities that border Holland Tract for about 2/3 mile include covered and uncovered boat berths. Small ancillary buildings and covered berths are constructed partly using wood siding. Wood pilings in the water adjacent to one of the marinas are connected by a low narrow ridge of automobile tires. Because these view components generally disrupt the intactness and unity of views in marina areas, visual quality is low along the water side of the levees in the marina areas.

Views of Holland Tract from adjacent waterways away from the marinas are similar to those described above for the other Project islands. The views are generally intact and somewhat vivid but are common to the region; therefore, the overall visual quality of the landscape from the waterways is moderate.

Old River, which borders the eastern side of Holland Tract, and Roosevelt Cut and the flooded Franks Tract waters north of Holland Tract are designated as scenic waterways by Contra Costa County. Furthermore, these waters are frequented by boaters and anglers. The view of Holland Tract levees from these waterways therefore is considered highly sensitive.

Environmental Commitments

The environmental commitments, as described in Chapter 2, would not alter the impact findings related to recreation and visual resources.

Environmental Effects

Methods

The analytical approach, impact mechanisms, and significance criteria remain as presented in the 2001 FEIR and 2001 FEIS and are summarized below.

Significance Criteria

The recreation and visual resources impact analysis considered several criteria for determining the significance of impacts related to this resource. The analysis took into account both relevant criteria contained in Appendix G of the State CEQA Guidelines (Association of Environmental Professionals 2009) and Project-specific criteria developed by the lead agency to address potential impacts unique to the Project's location and elements.

Recreation Assessment and Criteria

Recreation impacts were evaluated by comparing changes in hunting, fishing and boating use that would occur under the Project alternatives with estimates of current recreational uses.

This analysis is based on the assumption that increased recreation opportunities in the Delta constitute beneficial impacts. An alternative is considered to have a significant impact on recreation if it would result in a substantial decrease in recreation use-days in the Delta or a substantial reduction in the quality of existing recreation experiences in the Delta.

Visual Resource Assessment and Criteria

The State CEQA Guidelines were used to determine whether the Project would have a significant environmental effect. A Project alternative is considered to have a significant impact on visual resources under CEQA if it would:

- cause a substantial, demonstrable negative aesthetic effect on a scenic vista or view open to the public have a substantial adverse effect on a scenic vista;
- substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway;
- substantially degrade the existing visual character or quality of the site and its surroundings; or
- create a new source of substantial light or glare that would adversely affect day or nighttime public views.

The Project is considered to have a beneficial impact on visual resources if it would improve the visual quality of views or if it would provide new viewing opportunities in the Project area.

Impacts and Mitigation Measures

The additions to the regulatory setting, and changes to the Project description as listed above are minor and do not affect the impact analysis or mitigation reported in the 2001 FEIR and 2001 FEIS. Impacts and mitigation measures from the 2001 FEIR and 2001 FEIS are listed and summarized below.

Proposed Project (Alternative 2)

Alternative 2 involves storage of water on Bacon Island and Webb Tract (Reservoir Islands) and management of Bouldin Island and Holland Tract (Habitat Islands) primarily for wildlife habitat. Reservoir islands would be managed principally for water storage, with wildlife habitat and recreation constituting secondary uses.

Implementation of Alternative 2 would include development of recreation facilities along the four Project island perimeter levees. These facilities would be run as a private operation and would provide year-round recreation opportunities at the Project islands.

Each recreation facility would include living quarters for as many as 80 people. Parking lots would be constructed at each facility along levee roads to allow vehicle access. A floating boat dock and gangway adjacent to each facility would provide boat access to island interiors along a network of ditches and canals. A similarly sized floating boat dock would be constructed on the slough or river side of the island levees to provide temporary and permanent boat berthing for members who likely would boat, waterski, and fish in Delta channels beyond the Project islands.

A general schedule of recreation facility use can be determined based on various factors. Boating and waterskiing in Delta channels would be expected to occur primarily during the warmer months of the year (mid-May to mid-September). Participation in sport fishing likely would occur primarily during February–November based on the expected presence of different fish species in the Delta. Participation in waterfowl and upland game hunting on the Project islands would take place mostly during October–January based on California hunting regulations. There would be some hunting during the first half of September for mourning dove. The Project applicant's proposed hunting program for the Habitat Islands is described in the HMP.

Other recreation activities at the Project islands could include but would not be limited to birdwatching, photography, skeet and trap shooting, relaxing, walking, nature study, windsurfing, swimming, and canoeing. Recreationists could participate in these activities for a fee or at the invitation of the Project applicant. Many of these activities could take place throughout the year, weather permitting.

Impact REC-1: Increase in Hunting on the Project Islands

As described in the 2001 FEIR and 2001 FEIS, implementation of Alternative 2 would result in a net increase of low- to medium-quality shallow-water wetland waterfowl habitat on Reservoir Islands during some years. All the Reservoir Island acreage would be in a water storage condition in some years. High-quality wintering waterfowl compensation habitat would be created on the Habitat Islands that would also support upland game. The combined habitats for waterfowl and upland game would increase annual hunting recreation use days in the Delta. Most other recreational uses (e.g., boating, fishing) occur during the summer and would not be affected by increases in hunting on the Project islands. This impact is considered beneficial and less than significant.

Mitigation

No mitigation is required.

Impact REC-2: Change in Regional Hunter Success outside the Project Area

As described in the 2001 FEIR and 2001 FEIS, the creation of wintering waterfowl compensation habitat on the Habitat Islands is expected to result in some redistribution of regional waterfowl populations to the Habitat Islands that may cause a decrease in hunter success outside the project area, especially in areas where wintering waterfowl habitat management and waterfowl hunting are secondary to other uses.

However, the decrease in hunter success outside the Project area likely would be offset by an increase in waterfowl populations that the Project attracts to the region. Also, during hunt days when waterfowl retreat from Habitat Islands to other areas in the Delta where they could be hunted outside the Project islands and as waterfowl forage in other areas as food sources diminish on Habitat Islands during the winter. Additionally, implementation of the HMP as part of Alternative 2 would include establishment of waterfowl breeding habitat that would be expected to increase numbers of waterfowl in the region. This impact is considered less than significant.

Mitigation
No mitigation is required.

Impact REC-3: Increase in Recreation Use-Days for Boating in the Delta

As described in the 2001 FEIR and 2001 FEIS, implementation of Alternative 2 would result in a net increase of annual boater use-days at Project build out. Sport fishing would occur primarily from February through November and most boating would occur during the warmer months. Although the Project would not contribute to relieving demands for public access to Delta waterways, implementing Alternative 2 would facilitate greater boating and fishing use in the Delta. Therefore, this impact is considered beneficial and less than significant.

Mitigation
No mitigation is required.

Impact REC-4: Change in the Quality of the Recreational Boating Experience in Delta Channels

As described in the 2001 FEIR and 2001 FEIS, implementation of Alternative 2 would increase boat congestion in Delta channels and alter existing boating conditions on waterways adjacent to the Project islands because new boat docks would require that boats traveling near boat docks maintain speeds of less than 5 mph. If all Project recreation facilities were constructed in waterways without existing speed restrictions, these facilities would place new speed limits on several miles of Delta waterways and could reduce the availability of areas that support waterskiing and other high speed water activities. An increase in the number of boaters in the Project vicinity could detract from the quality of the overall recreation experience for some people. Implementing Mitigation Measure REC-MM-1 would reduce the number of boat dock facilities as well as the number of boats originating from Project recreation facilities. This reduction in facilities would lessen impacts on the quality of the recreational boating experience in Delta channels to a less-than-significant level.

Mitigation Measure REC-MM-1: Reduce the Size or Number of Recreation Facilities

The Project will reduce the total number or size of recreation facilities proposed by removing all 22 facilities proposed for construction from Bacon Island and Webb Tract, and reducing the number or size of proposed facilities on Bouldin Island and Holland Tract by 70%. This will reduce the number of permanent boat docking spaces provided by the recreation facilities from 2,508 to 330 slips, and will result in an approximately 86% reduction in Project recreation facilities.

Impact REC-5: Increase in Recreation Use-Days for Other Recreational Uses in the Delta

As described in the 2001 FEIR and 2001 FEIS, implementation of Alternative 2 would increase opportunities for Delta recreational activities other than hunting, fishing, and boating such as relaxing, sightseeing, camping, picnicking, photography, and bicycling. This impact is considered beneficial and less than significant.

Mitigation

No mitigation is required.

Impact REC-6: Reduction in the Quality of Views of Bacon Island and Webb Tract Interiors from Island Levees

As described in the 2001 FEIR and 2001 FEIS, implementation of Alternative 2 would result in the conversion of the Bacon Island and Webb Tract interiors from agricultural use to open water or shallow-water wetland vegetation, improvements to existing levees, and the construction of recreation facilities, intake siphons, and discharge pumps along Project levees. These Project features would reduce the vividness and intactness of interior island views from existing island roads, but, as described above in the Affected Environment discussion, there are low numbers of sensitive viewers present on the Reservoir Islands. Therefore, this impact is considered less than significant.

Mitigation

No mitigation is required.

Impact REC-7: Potential Conflict with the Scenic Designation for Bacon Island Road

As described in the 2001 FEIR and 2001 FEIS, implementation of Alternative 2 would remove vegetation along project levees and introduce rock revetment, recreation facilities, and a siphon station facility that would be visible and change views from Bacon Island Road, a designated scenic corridor, toward the Project area. Access to recreation areas and views of other adjacent waterways, criteria for Bacon Island Road's scenic designation, would not be affected. Therefore, this impact is considered less than significant.

Mitigation

No mitigation is required.

Impact REC-8: Reduction in the Quality of Views of Bacon Island and Webb Tract from Adjacent Waterways and from the Santa Fe Railways Amtrak Line

Implementation of Alternative 2 would substantially reduce the intactness and unity of highly sensitive views of these island levees from adjacent waterways, including waterways around Bacon Island and Webb Tract that are designated as scenic, by removing vegetation and introducing rock revetment, siphon stations, pump stations, and recreation facilities along project levees. Views from the Santa Fe rail line along the south side of Bacon Island would be similarly affected. Implementation of Mitigation Measures REC-MM-1, REC-MM-2, and REC-MM-3 would reduce the severity of Impact REC-8, but not to a less-than-significant level. Therefore, this impact is considered significant and unavoidable.

Mitigation Measure REC-MM-1: Reduce the Size or Number of Recreation Facilities

This mitigation measure is described above, under Impact REC-4. Implementation of Mitigation Measure REC-MM-1 would eliminate all recreation facilities on Bacon Island and Webb Tract.

Mitigation Measure REC-MM-2: Partially Screen Proposed Recreation Facilities and Pump and Siphon Stations from Important Viewing Areas

The Project will, consistent with flood control and levee or facility maintenance requirements, establish screening that could consist of native trees, shrubs, landscape berms, and ground covers between the Project facilities and designated scenic waterways. Landscape berms near structures will provide partial screening and will better connect the buildings visually to the site and the area. Screening vegetation will be planted in locations and at a density that would provide at least a 50% visual screen after 5 years.

Mitigation Measure REC-MM-3: Design Levee Improvements, Siphon and Pump Stations, and Recreation Facilities and Boat Docks to Be Consistent with the Surrounding Landscape

The Project will require that pump and siphon station structures and recreation facilities be painted in earth tones to blend with the surrounding landscape. Rock revetment material will be selected to blend with the surrounding landscape. The Project will limit structure heights and emphasize horizontal features in its design. Boat docks and related structures will be constructed of natural appearing materials with subdued, earth-tone colors to blend in with the surrounding environment.

Impact REC-9: Enhanced Views of Bouldin Island from SR 12

Implementation of Alternative 2 would involve management of Bouldin Island for wildlife habitat, which would enhance the vividness of views from SR 12. This impact is considered beneficial and less than significant.

Mitigation

No mitigation is required.

Impact REC-10: Reduction in the Quality of Views of Bouldin Island and Holland Tract from Adjacent Waterways

Implementation of Alternative 2 would include construction of boat docks and related structures, which would introduce built elements into a generally intact landscape, reduce the quality of views of island levees from designated scenic and significant waterways, and reduce the unity and intactness of the highly sensitive views from adjacent channels. Therefore, this impact is considered significant.

Implementation of Mitigation Measures REC-MM-1, REC-MM-2, and REC-MM-3 would reduce Impact REC-10 to a less-than-significant level.

Mitigation Measure REC-MM-1: Reduce the Size or Number of Recreation Facilities

This mitigation measure is described above, under Impact REC-4.

Mitigation Measure REC-MM-2: Partially Screen Proposed Recreation Facilities and Pump and Siphon Stations from Important Viewing Areas

This mitigation measure is described above under Impact REC-8.

Mitigation Measure REC-MM-3: Design Levee Improvements, Siphon and Pump Stations, and Recreation Facilities and Boat Docks to Be Consistent with the Surrounding Landscape

This mitigation measure is described above under Impact REC-8.

Impact REC-11: Increase in Opportunities for Recreation Facility Members to View Island Interiors and Other Areas in the Project Vicinity

Implementation of Alternative 2 would provide increased access to the Project area through new recreation facilities on Reservoir Islands that would provide views to open water and wetland areas at or near Reservoir Islands. In addition, a complex mosaic of wildlife habitats would be established within the interiors of the Habitat Islands that would greatly enhance the vividness of views of the island interiors from the surrounding levees. Recreation facility members would benefit from these enhanced views. This impact is considered beneficial and less than significant.

Mitigation

No mitigation is required.

Alternative 1

The recreation program under this alternative is the same as under Alternative 2. Impacts and mitigation measures under Alternative 1 are the same as described above for Alternative 2.

Alternative 3

Impact REC-1: Increase in Hunting on Project Islands

As described in the 2001 FEIR and 2001 FEIS, implementation of Alternative 3 would result in a net increase of shallow-water wetland habitat on the four Project islands in some operating years and provide low- to medium quality waterfowl foraging habitat. High-quality wintering waterfowl foraging habitat in the NBHA would also be available for hunting. Water storage on Project islands would allow waterfowl to rest on the open water and possibly forage in shallow areas around the storage pool edges. The Project islands also support a net increase in annual recreation use-days in the Delta for waterfowl and upland game hunting. This impact is considered beneficial and less than significant.

Mitigation

No mitigation is required.

Impact REC-3: Increase in Recreation Use-Days for Boating in the Delta

As described in the 2001 FEIR and 2001 FEIS, implementation of Alternative 3 would result in a net increase of annual boater use-days at Project build out. This impact is considered beneficial and less than significant.

Mitigation

No mitigation is required.

Impact REC-4: Change in the Quality of the Recreational Boating Experience in Delta Channels

As described in the 2001 FEIR and 2001 FEIS, implementation of Alternative 3 would increase boat congestion in Delta channels and alter existing boating conditions on waterways adjacent to the Project islands. This impact is described above under Impact REC-4. Implementation of mitigation measure REC-MM-1 would reduce the severity of Impact REC-4 to a less-than-significant level.

Mitigation Measure REC-MM-1: Reduce the Size or Number of Recreation Facilities

This mitigation measure is described above, under Alternative 2.

Impact REC-5: Increase in Recreation Use-Days for Other Recreational Uses in the Delta

As described in the 2001 FEIR and 2001 FEIS, implementation of Alternative 3 would increase participation in other recreational activities in the Delta, support recreation use-days for other recreational activities, and provide accommodations to support these activities. This impact is considered beneficial and less than significant.

Mitigation

No mitigation is required.

Impact REC-6: Reduction in the Quality of Views of Bacon Island and Webb Tract Interiors from Island Levees

This impact is described above under Alternative 2. This impact is considered less than significant.

Mitigation

No mitigation is required.

Impact REC-7: Potential Conflict with the Scenic Designation for Bacon Island Road

This impact is described above under Alternative 2. This impact is considered less than significant.

Mitigation

No mitigation is required.

Impact REC-8: Reduction in the Quality of Views of Bacon Island and Webb Tract from Adjacent Waterways and from the Santa Fe Railways Amtrak Line

This impact is described above under Alternative 2. This impact is considered significant and unavoidable. Implementation of Mitigation Measures REC-MM-1, REC-MM-2, and REC-MM-3 would reduce the severity of Impact REC-8, but not to a less-than-significant level. This impact is significant and unavoidable.

Mitigation Measure REC-MM-1: Reduce the Size or Number of Recreation Facilities

This mitigation measure is described above, under Impact REC-4.

Mitigation Measure REC-MM-2: Partially Screen Proposed Recreation Facilities and Pump and Siphon Stations from Important Viewing Areas

This mitigation measure is described above under Alternative 2.

Mitigation Measure REC-MM-3: Design Levee Improvements, Siphon and Pump Stations, and Recreation Facilities and Boat Docks to Be Consistent with the Surrounding Landscape

This mitigation measure is described above under Alternative 2.

Impact REC-10: Reduction in the Quality of Views of Bouldin Island and Holland Tract from Adjacent Waterways

Implementation of Alternative 3 would remove vegetation along project levees and introduce rock revetment, recreation facilities, and siphon and pump station facilities along Bouldin Island and Holland Tract levees. These changes would substantially reduce the high quality of views from adjacent waterways and other recreation areas that are designated as scenic and sensitive by San Joaquin and Contra Costa Counties. Implementation of Mitigation Measures REC-MM-1, REC-MM-2, and REC-MM-3 would reduce the severity of Impact REC-10, but not to a less-than-significant level. This impact is considered significant and unavoidable.

Mitigation Measure REC-MM-1: Reduce the Size or Number of Recreation Facilities
This mitigation measure is described above under Impact REC-4.

Mitigation Measure REC-MM-2: Partially Screen Proposed Recreation Facilities and Pump and Siphon Stations from Important Viewing Areas.
This mitigation measure is described above under Alternative 2.

Mitigation Measure REC-MM-3: Design Levee Improvements, Siphon and Pump Stations, and Recreation Facilities and Boat Docks to Be Consistent with the Surrounding Landscape
This mitigation measure is described above under Alternative 2.

Impact REC-11: Increase in Opportunities for Recreation Facility Members to View Reservoir Island Interiors and Other Areas in the Project Vicinity

Implementation of Alternative 3 would provide increased access to the Project area through new recreation facilities on the Project islands that would provide views to open water and wetland areas at or near the islands. Members of recreation facilities located in the NBHA would benefit from the increased variation of habitat types created in this area. This impact is considered beneficial and less than significant.

Impact REC-12: Change in Views Southward from SR 12

As described in the 2001 FEIR and 2001 FEIS, implementation of Alternative 3 would substantially alter the viewshed south from SR 12 as it crosses Bouldin Island as a result of construction of a new levee parallel to the highway. Enhancement of habitat north of SR 12 would increase the vividness of views north of the highway.

However, the portion of SR 12 in the Project area is not designated by Caltrans or San Joaquin County as a scenic roadway. Therefore, this impact is considered less than significant.

Mitigation
No mitigation is required.

Impact REC-13: Reduction in the Quality of Views of Holland Tract from the Island Levee

Implementation of Alternative 3 would convert land use of the island floor from agriculture to open water or wetland vegetation; remove vegetation along project levees; and introduce rock revetment, recreation facilities, and a siphon station facility that would be visible and change views from the island levee.

Because the agricultural nature of Holland Tract is common to the region, the visual quality is considered moderate. The visual sensitivity is moderate because of limited access along the south side of the island. Therefore, this impact is considered less than significant.

Mitigation
No mitigation is required.

No-Project Alternative

The No-Project Alternative analysis remains largely as it was presented in the 2001 FEIR and 2001 FEIS and is hereby incorporated by reference. It is briefly summarized below.

Increase in Recreation Use-Days for Hunting in the Delta

Under the No-Project Alternative, an intensive for-fee hunting program would be operated on the Project islands. This program would generate approximately 12,000 additional recreation use-days, resulting in a 17% increase over the existing hunting recreation use-days in the Delta. Implementation of the No-Project Alternative would also contribute to a cumulative increase in recreation opportunities in the Delta.

Section 4.10
Traffic and Navigation

Introduction

This section describes recent changes to the existing environmental conditions and regulatory setting of the Project area, summarizes the unchanged affected environment, and describes changed environmental effects related to traffic and navigation for the Project. This section contains a review and update of the1995 DEIR/EIS traffic and navigation impact assessment, incorporated by reference in the 2001 FEIR. The traffic and navigation impacts of the Project were analyzed most recently in the 2001 FEIS, which also served as a basis for this analysis.

The 2001 FEIR and 2001 FEIS concluded that the Project alternatives would affect traffic and navigation on and in the vicinity of the four Project islands. Since that time, there have been minor changes in the affected environment and regulatory setting. However, there have been no changes in the Project that result in new significant environmental effects or a substantial increase in the severity of previously identified significant effects on traffic and navigation.

The 2001 FEIR and 2001 FEIS traffic and navigation analysis has been updated here to reflect existing conditions (2008); and to analyze future years 2012 (expected built-out year) and 2030 (long-range planning year). This section presents a summary of the transportation infrastructure and traffic conditions in the Project vicinity and addresses the impacts of the Project on the surrounding transportation system.

Most of the changes are in the affected environment and regulatory setting sections. The changes in the affected environment, revised traffic projections, and regulatory settings did not alter the 2001 FEIR and 2001 FEIS findings related to mitigation of Project impacts during operations; with the exception of the addition of Mitigation Measure TRA-MM-1, which requires development and implementation of a Traffic Control Plan. Mitigation Measure TRA-MM-1 is common practice and will further reduce identified less than significant construction-related traffic impacts.

Identification of the Project's specific places of use as part of the affected Project environment does not affect traffic and navigation in any way that alters the conclusions of the 2001 FEIR and 2001 FEIS. The Project will not have any direct effects on traffic and navigation in the places of use; the effects on traffic and navigation, if any, associated with the provision of Project water to the place of use are addressed in Chapter 5, "Cumulative Impacts," and Chapter 6, "Growth-Inducing Impacts."

Summary of Impacts

Table 4.10-1 presents a summary of the impacts and mitigation measures identified in the 2001 FEIR and 2001 FEIS and the differences in the Place of Use EIR as a result of the updated analysis.

Table 4.10-1. Comparison between Delta Wetlands Project 2010 Place of Use EIR Impacts and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures for Traffic and Navigation

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
ALTERNATIVES 1 AND 2	
Impact L-1: Increase in Traffic on Delta Roadways during Project Construction (LTS) **Mitigation:** No mitigation is required.	**Impact TRA-1:** Increase of Traffic and Roadway Level of Service Impact during Construction (LTS) Mitigation is not required, but the following will reduce Project impacts: **Mitigation Measure TRA-MM-1:** Develop and Implement a Traffic Control Plan. This is a new mitigation measure introduced to mitigate construction-related traffic impacts.
Impact L-2: Increase in Traffic on Delta Roadways during Project Operation (SU) **Mitigation RJ-1:** Reduce the Number of Outward Boat Slips Located at Recreation Facilities	**Impact TRA-2:** Increase of Traffic and Roadway Level of Service Impact during Operation (LTS) **Mitigation:** No mitigation is required. This impact is now considered less than significant.
Impact L-3: Creation of Safety Conflicts on Delta Roadways during Project Construction (LTS-M) **Mitigation Measure L-1:** Clearly Mark Intersections with Poor Visibility in the DW Project Vicinity	**Impact TRA-3:** Potential for Traffic Safety Conflicts during Construction (LTS-M) **Mitigation Measure TRA-MM-2:** Clearly Mark Intersections with Poor Visibility in the Project Vicinity No change.
Impact L-4: Reduction in Safety Conflicts on Delta Roadways during Project Operation (B) **Mitigation:** No mitigation is required.	**Impact TRA-4:** Potential for Traffic Safety Conflicts during Operation (NI) **Mitigation:** No mitigation is required. No change.
Impact L-5: Change in Circulation on or Access to Delta Roadways during Project Construction (LTS) **Mitigation:** No mitigation is required.	**Impact TRA-5:** Change in Circulation on or Access to Delta Roadways during Construction (LTS) **Mitigation:** No mitigation is required. No change.
Impact L-6: Change in Circulation on Delta Roadways during DW Project Operation. (LTS) **Mitigation:** No mitigation is required.	**Impact TRA-6:** Change in Circulation on or Access to Delta Roadways during Operation (LTS) **Mitigation:** No mitigation is required. No change.

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
Impact L-7: Increase in Boat Traffic and Congestion on Delta Waterways during DW Project Operation (SU) **Mitigation RJ-1:** Reduce the Number of Outward Boat Slips Located at Recreation Facilities	**Impact TRA-7:** Increase in Boat Traffic and Congestion on Delta Waterways during Operation (LTS-M) **Mitigation Measure REC-MM-1:** Reduce the Size or Number of Recreation Facilities. This mitigation would reduce impact to LTS. This impact has not changed. The mitigation measure was revised.
Impact L-8: Change in Navigation Conditions on Delta Waterways Surrounding the DW Project Islands during Project Operation (LTS) **Mitigation:** No mitigation is required.	**Impact TRA-8:** Change in Navigation Conditions on Delta Waterways Surrounding the Project Islands during Operation (LTS) **Mitigation:** No mitigation is required. No change.
Impact L-9: Creation of Safety Conflicts on Delta Waterways during Project Construction (LTS-M) **Mitigation Measure L-2:** Clearly Mark the Barge and Notify the U.S. Coast Guard of Construction Activities	**Impact TRA-9:** Creation of Safety Conflicts on Delta Waterways during Construction (LTS-M) **Mitigation Measure TRA-MM-3:** Clearly Mark the Barge and Notify the U.S. Coast Guard of Construction Activities No change.
Impact L-10: Increase in the Potential for Safety Problem on Waterways Surrounding the DW Project Islands (LTS-M) **Mitigation Measure L-3:** Clearly Post Waterway Intersections, Speed Zones, and Potential Hazards in the DW Project Vicinity	**Impact TRA-10:** Increase in the Potential for Safety Problem on Waterways Surrounding the Project Islands (LTS-M) **Mitigation Measure TRA-MM-4:** Clearly Post Waterway Intersections, Speed Zones, and Potential Hazards in the Project Vicinity No change.
ALTERNATIVE 3	
Impact L-11: Increase in Traffic on Delta Roadways during Project Construction (LTS) **Mitigation:** No mitigation is required.	**Impact TRA-1:** Increase of Traffic and Roadway Level of Service Impact during Construction (LTS) Mitigation is not required, but the following will reduce Project impacts: **Mitigation Measure TRA-MM-1:** Develop and Implement a Traffic Control Plan. This is a new mitigation measure introduced to mitigate construction-related traffic impacts.
Impact L-12: Increase in Traffic on Delta Roadways during Project Operation (SU) **Mitigation RJ-1:** Reduce the Number of Outward Boat Slips Located at Recreation Facilities	**Impact TRA-2:** Increase of Traffic and Roadway Level of Service Impact during Operation (LTS) **Mitigation:** No mitigation is required. This impact is now considered less than significant.
Impact L-13: Creation of Safety Conflicts on Delta Roadways during Project Construction (LTS-M) **Mitigation Measure L-1:** Clearly Mark Intersections with Poor Visibility in the DW Project Vicinity	**Impact TRA-3:** Potential for Traffic Safety Conflicts during Construction (LTS-M) **Mitigation Measure TRA-MM-2:** Clearly Mark Intersections with Poor Visibility in the Project Vicinity No change.
Impact L-14: Reduction in Safety Conflicts on Delta Roadways during Project Operation (B) **Mitigation:** No mitigation is required.	**Impact TRA-4:** Potential for Traffic Safety Conflicts during Operation (NI) **Mitigation:** No mitigation is required. No change.

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
Impact L-15: Change in Circulation on or Access to Delta Roadways during Project Construction (LTS) **Mitigation:** No mitigation is required.	**Impact TRA-5:** Change in Circulation on or Access to Delta Roadways during Construction (LTS) **Mitigation:** No mitigation is required. No change.
Impact L-16: Change in Circulation on Delta Roadways during Project Operation (LTS) **Mitigation:** No mitigation is required.	**Impact TRA-6:** Change in Circulation on or Access to Delta Roadways during Operation (LTS) **Mitigation:** No mitigation is required. No change.
Impact L-17: Increase in Boat Traffic and Congestion on Delta Waterways during DW Project Operation (SU) **Mitigation Measure RJ-1:** Reduce the Number of Outward Boat Slips Located at Recreation Facilities	**Impact TRA-7:** Increase in Boat Traffic and Congestion on Delta Waterways during Operation (LTS-M) **Mitigation Measure REC-MM-1:** Reduce the Size or Number of Recreation Facilities. This mitigation would reduce impact to LTS. This impact has not changed. The mitigation measure was revised.
Impact L-18: Change in Navigation Conditions on Delta Waterways Surrounding the DW Project Islands during Project Operation (LTS) **Mitigation:** No mitigation is required.	**Impact TRA-8:** Change in Navigation Conditions on Delta Waterways Surrounding the Project Islands during Operation (LTS) **Mitigation:** No mitigation is required. No change.
Impact L-19: Creation of Safety Conflicts on Delta Waterways during Project Construction (LTS-M) **Mitigation Measure L-2:** Clearly Mark the Barge and Notify the U.S. Coast Guard of Construction Activities	**Impact TRA-9:** Creation of Safety Conflicts on Delta Waterways during Construction (LTS-M) **Mitigation Measure TRA-MM-3:** Clearly Mark the Barge and Notify the U.S. Coast Guard of Construction Activities No change.
Impact L-20: Increase in the Potential for Safety Problem on Waterways Surrounding the DW Project Islands (LTS-M) **Mitigation Measure L-3:** Clearly Post Waterway Intersections, Speed Zones, and Potential Hazards in the DW Project Vicinity	**Impact TRA-10:** Increase in the Potential for Safety Problem on Waterways Surrounding the Project Islands (LTS-M) **Mitigation Measure TRA-MM-4:** Clearly Post Waterway Intersections, Speed Zones, and Potential Hazards in the Project Vicinity No change.

Note: SU = Significant and unavoidable; LTS = Less than significant; LTS-M = Less than significant with mitigation; B = Beneficial; NI = No impact.

Summary of Changes, New Circumstances, and New Information

Changes that potentially may concern the affected environment, regulatory setting, or environmental effects of the Project on traffic and navigation are described in the Existing Conditions and Impacts and Mitigation Measures sections below. A summary of findings based on that consideration follows.

Substantial Changes in the Project

Since the 2001 FEIR and 2001 FEIS were completed, there have been no substantial changes to the Project resulting in new significant effects or substantial increase in the severity of effects on traffic and navigation.

New Circumstances

Since the 2001 FEIR and 2001 FEIS were completed, there have been no new circumstances pertinent to the traffic and navigation analysis resulting in new significant effects or substantial increase in the severity of effects on traffic and navigation.

New Information

There is no new information of substantial importance that would result in an increased in severity of effects on traffic and navigation. However, since the publication of the 2001 FEIR and 2001 FEIS, various agencies have adopted a number of new plans and policies that affect the transportation system in the area. New studies have been conducted, and updated information became available regarding the use of the transportation system. The new information and data were incorporated in this revised traffic and navigation analysis.

More specifically, this section has been revised to include updated information as described below.

- The latest relevant plans and policies were reviewed to ensure that the methods used to analyze existing and future transportation conditions were appropriate. In particular, the revised analysis is consistent with adopted level of service (LOS) standards, prescribed LOS methodologies, and development review regulations.
- The existing roadway traffic and boating conditions were updated to reflect the latest data available.
- Planned roadway improvements identified in the area were reviewed to ensure that they were appropriately accounted for in the analysis.

This section also has been updated to reflect existing conditions as of 2008, and future years 2012 (for Project built-out year) and 2030 (for the long-term planning horizon). Regional growth projections have been updated accordingly.

Existing Conditions

This section discusses changes in the existing conditions or regulatory setting since the 2001 FEIR and 2001 FEIS.

Regulatory Setting

Federal and State

The California Department of Transportation (Caltrans) is responsible for planning, designing, constructing, operating, and maintaining all state-owned roadways in San Joaquin and Contra Costa Counties. Caltrans implements federal highway standards in California.

Local

Bacon and Bouldin Islands are located in San Joaquin County, and Webb and Holland Tracts are located in Contra Costa County. The local regulations established by San Joaquin and Contra Costa Counties that pertain to the islands that fall within their respective boundaries are described below.

Contra Costa Transportation Authority

The Contra Costa Transportation Authority (CCTA) was formed to manage and oversee the funds generated by the half-cent transportation sales tax Contra Costa County voters enacted in 1988 known as *Measure C*. That sales tax expires in 2009, and the new Measure J will replace the current measure. In 2004, the sales tax was renewed for an additional 25 years (to 2034) and a new expenditure plan adopted, the *Measure J Expenditure Plan*. (Contra Costa Transportation Authority 2004.)

As Contra Costa County's transportation sales tax agency, CCTA oversees the design and construction of the transportation projects included in the Expenditure Plans, carries out the programs included in the Expenditure Plans (most notably, the county's Growth Management Program), and provides the financial structure that ensures the optimum use of the sales tax dollars as intended by the voters.

In 1990, CCTA took on the role of Contra Costa County's Congestion Management Agency (CMA). In that capacity, CCTA is the primary transportation planning agency for Contra Costa County, responsible for prioritizing the 'county's share of available federal, state, and regional transportation funds. As the CMA, the Authority prepares the county's Congestion Management Plan (CMP), monitors levels of service on the county's roadways, and works with other CMAs and agencies to address regional issues. The most recent CMP update was adopted in November 2007 (Contra Costa Transportation Authority 2007).

The CMP indicates the LOS standard along regional facilities. The LOS is a measure of the performance of transportation facilities. Using procedures defined in the Highway Capacity Manual (Transportation Research Board 2000), the quality of traffic operation is graded as one of six LOS designations, from A to F.

LOS A and B represent the best traffic operations. LOS C and D represent intermediate operations, and LOS E and F represent high levels of congestion and unstable traffic flow. More details on the LOS analysis are provided in the Methods section.

Appendix D of the CMP indicates that the LOS standard along State Route 4 (SR 4) is LOS E between monitoring intersections.

Contra Costa County Measure J

In November 2004, Contra Costa County voters approved Measure J. The measure provided for the continuation of our county's half-cent transportation sales tax for 25 more years beyond the original expiration date of April 2009. As with Measure C (the original 1988 transportation sales tax measure), the tax revenues will be used to fund a voter-approved Expenditure Plan of transportation programs and projects. Measure J will provide approximately $2.5 billion for countywide and local transportation projects and programs through the year 2034. The expenditure plan includes major capital improvement projects, countywide capital and maintenance programs, various transit programs and projects, and subregional and local projects.

Contra Costa County General Plan

The 2005–2020 Contra Costa County General Plan (Contra Costa County 2005) expresses the broad goals and policies, and specific implementation measures that will guide decisions on future growth, development, and the conservation of resources through the year 2020. The Transportation and Circulation Element, Chapter 5 of the General Plan, includes goals and policies regarding major thoroughfares, railroad and transit routes, terminals, and other local public transportation systems.

The Growth Management Element, Chapter 4 of the General Plan, indicates that each jurisdiction within the county must adopt Traffic LOS standards keyed to types of land use:

- Rural: low C
- Semi-Rural: high C
- Suburban: low D
- Urban: high D
- Central Business District (CBD): low E

LOS would be measured by Circular 212 or the method described in the most commonly used version of the Highway Capacity Manual (HCM) (Transportation Research Board 2000).

Figure 4-2 of the General Plan shows the LOS designations for unincorporated areas. Land use designations for study roadways within the Project vicinity are:

- Cypress Road: urban (within Oakley city limits) then suburban;
- Jersey Island Road: suburban (in Hotchkiss Tract) then semi-rural (on Jersey Island); and
- Delta Road, Holland Tract Road, and Byron Highway: semi-rural.

City of Oakley General Plan

The Circulation Element of the City's 2020 General Plan (City of Oakley 2002a) outlines Oakley's plan for the provision of convenient and efficient travel within the community and between Oakley and the region. Key circulation issues relevant to the Project for Oakley are:

- prioritization and construction of roadway improvements necessary to improve circulation and LOS;
- establishment of a minimum LOS standard for the community;
- support for the realignment of SR 4.

Roadway capacity and LOS calculation are based on the 2000 HCM (Transportation Research Board 2000). The City has adopted LOS D as its LOS standard, which is a common standard used in communities throughout Contra Costa County.

San Joaquin Council of Governments Congestion Management Program

San Joaquin Council of Governments (SJCOG) provides the regional framework to connect land use to transportation systems, manage population growth, preserve the environment, and sustain economic prosperity.

SJCOG is revising the CMP (San Joaquin Council of Governments 2007a) for San Joaquin County. The revised CMP will incorporate the congestion management requirements adopted by SJCOG as a part of the Measure K Renewal transportation sales tax program with an update of the 1996 San Joaquin County CMP.

As stated in the final draft (San Joaquin Council of Governments 2007a), the current CMP for San Joaquin County reflects a renewed vision of the future of travel in the region. Strategies to combat congestion and its impacts on economic development must focus on a broad set of supply-side and demand-side strategies that embrace the latest thinking about reducing single-occupant-vehicle trips, including more proactive land use and pricing policies, coordinated investment in alternative modes of transportation, and new incentives for getting people out of their cars.

All jurisdictions in San Joaquin County set a LOS goal of D or higher in their circulation elements. The standard of D also represents the goal set in the Caltrans Concept LOS for state highways in all urban and some rural areas of the county. The SJCOG Board voted in 2007 to set an innovative two-tiered LOS standard. The first tier is triggered by any roadway operating at LOS D. This begins an effort by SJCOG to broaden alternative modal programs and target travel demand management (TDM) measures. The second tier is triggered by any roadway operating at LOS E or F. This triggers the requirement for a Deficiency Plan.

The 2007 renewal of the Measure K Ordinance stipulates that SJCOG will

> review all environmental documents and/or development applications for residential, commercial, retail, and industrial development in San Joaquin County generating 125 or more peak hour trips, based on Institute of Transportation Engineers (ITE) trip factors. (San Joaquin Council of Governments 2007a).

SJCOG is to comment on each of these developments as to their impact on the region and recommend the appropriate mitigation to address the impacts the new development will have on the existing transportation system. Where appropriate, SJCOG is to coordinate with Caltrans on these comments.

Within the Project vicinity, SR 4 and SR 12 are designated as CMP roadways by the current SJCOG CMP.

San Joaquin County General Plan

The San Joaquin County General Plan was adopted in 1992. In June 2008, the County began a 36-month process to update the 1992 General Plan.

The 1992 General Plan (San Joaquin County 1992) established the county's traffic LOS policy. On minor arterials and roadways of higher classification (not including freeways, which are treated separately in the CMP), the County adopted the following LOS roadway standards:

- LOS D on state highways;
- LOS D within a city's sphere of influence, or LOS C when the city plans for that level of service or better; and
- LOS C on other roads.

LOS is measured using standards defined by the HCM (Transportation Research Board 2000) or the state.

The General Plan includes a list of state route improvements needed with the goal of serving projected 20-year growth with an LOS D; this list includes widening SR 12 to 4 lanes (noting that it "may be difficult or very expensive due to the unstable peaty soils in the Delta"); and widening SR 4 between Tracy Boulevard and the Contra Costa County line to four lanes. The General Plan also listed major arterial improvements needed with the goal of serving projected 20-year growth with an LOS C.

Affected Environment

This section describes the existing roadway and waterway system and traffic conditions on and in the vicinity of the Project islands. An approximate 10-mile radius around the Project islands was used as the geographic scope for the traffic analysis. Information on the roadway system and traffic conditions is based, in part, on information collected for the 2001 FEIR and 2001 FEIS. The information has been updated to reflect existing conditions as of 2008.

Sources of information used to document existing conditions include all the sources listed in the 2001 FEIR and 2001 FEIS (data, reports, and conversations with the California Department of Boating and Waterways, the State Lands Commission, San Francisco Estuary Project, State Water Board, the DPC, and Delta marina operators). Additional data used in the revised analysis were compiled from the following sources: Caltrans, SJCOG, CCTA, Counties of San Joaquin and Contra Costa, Cities of Oakley and Brentwood, Delta Ferry Authority, California Department of Boating and Waterways.

Existing Roadway System

The Delta is served by a network of county roads, private roads, and state highways. Regional highways serving the Project vicinity are Interstate 5 (I-5), SR 12, SR 4, and SR 160. In addition, ferries provide transportation between islands that do not have bridges. Transportation facilities in the Project area are described below and are shown in Figure 4.10-1.

Bouldin Island

SR 12 crosses the north side of Bouldin Island, providing access to Fairfield and Napa to the west and extending to Lodi and the foothills to the east. On the island, SR 12 is a narrow-shouldered, two-lane highway across the island bottom, at 10–15 feet below the water level in the exterior channels. In addition to SR 12, several narrow private interior roads provide access to agricultural operations on the island.

At the east end of Bouldin Island, SR 12 crosses Little Potato Slough on a two-lane swing bridge that has an approximately 35-foot clearance for boats. The speed limit is 55 mph on this segment of SR 12. Access to the private dirt levee roads on Bouldin Island north and south of SR 12 is available approximately 0.25 mile west of the bridge. At the west end of the island, SR 12 crosses the Mokelumne River on a swing bridge.

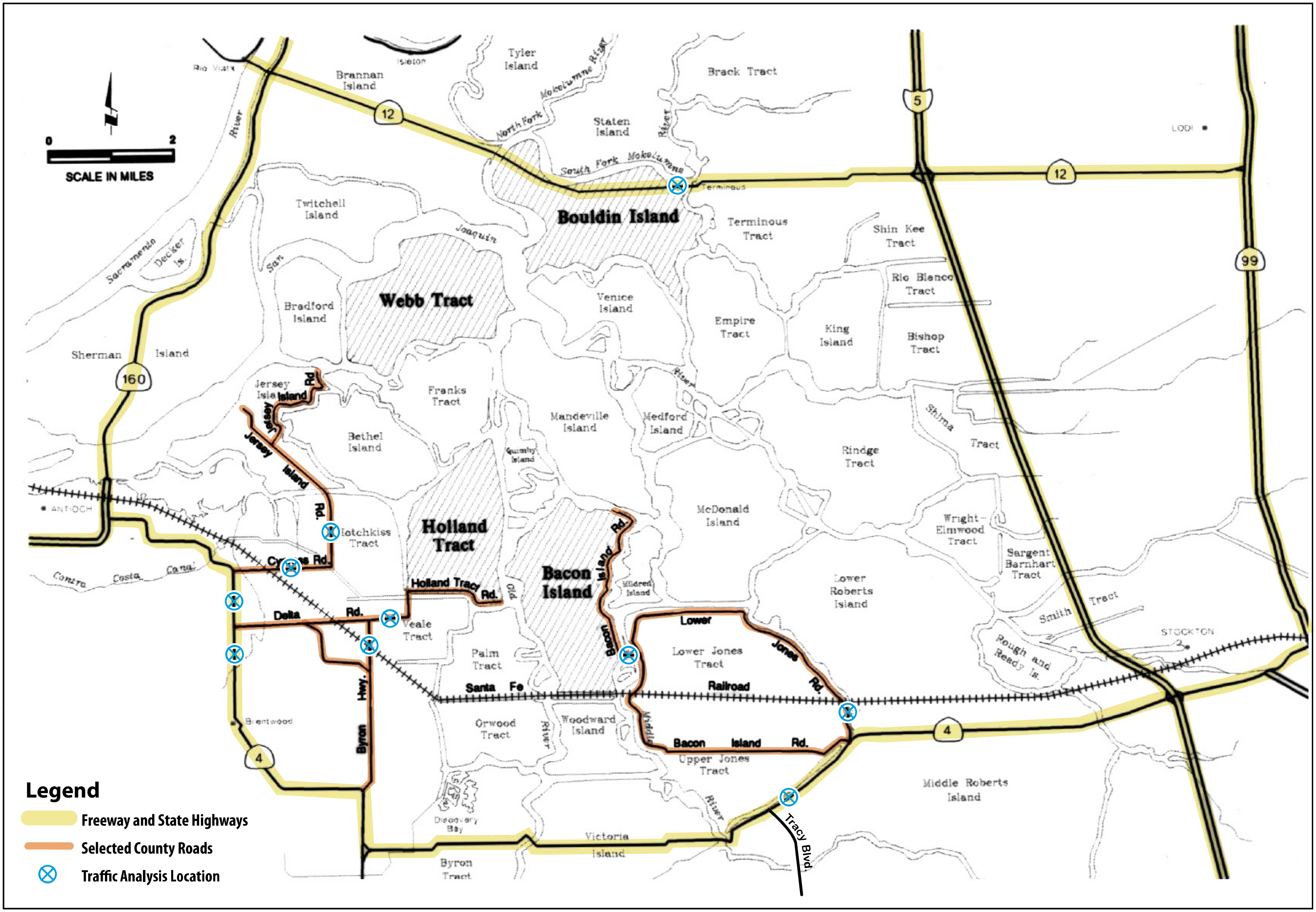

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Figure 4.10-1
Highways and County Roads in the Delta Wetlands Project Vicinity

Webb Tract

No roads provide access to Webb Tract; the Jersey-Bradford-Webb ferry, operated by the Delta Ferry Authority, provides ferry service to Webb Tract and Bradford Island from Jersey Island. Private interior roads exist on Webb Tract to enable vehicles to circulate once they are on the island.

Jersey Island Road provides access to the ferry on Jersey Island. Jersey Island Road is a narrow, two-lane road with narrow shoulders and a posted speed limit of 25 miles per hour (mph). It crosses Jersey Island and then winds along the narrow levee the final 3 miles to the ferry landing. In the 1980s, Contra Costa County Department of Public Works abandoned maintenance on the levee portion of the road.

Cypress Road provides access to Jersey Island Road from SR 4 and the city of Oakley. It is a two-lane arterial, with a posted speed limit of 50 miles per hour. Planned future improvements, as outlined in the City's Long Range Roadway Plan (City of Oakley 2002b), include widening the current roadway to a six-lane arterial between Sellers Avenue and Jersey Island Road.

The Delta Ferry Authority operates the Jersey-Bradford-Webb ferry each hour from 8:00 a.m. to 5:00 p.m., Monday through Friday, and half days on weekends. During fiscal year 2006–2007, the total number of passengers using the ferry was 6,440 (California Office of the Controller 2008).

Based on this figure, average use for that year is estimated to have been approximately 25 passenger trips per day (6,440 trips/260 days). The ferry system is funded through the Delta Ferry Authority. The Delta Ferry Authority is composed of Reclamation District No. 2026 (Webb Tract) and Reclamation District No. 2059 (Bradford Island).

Holland Tract

Just north of the town of Brentwood in Contra Costa County, the east-west Delta Road turns north, crosses Rock Slough on a two-lane bridge, and becomes Holland Tract Road. Holland Tract Road is a narrow, two-lane levee road that enters the southwest corner of Holland Tract. Access northward on the west levee is blocked by a locked gate. To the east, the county road runs along the southern levee to the Holland Tract Marina, located at the southeast corner of the island. At the marina, the county road ends at a locked gate. In 1993, the Contra Costa County Department of Public Works abandoned responsibility for those sections of Holland Tract Road along the east and west perimeter levees beyond the locked gates; these are now private roads. The posted speed limit is 35 mph on the public access portion of Holland Tract Road on the southern perimeter levee and is 25 mph at the marina. Additionally, private interior roads provide access to agricultural operations on the island.

Bacon Island

Bacon Island Road, the only public road to Bacon Island, provides access from SR 4 to Bacon Island from the east. As it approaches Bacon Island, Bacon Island Road is a narrow, two-lane, east-west road with narrow shoulders, and posted speed limits range 15–30 mph. Access to Bacon Island via Bacon Island Road is provided by the Bacon Island Bridge, a 2-lane swing bridge over Middle River built in 1995.

On Bacon Island, Bacon Island Road is a narrow, winding, north-south levee road with a posted speed limit of 25 mph. Bacon Island Road provides access to the Bullfrog Landing Marina and agricultural properties on the island. The public portion of Bacon Island Road ends at the north end of Bacon Island at a bridge to Mandeville Island. Beyond the bridge, a private dirt/gravel road extends to the western edge of Bacon Island.

SR 4 provides access from Bacon Island Road east to Stockton and the Sierra Nevada foothills and west to Brentwood and Antioch. SR 4 is a two-lane, east-west highway with wide shoulders. SR 4 is a levee-top road at its intersection with Bacon Island Road.

Existing Traffic Conditions

A number of roadway segments were chosen for evaluation because they are located at the major access points to each island. These include:

- Bouldin Island
  - SR 12 west of Terminous
- Webb Tract
  - SR 4 south of Cypress Road
  - Cypress Road west of Jersey Island Road
  - Jersey Island Road north of Dutch Slough Road
- Holland Tract
  - SR 4 south of Delta Road
  - Byron Highway south of Delta Road
  - Delta Road east of Byron Highway
- Bacon Island
  - SR 4 east of Tracy Boulevard
  - Bacon Island Road at the Bacon Island Road Bridge
  - Lower Jones Road north of Cook Road

For each of these roadway segments, recent traffic volumes (daily and peak hour directional counts) were assembled from various sources. On state highways, Caltrans provides annual traffic count reports (California Department of Transportation 2009). Contra Costa County and San Joaquin County Public Works Departments provided data on county roadways. Data for Cypress Road and Jersey Island Road came from the City of Oakley.

Original traffic volume data was collected on different years, with the oldest data dating from 2002. All state highway data is from 2008. For this analysis, all traffic volume data were converted to 2008 data using appropriate growth rates (based on historical trends).

Based on 2008 traffic volumes, an analysis of roadway LOS was conducted on all studied roadway sections. The LOS analysis was performed using the HCM methods (Transportation Research Board 2000) for two-lane highway operations.

The HCM methods estimate measures of traffic operation along a section of a two-lane highway based on terrain, geometric design, and traffic conditions. Criteria for two-lane highway LOS are shown in Table 4.10-2 below. On major two-lane highways (Class I), both percent time following and average travel speed define LOS; on highways where accessibility is paramount and mobility less critical (Class II), LOS is defined only in terms of percent time spent following, without consideration of average travel speed.

Table 4.10-2. LOS Criteria for Two-Lane Highways

	Class I[1]		Class II[2]
LOS	Percent Time Spent Following[3]	Average Travel Speed	Percent Time Spent Following[3]
A	≤ 35	> 55	≤ 40
B	> 35–50	> 50–55	> 40–55
C	> 50–65	> 45–50	> 55–70
D	> 65–80	> 40–45	> 70–85
E	> 80	≤ 40	> 85
F	–[4]	–[4]	–[4]

Notes:
1 Class I highways are major intercity routes that serve long distance trips (primary arterials, state highways…).
2 Class II highways are access routes, scenic, or recreational routes.
3 Percent time spent following is the average percentage of travel time that vehicles must travel in platoons behind slower vehicles because of the inability to pass.
4 LOS F applies whenever the flow rate exceeds the segment capacity.

Table 4.10-3 shows the existing peak hour volumes (2008) and corresponding LOS of analysis road segments. The table also indicates the adopted LOS standards for each segment, based on sources identified in the Regulatory Setting.

Table 4.10-3. Existing Peak Hour Volumes and Level of Service

Segment Location	Peak Hour Volume[1]	LOS[2]	V/C[3]	LOS Standard[4]	Source[5]
SR 4 south of Cypress Road	1,150	D	0.39	E	CCTA 2007
SR 4 south of Delta Road	1,300	D	0.44	E	CCTA 2007
SR 4 east of Tracy Boulevard	790	C	0.29	D	SJCOG 2007a
SR 12 west of Terminous	1,850	**E**	0.75	D	SJCOG 2007a
Bacon Island Road at the Bacon Island Road Bridge	80	A	0.03	C	San Joaquin County 1992
Lower Jones Road north of Cook Road	40	A	0.02	C	San Joaquin County 1992
Jersey Island Road north of Cypress Road	60	A	0.02	D	City of Oakley 2002a
Cypress Road west of Jersey Island Road	720	C	0.25	D	City of Oakley 2002a
Byron Highway south of Delta Road	130	A	0.05	High-C	Contra Costa County 2005
Delta Road east of Byron Highway	50	A	0.02	High-C	Contra Costa County 2005

1 Peak hour volume is the highest sum of the volumes (both directions) during a peak hour of the day.
2 LOS = Level of service.
3 V/C = Volume to capacity ratio.
4 LOS standard based on adopted plans and policies (see Regulatory Setting).
5 Indicates source for LOS standard.

All of the segments currently operate below the adopted LOS standard, except for the section of SR 12 west of Terminous, which is shown to operate at LOS E under existing conditions.

Planned Roadway Improvements

Several roadway improvements are planned on and near the studied roadways in the near term (2012) and long term (2030). Only the funded projects were incorporated into the analysis of future traffic conditions.

Funded Roadway Projects

SR 4 Bypass

The SR 4 Bypass project is a roadway project being developed by a cooperative effort between Contra Costa County and the Cities of Antioch, Brentwood, and Oakley to ease traffic congestion through the Brentwood and Oakley areas. This Project will create a new four-lane at-grade divided freeway with interchanges at Lone Tree Way, Sand Creek Road, Balfour Road, Marsh Creek Road, and Walnut Boulevard. The Bypass will replace existing SR 4 from just south of the Main Street interchange to the existing intersection with Marsh Creek Road. As of 2010, the project is now completed with the exception of the final lift of rubberized asphalt concrete (RAC) on Marsh Creek Road, which is scheduled for summer 2010.

Operational and Intersection Improvements on State Route 4 between Daggett Road and I-5 (posted mile [PM] 12.6/15.9)

This Project is programmed as Tier I priority in the 2007 Regional Transportation Plan (San Joaquin Council of Governments 2007b). NEPA approval is expected in 2010 and construction is expected to be completed by 2014.

Extension and New Alignment of State Route 4 between Fresno Avenue and east of Daggett Road

The Project is programmed as Tier I priority in the 2007 Regional Transportation Plan (San Joaquin Council of Governments 2007b). NEPA approval is expected in 2012 and the project is expected to be open to traffic in 2016.

Safety and Operational Improvements on State Route 12 between the San Joaquin County Line and I-5

Caltrans is designing and constructing safety and operational improvements to include roadway realignment, profile correction, shoulder widening, centerline and shoulder rumble strips, intersection improvements, and extended passing lanes. Improvements between I-5 and Bouldin Island are programmed as Tier I priority in the 2007 Regional Transportation Plan (San Joaquin Council of Governments 2007b). NEPA approval is expected in 2011 and the project is expected to be open to traffic in 2017.

Unfunded Roadway Projects

State Route 12 Widening

Caltrans 2030 concept for SR 12 is a four-lane facility with a concrete barrier between Rio Vista Bridge and I-5, as described in the SR 12 Comprehensive Transportation Corridor Study (California Department of Transportation 2006). It was recognized that the project is in environmentally sensitive areas west of the Potato Slough Bridge that could cause construction to be significantly more expensive because of soil conditions and environmental concerns. This project is not currently programmed or funded.

State Route 4 Widening between the San Joaquin County Line and I-5

Caltrans Transportation Concept Report (California Department of Transportation 2002) calls for a four-lane, conventional facility with passing lanes and left turn pockets as the 2020 concept. This project is not currently programmed or funded.

State Route 4 Widening through Oakley

This project is included in the City of Oakley General Plan Circulation Element (City of Oakley 2002a). The project involves the expansion of Main Street (existing SR 4) to major arterial standards (four to six lanes with median) from SR 160 to the southern city limit. This project is not currently programmed or funded, with the exception of the widening of Main Street between Laurel Road and Hill Avenue, which is included in the City's Capital Improvement Program for Fiscal Years 2006/07 to 2010/11 (City of Oakley 2006). The City of Oakley has proposed that the existing non-freeway portion of SR 4 from the SR 160 interchange to Delta Road be relinquished from Caltrans to the local agency, and that the state route be transferred to the new SR 4 Bypass facility.

Cypress Road Widening in Oakley

As outlined in the City's Long Range Roadway Plan (City of Oakley 2002b), the project includes widening of the current roadway to a six-lane arterial between Sellers Avenue and Jersey Island Road to accommodate the expected traffic growth. This project is not currently programmed or funded.

Waterway Traffic and Safety

Boat-related recreational activity in the Delta has increased over recent years. Approximately 955,730 boats are registered in California (California Department of Boating and Waterways 2007). Of these, approximately 37,965, or 4.0%, are registered in Contra Costa County, and 27,629, or 2.9%, are registered in San Joaquin County. Boating traffic in the Delta includes recreational, commercial, residential, and emergency service traffic. Fisherman's Cut and False River, for example, are used to transport large barges, tugs, cranes, and other types of equipment. Bradford Island residents use the channels to commute to work and to shopping locations. Police and fire services also use the waterways for emergency response to various locations in the Delta.

Boat traffic congestion occurs along Delta waterways and often occurs at launch ramps and boat mooring areas. The Department of Boating and Waterways requires that boats traveling within 200 yards upstream or downstream of boat docks maintain speeds of less than 5 mph. Restricted speeds, combined with boats moving into and out of waterways, create boat congestion on days of heavy recreational use (e.g., summer and holiday weekends).

A study of boating safety in the Delta found that most safety problems on waterways are a result of:

- boaters having limited knowledge and experience,
- boats traveling at excessive speeds that create large wakes, and
- lack of uniformity in signs regulating boat speeds and other boater information.

Boaters and enforcement agencies also agree that obscured visibility at intersecting waterways and the operation of vessels by boaters under the influence of alcohol and/or drugs contribute to unsafe waterway conditions and boating accidents. In 2007, 804 boating accidents occurred on California waterways. Of these, 23 boating accidents occurred in Contra Costa County, and 44 occurred in San Joaquin County. A total of 83 boating accidents occurred in the Delta, including 4 fatalities (California Department of Boating and Waterways 2008).

Fog is common during the winter months throughout the Delta. Fog may sometimes settle low on bodies of water (i.e., Delta channels) when there is little or no wind, creating a dense fog condition in that localized area, making marine navigation difficult. However, according to the U.S. Coast Guard, the level of boating activity and the need for search and rescue efforts during the winter months are relatively low compared with the need in summer months (Jones & Stokes 2001). Boaters who use the Delta in the winter generally are experienced in boating, carry navigational equipment, and are familiar with marine navigation in foggy weather (Jones & Stokes 2001).

The Delta Vision Strategic Plan recently released by the Governor's Blue Ribbon Task Force (Blue Ribbon Task Force 2008) includes a recommendation to reconfigure Delta waterway geometry by 2015 to increase variability in estuarine circulation patterns. These reconfigurations should be planned in conjunction with near-term and long-term conveyance modifications. These reconfigurations will include installing removable or operable flow barriers, especially in channels of the south Delta, so that channel lengths are greater than tidal excursion distances. These modifications should allow for continued navigation.

Air Traffic

A small private airstrip is located on the east side of Bouldin Island, south of SR 12, and runs generally east-west. The airstrip is used primarily for agricultural activities (crop dusting) on Bouldin Island, Holland Tract, and Webb Tract. A similar airstrip also exists on the eastern edge of Bacon Island (Delta Protection Commission 2001: 5, 6).

Non-Motorized Transportation

The Project area consists of two-lane rural roads. No facilities are provided for bicycles or pedestrians except within nearby urban areas in the communities of Oakley and Brentwood and at new developments near the Project area.

Public Transit

Tri Delta Transit provides public transit service in Brentwood and Oakley weekdays between 6:00 a.m. and 8:00 p.m. in 30-minute headways. Saturday service is provided in 60-minute headways between 9:00 a.m. and 5:00 p.m. Tri Delta Transit provides express bus service connecting Brentwood and Oakley to the Pittsburg/Bay Point BART station, using SR 4. A local service route (#386) also connects Brentwood with Byron and Discovery Bay.

Environmental Commitments

The environmental commitments, as described in Chapter 2, would not alter the impact findings related to traffic and navigation.

Environmental Effects

Traffic Projection Methods

Development of Future without Project Traffic Volumes

The future no project traffic conditions represent traffic levels that would exist in the study area if the Project is not implemented and the intensified agricultural activities associated with the No-Project Alternative do not occur. Future no project conditions are used as a basis for comparison to determine the increment of change directly related to the implementation of the proposed Project.

Future no project traffic volumes were developed for the expected Project buildout year (2012) and for the long-range planning horizon (2030). The traffic forecasts were generally based on existing volumes and annual traffic growth rate assumptions reflecting historical trends. In and near the city of Oakley, the 2030 baseline traffic volume projections were derived from the City's Long Range Roadway Plan (City of Oakley 2002b).

For the state highway sections (outside of Oakley), the annual traffic growth rate used to project future volumes is based on a comparison of Caltrans field measurements between 1988 and 2008. On these facilities, the annual growth rate that was observed in the last 20 years is assumed to continue in the coming 20 years. An annual growth rate of 1.0% was used for SR 12 (west of Terminous); an annual growth rate of 1.1% was used for SR 4 east of Tracy Boulevard.

For the county roadway sections, annual growth rates were derived from a comparison of two sets of counts. Observed annual growth rates typically vary between 1% and 2%. A conservative 2% annual growth rate was used to project future traffic volumes on Bacon Island Road, Byron Highway, and Delta Road.

For the SR 4 sections within the city of Oakley, Jersey Island Road and Cypress Road, the 2012 baseline projections also are based on continuation of historical trends (annual growth rates varying between 1.0% and 2.8%); however, the 2030 projections are based on the City of Oakley Long Range Roadway Plan, which better captures expected future changes in land use and transportation conditions in the area. The Long Range Roadway Plan presents traffic forecasts based on CCTA's East County Travel Demand Model. This subregional model forecasts traffic volumes based on population and employment projections and assumptions on future improvements to the transportation system. The model was used to estimate traffic volumes assuming the cumulative effects of the buildout of the Oakley General Plan Preferred Alternative, as well as growth in neighboring cities, consistent with their current adopted General Plans. The model also captures the impact of the SR 4 Bypass, which lowers the increase of traffic along the existing SR 4.

Development of Proposed Project Traffic Volumes

As described in Chapter 1, the Project description essentially is unchanged since the 2001 FEIR and 2001 FEIS. The Project applicant removed construction of recreation facilities from its CWA permit applications, and the Corps will not include the construction of such facilities in permits issued for the Project at this time. However, it is anticipated that the Project applicant would subsequently apply for CWA and Rivers and Harbors Act permits for some or all of these recreational facilities. The impact analysis on traffic and navigation evaluates the construction and operation of the recreation facilities. Impacts on roadway traffic and waterway traffic both were assessed.

Trip Generation

Sources of traffic generated from the Project alternatives are recreational activities, agricultural operations, and Project maintenance activities. Vehicle travel between recreation facilities and the Bouldin Island airstrip was not included in the sources of traffic. Although agricultural and recreation-related traffic would not peak during the same months, all sources of traffic were combined to make this a worst-case analysis.

Recreation-related trip generation was calculated for each alternative, as shown in Table 4.10-4 for vehicle trips and Table 4.10-5 for boat use-days. These two tables list daily trip generation for recreation-related use for all seasons, which were used to determine the season with the greatest amount of recreational trip generation.

As shown in Table 4.10-4 and Table 4.10-5, summer (June–August) would be the peak recreation season, which includes the highest boating, fishing, and other miscellaneous recreational activities. Hunting is not included as a source of recreation-related trips for the peak-use impact assessment for these alternatives because hunting would not occur during summer.

Hunting-related vehicle trip generation for the Project was estimated in the same manner as for existing conditions. The Project would include lodging facilities for hunters; therefore, the number of hunters was estimated based on the following assumptions: an overnight hunter accounts for two hunter use-days, 70% of the hunters would stay overnight at the Project facilities and the remaining 30% of the hunters would come for day use only. Also, it was assumed that 10% of the hunters using Webb Tract would travel by private boats and would not use the ferry.

Estimates of annual hunter use-days described in the Recreation and Visual Resources analysis of the 2001 FEIR and 2001 FEIS (Jones & Stokes 2001) were used for the trip generation analysis. These numbers represent the maximum amount of hunting that would occur during the approximately 5- to 15-year period following Project start-up. After this initial period, hunting activity on the Project islands is expected to decrease. These maximum numbers were used for a worst-case analysis. Depending on the alternative and the island under consideration, the number of days on which hunting would be allowed in future years varied from 47 to 86 days per year.

Hunting also would result in boating on the interior of the Project islands. Trip generation for hunting-related boating was estimated based on the number of hunters expected to use the Project islands each day, assuming two people per boat. This activity is not considered a part of pleasure boating activities, which would take place in the Delta on the exterior of the Project islands. Additionally, hunting-related boat trips would be much shorter in duration, and boats used for hunting are smaller than pleasure boats.

Boating activity would result in both vehicle traffic and boat traffic. Trip generation for boats and boating-related vehicles was estimated using peak-use estimates for each season. Boating activity is the largest source of vehicle trip generation for the Project during the summer. Permanent boat berths that would be constructed under the proposed Project alternatives are projected to have an average boat occupancy rate of 70% (see Section 4.9, Recreation and Visual Resources). The percentage of docked boats projected to be used on a peak day was used to estimate the total number of boats that would be used per peak day for each season.

It is assumed that each peak boat use-day represents an average of 4 hours of use by three people. The number of boating-related vehicle trips was calculated based on the numbers of boaters, the number of peak-day boat trips, and an occupancy rate of two people per car. The number of boating-related vehicle trips therefore would be three trips per boat use-day. The availability of overnight lodging facilities was not used to reduce the trips undertaken by boating-related vehicles.

During the hunting season (November–January), 5% of the hunters are assumed to engage in pleasure boating activities, which would generate additional boating-related boat trips. However, the hunter would not generate additional boating-related vehicle trips. Therefore, 5% of the hunting-related vehicle trips were subtracted from the boating-related vehicle trips.

Generation of vehicle trips related to other recreational activities was estimated for each season using the number of recreationists other than boaters or hunters expected to use each island. This number was estimated in relation to the number of boaters expected to use the islands (see the Recreation and Visual Resources analysis). It was assumed that 90% of these recreationists would drive to the islands or, in the case of Webb Tract, to the ferry. A vehicle occupancy rate of two people per car was assumed.

It should be noted that all trips referred to in this section are one-way trips, while a boat use-day represents 4 hours of boat usage. It should also be noted that the vehicle-to-boat trips included in this analysis are not vehicle trips made to the ferry, but are vehicle trips made to private boats. However, all vehicle trips made “directly” to Webb Tract are actually vehicle trips made to the Jersey-Bradford-Webb ferry, which would transport the vehicles and passengers to Webb Tract.

These vehicle trips should not be confused with vehicle trips made to private boats going to Webb Tract.

Also, harvest vehicle trips are distinguished from non-harvest agricultural trips by the fact that harvest trips are made to deliver harvested crops. Non-harvest agricultural trips include all other agricultural trips.

Non-recreational vehicle trips were estimated based on agriculture- and construction-related trip generation estimates provided by the Project applicant. When combined with recreational trips, overall vehicle trips generated by the Project are presented in Table 4.10-4 and boat use-days generated by the Project on peak days are presented in Table 4.10-5.

Table 4.10-4. Daily Vehicle Trip Generation from Project Operation and Maintenance

Vehicle Type	Season	Bouldin Island Alt 1 or 2	Bouldin Island Alt 3	Webb Tract Alt 1 or 2	Webb Tract Alt 3	Holland Tract Alt 1 or 2	Holland Tract Alt 3	Bacon Island Alt 1 or 2	Bacon Island Alt 3
Daily Vehicle Trip Generation from Project Construction									
Worker vehicle trips to islands		30	151	53	53	14	103	67	67
Worker vehicle trips to boats[1]		1	7	31	31	1	4	3	3
Delivery truck trips to islands		0	1	2	2	0	1	2	2
Total daily construction vehicle trips		**31**	**159**	**86**	**86**	**15**	**108**	**72**	**72**
Daily Vehicle Trip Generation from Project Operation and Maintenance									
Hunting-related vehicles	Nov–Jan	93	22	17	17	43	14	18	18
	Feb–May	0	0	0	0	0	0	0	0
	Jun–Aug	0	0	0	0	0	0	0	0
	Sep–Oct	0	0	0	0	0	0	0	0
Boating-related vehicles	Nov–Jan	58	62	68	68	36	50	68	68
	Feb–May	252	252	277	277	151	202	277	277
	Jun–Aug	441	441	485	485	265	353	485	485
	Sep–Oct	315	315	347	347	189	252	374	347
Other recreation-related vehicles	Nov–Jan	2	2	2	2	1	2	2	2
	Feb–May	8	8	8	8	5	6	8	8
	Jun–Aug	33	33	36	36	20	26	36	36
	Sep–Oct	14	14	16	16	9	11	16	16
Total recreation-related vehicles	Nov–Jan	153	85	87	87	80	65	88	88
	Feb–May	260	260	286	286	156	208	286	286
	Jun–Aug[2]	474	474	521	521	284	379	521	521
	Sep–Oct	329	329	362	362	198	263	362	362
Maximum recreation-related vehicle trips		474	474	521	521	284	379	521	521
Harvest vehicles trips		0	0	0	0	1	0	0	0
Nonharvest vehicle trips		0	0	0	0	5	0	0	0
Maintenance vehicle trips		14	27	25	25	15	41	33	33
Maintenance vehicle trips to boats[1]		1	2	8	8	1	2	2	2
Total daily operation vehicle trips		**489**	**503**	**555**	**555**	**306**	**422**	**556**	**556**

Source: 2001 FEIR and 2001 FEIS.

[1] Number of vehicle trips made to boats (other than ferry) that carry workers to islands.

[2] Maximum daily vehicle trips (underlines) are anticipated to be generated from the recreation-related activities during June–August.

Table 4.10-5. Boat Use-Days from Project Operation and Maintenance

Boat Type	Season	Bouldin Island Alt 1 or 2	Bouldin Island Alt 3	Webb Tract Alt 1 or 2	Webb Tract Alt 3	Holland Tract Alt 1 or 2	Holland Tract Alt 3	Bacon Island Alt 1 or 2	Bacon Island Alt 3
Daily Boat Trip Generation from Project Construction									
Barge trips to islands		1	1	1	1	1	1	1	1
Worker boat trips to islands		2	12	2	2	2	16	3	3
Total daily construction boat trips		**3**	**13**	**13**	**13**	**3**	**17**	**4**	**4**
Peak Day Boat Use Days from Project Operation and Maintenance									
Peak day hunting-related boats	Nov–Jan	93	22	18	18	43	14	18	18
	Feb–May	0	0	0	0	0	0	0	0
	Jun–Aug	0	0	0	0	0	0	0	0
	Sep–Oct	0	0	0	0	0	0	0	0
Peak day boating-related boat use-days	Nov–Jan	21	21	23	23	13	17	23	23
	Feb–May	84	84	93	93	51	67	93	93
	Jun–Aug	147	147	162	162	88	118	162	162
	Sep–Oct	105	105	116	116	63	84	116	116
Other recreation-related boats	Nov–Jan	0	0	0	0	0	0	0	0
	Feb–May	0	0	0	0	0	0	0	0
	Jun–Aug	0	0	0	0	0	0	0	0
	Sep–Oct	0	0	0	0	0	0	0	0
Total peak day recreation-related boats	Nov–Jan	114	43	41	41	56	31	41	41
	Feb–May	84	84	93	93	51	67	93	93
	Jun–Aug[1]	147	147	162	162	88	118	162	162
	Sep–Oct	105	105	116	116	63	84	116	116
Maximum recreation-related boat use-days		147	147	162	162	88	118	162	162
Agriculture boat trips		0	0	0	0	0	0	0	0
Maintenance boat trips to islands		1	1	3	3	1	2	1	1
Total operation boat use-days		**148**	**148**	**165**	**165**	**89**	**120**	**163**	**163**

Source: 2001 FEIR and 2001 FEIS.

[1] Maximum boat use-days (underlines) are anticipated to be generated from the recreation-related activities during June–August.

Peak-hour vehicle trips are vehicle trips made during the hour of the day with the greatest traffic volume. Commonly, an approximately 10:1 relationship exists between daily traffic and peak-hour volumes. Therefore, it was assumed that 10% of daily trips, presented in Table 4.10-6, would operate during the peak hour. Table 4.10-6 shows peak-hour vehicle trip generated from construction and operation activities for each alternative.

Table 4.10-6. Peak Hour Vehicle Trip Generation

	Construction		Operation and Maintenance	
Project Site	Alternative 1 or 2	Alternative 3	Alternative 1 or 2	Alternative 3
Bouldin Island	3	16	49	50
Webb Tract	9	9	55	55
Holland Tract	1	11	31	42
Bacon Island	7	7	56	56
Total	**20**	**43**	**191**	**203**

Source: 2001 FEIR and 2001 FEIS.

Trip Distribution and Assignment

Trips generated by the Project were assigned to the roadway system. The Project trip distribution and assignment assumptions represent the most logically traveled routes for traffic accessing the proposed Project. The following assumptions were used to distribute Project traffic among area roadways:

- 50% of all trips generated by the Project are assumed to access each Project site from the west, and the other 50% of trips would access from the east;
- for the Bacon Island site, 100% of all Project generated trips are assumed to access the site using Bacon Island Road (rather than Lower Jones Road);
- for the Holland Tract site, 50% of all Project generated trips are assumed to access the site via Delta Road, and the other 50% of trips would use Byron Highway.

The first and third assumptions listed above are based on the understanding that there are population centers and appropriate work forces located both east and west of the Project site and the assumption that it is equally likely that recreationists and Project workers would come from one direction as from the other. The second assumption is based on the fact that Bacon Island Road is the more direct and faster route to access Bacon Island from SR 4. These assumptions are based on existing traffic patterns.

Table 4.10-7 summarizes the peak hour trip assignment to analysis roadway segments.

Table 4.10-7. Peak Hour Trip Assignment to Analysis Roadway Segments (Project Alternatives)

	Construction		Operation and Maintenance	
Segment Location	Alternative 1 or 2	Alternative 3	Alternative 1 or 2	Alternative 3
SR 4 south of Cypress Road	9	14	71	77
SR 4 south of Delta Road	9	14	71	77
SR 4 east of Tracy Boulevard	9	14	71	77
SR 12 west of Terminous	2	8	25	25
Bacon Island Road at the Bacon Island Road Bridge	7	7	56	56
Lower Jones Road north of Cook Road	0	0	0	0
Jersey Island Road north of Cypress Road	9	9	55	55
Cypress Road west of Jersey Island Road	9	9	55	55
Byron Highway south of Delta Road	1	6	16	21
Delta Road east of Byron Highway	1	6	16	21

Development of No-Project Alternative Traffic Volumes

As described in Chapter 1, the No-Project Alternative involves intensified agricultural activities and is not the same as future no project conditions. The No-Project Alternative also involves the implementation of an intensive for-fee hunting program. The expanded hunting program will include both upland game and waterfowl.

Trip Generation

Sources of traffic under No-Project Alternative conditions include recreational activities and agricultural activities. Although agricultural and recreation-related activities are not expected to peak during the same months, all sources of traffic were combined to make this a worst-case analysis.

Trip generation estimates for agricultural activities associated with the No-Project Alternative were provided by the Project proponent and are shown in Table 4.10-8.

Recreational trip generation estimates were calculated based on the number of hunter use-days shown in the Recreation and Visual Resources analysis of the 2001 FEIR and 2001 FEIS and the 1995 DEIR/EIS for the No-Project Alternative. Recreational trip generation estimates account for the implementation of the intensive for-fee hunting program.

The resulting daily trips by vehicles and by boats are shown in Table 4.10-8.

Table 4.10-8. Daily Vehicle and Boat Trips under the No-Project Alternative

Number of Daily Trips	Bouldin Island	Webb Tract	Holland Tract	Bacon Island
Vehicle trips to recreation areas	131	120	92	121
Harvest vehicle trips	13	4	3	62
Nonharvest agricultural vehicle trips	56	64	23	46
Total Vehicle Trips	**200**	**188**	**118**	**228**
Agricultural boat trips	0	10	0	0
Total Boat Trips	**0**	**10**	**0**	**0**

Source: 2001 FEIR and 2001 FEIS.

Peak-hour vehicle trips are vehicle trips made during the hour of the day with the greatest traffic volume. Commonly, an approximately 10:1 relationship exists between daily traffic and peak-hour volumes. Therefore, it was assumed that 10% of daily trips, presented in Table 4.10-8, would operate during the peak hour.

Trip Distribution and Assignment

Trips generated under the No-Project Alternative were assigned to the roadway system. Trip distribution and assignment assumptions represent the most logically traveled routes for recreational and agricultural traffic accessing the facilities. The following assumptions were used to distribute access traffic among area roadways:

- 50% of all trips generated by the Project are assumed to access each Project site from the west, and the other 50% of trips would access from the east;
- for the Bacon Island site, 100% of all Project generated trips are assumed to access the site using Bacon Island Road (rather than Lower Jones Road);
- for the Holland Tract site, 50% of all Project generated trips are assumed to access the site via Delta Road, and the other 50% of trips would use Byron Highway.

The first and third assumptions above are based on the understanding that there are population centers and appropriate work forces located both east and west of the Project site and the assumption that it is equally likely that recreationists would come from one direction as from the other. The second assumption is based on the fact that Bacon Island Road is the more direct and faster route to access Bacon Island from SR 4. These assumptions are based on existing traffic patterns.

Table 4.10-9 summarizes the peak hour trip assignment to analysis roadway segments.

Table 4.10-9. Peak Hour Trip Assignment to Analysis Roadway Segments (No-Project Alternative)

Segment Location	No-Project Alternative Operations
SR 4 south of Cypress Road	27
SR 4 south of Delta Road	27
SR 4 east of Tracy Boulevard	27
SR 12 west of Terminous	10
Bacon Island Road at the Bacon Island Road Bridge	23
Lower Jones Road north of Cook Road	0
Jersey Island Road north of Cypress Road	19
Cypress Road west of Jersey Island Road	19
Byron Highway south of Delta Road	6
Delta Road east of Byron Highway	6

Significance Criteria

The transportation impact analysis considered several criteria for determining the significance of impacts related to this resource. The analysis took into account both relevant criteria contained in Appendix G of the State CEQA Guidelines (Association of Environmental Professionals 2009) and Project-specific criteria developed by the lead agency to address potential impacts unique to the Project's location and elements.

The proposed Project would have a significant impact on the environment if it would:

- cause an increase in traffic that is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections);
- exceed, either individually or cumulatively, an LOS standard established by the County CMA;
- substantially increase hazards because of a design feature (e.g., sharp curves, dangerous intersections) or incompatible uses (e.g., farm equipment);
- result in inadequate emergency access; or
- conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks).

Other criteria for determining impact significance used in this analysis include:

- **Impacts on traffic safety**. An alternative is considered to have a significant impact if it would result in the operation of additional large trucks or other equipment on Delta roadways during construction or operation, compared with future no project conditions. Conversely, an alternative is considered to have a beneficial impact if it would result in the removal of any large trucks or other equipment from operation on Delta roadways during construction or operation, compared with future no project conditions.

- **Impacts on traffic circulation and access.** An alternative is considered to have a significant impact if it would limit access to the Project site or along haul routes during construction. An alternative is also considered to have a significant impact if it would alter circulation patterns on highways in the Project vicinity during construction or operation.
- **Impacts on waterway traffic and safety.** An alternative is considered to have a significant impact on waterway traffic or safety if it would:
    - substantially increase boat traffic on waterways in the Project vicinity during construction or operation;
    - adversely affect boat navigation in Delta waterways by altering physical conditions in a channel;
    - involve the permanent placement of an obstruction greater than one-third the width of the channel in waterways surrounding the Project islands during construction or operation; or
    - increase the potential for boating accidents to occur in waterways surrounding the Project islands during Project construction or operation.

Future No Project Traffic Conditions

Future Level of Service

Table 4.10-10 summarizes the expected peak hour traffic volumes and resulting LOS projected on the studied roadway segments under future no project conditions (2012 and 2030).

Among the projects described under Planned Roadway Improvements in the Existing Conditions section, only the funded projects were incorporated into the analysis of future no project traffic conditions reported in Table 4.10-10. As shown in the table, two roadway segments will require improvements to meet the LOS standards under future no project conditions: SR 12 west of Terminous (2012 and 2030 conditions) and Cypress Road west of Jersey Island Road (2030).

Table 4.10-10. Projected Future No Project LOS Conditions

Segment Location	LOS Standard	2012 Peak Hour Volume	2012 LOS	2030 Peak Hour Volume	2030 LOS
SR 4 south of Cypress Road	E	1,240	D	1,500	D
SR 4 south of Delta Road	E	1,400	D	1,320	D
SR 4 east of Tracy Boulevard	D	830	C	1,000	D
SR 12 west of Terminous	D	1,930	**E**	2,300	**F**
Bacon Island Road at the Bacon Island Road Bridge	C	90	A	120	A
Lower Jones Road north of Cook Road	C	40	A	60	A
Jersey Island Road north of Cypress Road	D	70	A	1,320	D
Cypress Road west of Jersey Island Road	D	750	C	3,430	**F**
Byron Highway south of Delta Road	High-C	140	A	200	A
Delta Road east of Byron Highway	High-C	50	A	80	A

Source: 2001 FEIR and 2001 FEIS.

Future Level of Service with Roadway Improvements

As described under Planned Roadway Improvements in the Existing Conditions section, a number of studies have identified potential roadway improvements in the area. Some of these improvements would address the LOS deficiencies in Table 4.10-10.

The proposed roadway improvements include:

- SR-12 west of Terminous: a passing lane should be added (2012), and the section should eventually be widened to four lanes (2030); and
- Cypress Road west of Jersey Island Road: the section should be widened to four lanes (2030).

It should be noted that these proposed roadway improvement projects are needed to address deficiencies anticipated in the future no project scenario, but there is no funding commitment to build those roadway improvements.

Table 4.10-11 shows the resulting LOS on these facilities assuming that these roadway improvements are implemented. As shown in the table, the proposed roadway improvements would ensure that both roadway sections would meet the LOS standards under 2012 and 2030 future no project conditions.

Table 4.10-11. Projected Future without Project LOS—Conditions with Roadway Improvements

Segment Location	LOS Standard	2012		2030	
		Peak Hour Volume	LOS	Peak Hour Volume	LOS
SR 12 west of Terminous	D	1,930	C[1]	2,300	B[3]
Cypress Road west of Jersey Island Road	D	n/a[2]	n/a[2]	3,430	C[3]

[1] With passing lane added.
[2] Not available—no additional roadway improvement needed.
[3] With widening to four lanes.

Impacts and Mitigation Measures

Future Conditions with Project

An assessment of the impacts of the proposed Project on the roadway system and on the waterway traffic and safety conditions is presented in this section.

Roadway Traffic

Impacts related to congestion, circulation, access, and safety are analyzed and discussed in the Impacts and Mitigation section below. Impacts related to congestion, circulation, and access are analyzed as they are the major indicators of traffic conditions in a given area. Safety impacts also are analyzed because of the potentially dangerous conditions associated with the addition of large construction or agricultural vehicles to semirural roadways.

The assessment of the impacts of the proposed development on the roadway operation system was conducted by adding the estimated Project-generated trips onto the projected future no project traffic conditions for the expected buildout year (2012) and the long-range planning horizon (2030).

Two periods of impact are assessed in this section: construction, which is temporary, and operation, which is long-term. Construction impacts are analyzed qualitatively. Operation impacts are analyzed through comparison of LOS for each Project alternative and future no project conditions.

Construction Impacts

Construction impacts consist of impacts related to traffic congestion, safety, circulation, and access occurring during the estimated 1.5-year Project construction period (the construction period is assumed to be approximately 2.5 years long under Alternative 3 on Bouldin Island). The construction period may be longer than 1.5 calendar years, but the shorter period is assumed in the traffic analysis to estimate a worst-case traffic scenario in which all construction traffic would occur within a short time frame. Although existing farming activities gradually would be phased out over the period of construction, under the worst-case scenario, it is assumed that some of the existing farming activities still would be conducted throughout the construction period. Because construction-related impacts would occur only during the period of construction, they are considered short-term impacts.

Operation Impacts

Operation-related impacts consist of impacts on traffic congestion, safety, and circulation during the life of the Project. Congestion was analyzed through comparison of future LOS with the Project operation and future no project LOS. Operation-related safety and circulation impacts were analyzed qualitatively.

Table 4.10-12 summarizes the expected traffic volumes and resulting LOS projected on the studied roadway sections under future conditions (Project and No-Project Alternatives) in 2012; Table 4.10-13 presents the same information for 2030. Alternatives 1 and 2 would have the same impacts on traffic and navigation, and therefore these two alternatives have been combined in the LOS tables.

As shown in the table, the two roadway segments that exceeded the LOS standards under the future no project conditions (SR 12 and Cypress Road) also would be deficient under the all Project conditions.

Table 4.10-12. Projected Future LOS—With Project and No-Project Conditions (2012)

		Alternative 1 or 2		Alternative 3		No-Project Alt.	
		Peak Hour Volume	LOS	Peak Hour Volume	LOS	Peak Hour Volume	LOS
SR 4 south of Cypress Road	E	1,311	D	1,317	D	1,267	D
SR 4 south of Delta Road	E	1,471	D	1,477	D	1,427	D
SR 4 east of Tracy Boulevard	D	901	C	907	C	857	C
SR 12 west of Terminous	D	1,955	**E**	1,955	**E**	1,940	**E**
Bacon Island Road at the Bacon Island Road Bridge	C	146	A	146	A	113	A
Lower Jones Road north of Cook Road	C	40	A	40	A	40	A
Jersey Island Road north of Cypress Road	D	125	A	125	A	89	A
Cypress Road west of Jersey Island Road	D	805	C	805	C	769	C
Byron Highway south of Delta Road	High-C	156	A	161	A	146	A
Delta Road east of Byron Highway	High-C	66	A	71	A	56	A

Table 4.10-13. Projected Future LOS—With Project and No-Project Conditions (2030)

		Alternative 1 or 2		Alternative 3		No-Project Alt.	
		Peak Hour Volume	LOS	Peak Hour Volume	LOS	Peak Hour Volume	LOS
SR 4 south of Cypress Road	E	1,571	D	1,577	D	1,527	D
SR 4 south of Delta Road	E	1,391	D	1,397	D	1,347	D
SR 4 east of Tracy Boulevard	D	1,071	D	1,077	D	1,027	D
SR 12 west of Terminous	D	2,325	**F**	2,325	**F**	2,310	**F**
Bacon Island Road at the Bacon Island Road Bridge	C	176	A	176	A	143	A
Lower Jones Road north of Cook Road	C	60	A	60	A	60	A
Jersey Island Road north of Cypress Road	D	1,375	D	1,375	D	1,339	D
Cypress Road west of Jersey Island Road	D	3,485	**F**	3,485	**F**	3,449	**F**
Byron Highway south of Delta Road	High-C	216	A	221	A	206	A
Delta Road east of Byron Highway	High-C	96	A	101	A	86	A

Tables 4.10-14 and 4.10-15 show the LOS on the two deficient facilities after the implementation of the improvements needed to address the future no project deficiencies (described under Future without Project Conditions), respectively for 2012 and for 2030.

As shown in the tables, the roadway improvements proposed under the future no project conditions would ensure that both roadway sections meet the LOS standards under all 2012 and 2030 Project conditions. As previously noted, there is no funding commitment at this stage to build those improvements.

Table 4.10-14. Projected Future LOS—With Project and No-Project Conditions with Roadway Improvements (2012)

		Alternative 1 or 2		Alternative 3		No-Project Alt.	
	LOS Standard	Peak Hour Volume	LOS	Peak Hour Volume	LOS	Peak Hour Volume	LOS
SR 12 west of Terminous	D	1,955	C[1]	1,955	C[1]	1,940	C[1]
Cypress Road west of Jersey Island Road	D	n/a[2]	n/a[2]	n/a[2]	n/a[2]	n/a[2]	n/a[2]

[1] With passing lane added.

[2] Not available—No additional roadway improvement needed.

Table 4.10-15. Projected Future LOS—With Project and No-Project Conditions with Roadway Improvements (2030)

	LOS Standard	Alternative 1 or 2		Alternative 3		No-Project Alt.	
		Peak Hour Volume	LOS	Peak Hour Volume	LOS	Peak Hour Volume	LOS
SR 12 west of Terminous	D	2,325	B[1]	2,325	B[1]	2,310	B[1]
Cypress Road west of Jersey Island Road	D	3,485	C[1]	3,485	C[1]	3,449	C[1]

[1] With widening to four lanes.

Waterway Traffic and Safety

The number of boat trips expected to occur per day during construction and operation of the Project is shown in Table 4.10-5 (Alternatives 1, 2, and 3) and Table 4.10-8 (No-Project Alternative). The analysis addresses Project effects on waterway traffic, safety, and navigability in Delta waterways during construction and operation. Waterway traffic and safety would be affected by changes in boat use in the Delta and changes in the condition of channels adjacent to the Project islands.

Proposed Project (Alternative 2)

The impacts of Alternative 2 on traffic and navigation conditions in the Project area are described below. In cases in which an impact is designated as significant, mitigation is recommended if available.

Level of Service on Delta Roadways

Traffic generated during construction under Alternative 2 would consist of vehicles carrying workers to the Project sites and trucks bringing materials to the Project sites. The sources of traffic generated during operation of Alternative 2 are recreation, agriculture, and Project maintenance activities. See Table 4.10-4 for estimates of the number of daily trips that would be generated on each island during construction and operation of Alternative 2.

Impact TRA-1: Increase of Traffic and Roadway Level of Service Impact during Construction

Temporary increases in traffic because of Project construction have the potential to worsen LOS on study area roadways. However, the detailed analysis presented in the 2001 FEIR and 2001 FEIS showed that traffic volumes generated during construction are low enough not to change traffic conditions significantly in the area. Estimates of peak-hour traffic volumes generated during construction are shown in Table 4.10-6.

The impact can be further reduced by the implementation of Mitigation Measure TRA-MM-1. This mitigation measure was not identified in the 2001 FEIR and 2001 FEIS.

Mitigation Measure TRA-MM-1: Develop and Implement a Traffic Control Plan

In keeping with standard practice, prior to beginning construction of any portion of the proposed Project, the contractor will develop and implement a Traffic Control Plan (TCP). The TCP will be implemented throughout the course of Project construction and will:

a. contain a plan for communicating construction plans with transit providers, emergency service providers, residences, and businesses located in the Project vicinity and anyone else who may be affected by Project construction;

b. identify roadway segments or intersections that are at or approaching an LOS that exceeds local standards and provide a means for construction-generated traffic to avoid these locations at the peak periods either by traveling different routes or by traveling at nonpeak times of day;

c. contain an access and circulation plan for use by emergency vehicles when lane closures and/or detours are in effect; if lane closures occur, provide advance notice to local fire and police departments to ensure that alternative evacuation and emergency routes are designed to maintain response times;

d. maintain access to existing residences in the area at all times;

e. provide adequate parking for construction trucks and equipment within the designated staging areas throughout the construction period;

f. provide adequate parking for construction workers within the designated staging areas;

g. require traffic controls on roadways adjacent to the proposed Project, including flag persons wearing bright orange or red vests and using a "Stop/Slow" paddle to control oncoming traffic; construction warning signs should be posted in accordance with local standards or those set forth in the Manual on Uniform Traffic Control Devices (Federal Highway Administration 2003) in advance of the construction area and at any intersection that provides access to the construction area;

h. require that written notification be provided to contractors regarding appropriate routes to and from the construction site and the weight and speed limits on local roads used to access the construction site; and

i. specify that a sign be posted at all active construction areas giving the name and telephone number or email address of the County staff person designated to receive complaints regarding construction traffic.

In addition, the following notes will be placed on all grading and building permits:

> "No construction equipment will be transported or materials delivered between the hours of 6:00 a.m. and 9:00 a.m. or 4:00 p.m. and 6:00 p.m. Monday through Friday (traffic peak hours)."
>
> "No local roads traversing a nearby neighborhood may be used as access to the project site by construction equipment or delivery equipment."

Upon application of Mitigation Measure TRA-MM-1, all Project impacts on roadway LOS during construction of Alternative 2 would be reduced to a less-than-significant level.

Impact TRA-2: Increase of Traffic and Roadway Level of Service Impact during Operation

Impacts of Alternative 2 on the roadway LOS during operation are shown in Table 4.10-12 (for 2012 conditions) and Table 4.10-13 (for 2030 conditions). As shown in the tables, two roadway segments are projected to exceed the LOS standards under the Alternative 2 conditions—SR 12 west of Terminous (2012 and 2030 conditions) and Cypress Road west of Jersey Island Road (2030). However, these two segments have been identified to be deficient under the future no project conditions (see Table 4.10-10).

Roadway improvements proposed for future no project conditions (Table 4.10-11) would be sufficient for both roadway sections to meet the LOS standards under 2012 and 2030 Project conditions (see Tables 4.10-14 and 4.10-15). As previously noted, there is no funding commitment at this stage to build those improvements. However, they are needed to address traffic deficiencies even without the Project moving forward. No additional improvements beyond what is needed to address future no project deficiencies are required under the Alternative 2 conditions.

There would be a slight increase of traffic during operation of Alternative 2, and therefore, there is a traffic impact but it is expected to be less than significant; no additional mitigation over what is required under the future no project scenario is needed.

Mitigation

No mitigation is required.

Safety on Delta Roadways

As presented in the 2001 FEIR and 2001 FEIS, traffic safety on Delta roadways would be adversely affected by the addition of large, slow-moving vehicles under Alternative 2. Large-vehicle traffic generated during construction under Alternative 2 would consist of trucks carrying materials to the Project sites as well as agricultural vehicle traffic associated with concurrent agricultural activities. Large-vehicle traffic generated during operation of Alternative 2 would consist solely of agricultural vehicle traffic. The issue of safety on Delta roadways was assessed qualitatively for this section. See Table 4.10-4 for the number of large vehicle trips generated on each island during construction and operation of Alternative 2.

Impact TRA-3: Potential for Traffic Safety Conflicts during Construction

Implementation of Alternative 2 is expected to slightly increase traffic during Project construction (Table 4.10-4). A portion of this increase would consist of large trucks transporting materials to the Project islands. As explained above under Significance Criteria, an alternative is considered to have a significant impact if it would result in the addition of large trucks or other equipment to Delta roadways. This criterion is quite stringent because of the great potential for safety conflicts on these roadways. Although agricultural activities would taper off from current levels throughout the construction period, under the worst-case scenario, it is assumed that all existing agricultural traffic levels would continue throughout the construction period. Therefore, because construction vehicles would be added to traffic on Delta roadways, this impact is considered significant.

Mitigation Measure TRA-MM-2 would reduce safety impacts during construction to a less-than-significant level. This mitigation measure is the same as the one identified in the 2001 FEIR and 2001 FEIS.

Mitigation Measure TRA-MM-2: Clearly Mark Intersections with Poor Visibility in the Project Vicinity

Before beginning construction at any of the Project sites, visibility at intersections in the Project vicinity will be assessed visually. If visibility is poor at any intersection, highly visible signs will be posted at all approaches to the intersection stating that construction activity is taking place and that drivers should be aware of construction vehicles traveling on roads in the area.

A construction contractor and a representative of the San Joaquin County Department of Public Works will visually assess visibility at intersections along Bacon Island Road, SR 4 from I-5 to Bacon Island Road, SR 4 from Bacon Island Road to the San Joaquin County line, and SR 12 from I-5 to the west end of Bouldin Island.

A construction contractor and a representative of the Contra Costa County Department of Public Works will visually assess visibility at intersections along SR 4 from the Contra Costa County line to SR 160, Jersey Island Road from Cypress Road to the Jersey-Bradford-Webb ferry, Cypress Road from SR 4 to Jersey Island Road, Delta Road from SR 4 to Holland Tract Road, Holland Tract Road from Delta Road to its end, Byron Highway from SR 4 to Delta Road, and SR 12 from the west end of Bouldin Island to SR 160.

Impact TRA-4: Potential for Traffic Safety Conflicts during Operation

Implementation of Alternative 2 is expected to result in a reduction in agricultural vehicle traffic on Delta roadways during Project operation compared to existing conditions (2001 FEIR and 2001 FEIS). None of the proposed activities generate additional large-truck traffic. Therefore, there is no impact.

Mitigation

No mitigation is required.

Circulation and Access to Delta Roadways

No changes were made in the Project impacts and mitigation measures compared to the 2001 FEIR and 2001 FEIS with regard to circulation on and access to Delta roadways. During construction of Alternative 2, circulation on and access to Delta roadways could be adversely affected by road closures or detours. During operation of Alternative 2, circulation and access could be adversely affected by increased peak-hour traffic volumes, as discussed above under Level of Service on Delta Roadways. The issues of circulation on and access to Delta roadways are assessed qualitatively in this section.

Impact TRA-5: Change in Circulation on or Access to Delta Roadways during Construction

Because most of the construction activity would take place on the interior side of the levees, implementation of Alternative 2 is not expected to cause traffic conflicts, detours, or lane closures during construction on the Project islands. Therefore, this impact is considered less than significant.

Mitigation

No mitigation is required.

Impact TRA-6: Change in Circulation on or Access to Delta Roadways during Operation

Implementation of Alternative 2 would not involve any alterations to the existing roadway network in the Project vicinity. Therefore, implementation of this alternative is not expected to change circulation patterns on Delta roadways. This impact is considered less than significant.

Mitigation

No mitigation is required.

Waterway Traffic and Circulation

No changes were made in the Project impacts and mitigation measures compared to the 2001 FEIR and 2001 FEIS with regard to waterway traffic and circulation. During operation of Alternative 2, waterway traffic would increase and could adversely affect boat circulation on Delta waterways. Under Alternative 2, an estimated 565 boats would originate from the Project recreation facilities on a peak summer day (see Table 4.10-5). In the 2001 FEIR, each boat's daily usage was described as two trips per boat. For the purposes of this analysis, each boat's daily usage is now described as 1 boat use-day, consisting of 4 hours of usage.

Bacon Island and Webb Tract each would generate 163 and 165 boat use-days; Bouldin Island and Holland Tract would generate 148 and 89 boat use-days, respectively (Table 4.10-5). There are no current studies to document boat-trip generation for the entire Delta (Jones and Stokes 2001). However, as described in the Recreation and Visual Resources analysis of the 2001 FEIR and 2001 FEIS, implementing Alternative 2 is projected to increase average annual boating in the

Delta by 5%. Therefore, the increase in peak-day boat use under Alternative 2 is assumed to be proportional to the estimated increase in annual boating recreation use.

Construction of new boat facilities would increase restrictions on existing boat use on waterways adjacent to the Project islands. As described in the Affected Environment section, boat speeds are restricted to 5 mph within 200 yards upstream or downstream of boat docks. If all Project recreation facilities were constructed in waterways that do not have existing speed restrictions, the facilities would require restrictions on more than 8 miles of Delta waterways. Restricted speeds, combined with boats moving into and out of waterways, create boat congestion on days of heavy recreation use. Therefore, implementing the Project would contribute to boat traffic congestion adjacent to the Project islands.

Navigation

During construction under Alternative 2, large barges loaded with rock would be transported to the Project islands. These barges most likely are to be loaded directly from a quarry located on the water (e.g., the San Rafael rock quarry on San Pablo Bay). Additionally, a barge would be permanently moored at the Project islands to assist offloading and placement of rock. Because of their size, barges could obstruct more than one-third the width of a channel. Therefore, use of barges would contribute to navigation and safety issues on Delta waterways during construction.

The maximum design of the recreation facilities includes a 30-berth floating boat dock and a gangway that extends 40 feet into the adjacent channels (see Appendix 2, "Supplemental Description of the Delta Wetlands Project Alternatives," of the 1995 DEIR/EIS, Figures 2-7 and 2-8). To minimize effects on navigability of Delta waterways, the Project would design and construct all floating boat docks and gangways in accordance with the recommended standards of the 1991 Department of Boating and Waterways' Layout, Design and Construction Handbook for Small Craft Boat Launching Facilities. In compliance with Corps recommendations for boat facilities, floating boat docks would not extend more than one-third the horizontal distance across the channel, and a navigation channel of not less than 100 feet would be maintained at all times.

Water discharged from the Reservoir Islands into adjacent channels would not adversely affect navigation in those locations. Pumps would have an expansion chamber to slow the speed of water entering the Delta channels. The cross-sectional area at the point of discharge would be 30 square feet, resulting in an exit velocity of 3.33 feet per second. By the time water has moved a few feet past the pump exit, the velocity would slow to well below scour velocity (see the Hydrodynamics analysis in the 2001 FEIR and 2001 FEIS), and with a pump spacing of 25 feet and a channel water depth of approximately 12 feet, the water velocity would slow to 0.33 foot per second by the time it reaches the surface. At this speed, water entering the Delta channels would not affect navigation of even small boats on the water surface.

Water storage on the Reservoir Islands could increase fog on the Project islands during the winter months but would not substantially affect existing fog conditions in the adjacent channel waters or in other parts of the Delta (Bohnak pers. comm.). Therefore, increased fog on the Reservoir Islands would not affect boater navigation in adjacent channels.

Safety

Implementation of Alternative 2 would adversely affect boating safety on Delta waterways by increasing boat traffic, contributing to congestion, and adversely affecting navigation during Project construction. The introduction of more boats to waterways surrounding the Project islands would increase the potential for accidents. As described above, excessive speeds, large wakes, boaters with limited knowledge and experience, and a lack of uniformity in signs regulating boat speeds and other boating information contribute to safety problems on Delta waterways. As described in the 2001 FEIR and 2001 FEIS, areas most prone to accidents are Little Potato Slough near Terminous, the southern end of Holland Tract near Palm Tract, areas along the southern portion of Bacon Island, and areas in the vicinity of Franks Tract along Piper Slough.

Impact TRA-7: Increase in Boat Traffic and Congestion on Delta Waterways during Operation

Implementation of Alternative 2 is projected to result in the addition of 565 boat use-days on a peak summer day to waterways in the Project vicinity. Based on estimated recreation use, it is estimated that boat use would increase by approximately 5% over existing conditions. Also, construction of the recreation facilities would restrict boat speeds on up to approximately 8 miles of Delta waterways. Restricted speeds, combined with boats moving into and out of waterways at the Project facilities, would create boat congestion on days of heavy recreational use. Therefore, this impact is considered significant.

Implementation of Mitigation Measure REC-MM-1 (see Section 4.9, Recreation and Visual Resources) would reduce Impact TRA-7 to a less-than-significant level.

Mitigation Measure REC-MM-1: Reduce the Size or Number of Recreation Facilities

Mitigation Measure REC-MM-1 will reduce the size or number of recreation facilities proposed on the Project Habitat islands (Bouldin Island and Holland Tract) by 70% and eliminate recreation facilities on the Reservoir Islands (Bacon Island and Webb Tract).

Implementation of this mitigation measure would reduce the number of permanent boat berths available from 1,140 to 144. As a result, the projected number of peak season (June–August) weekend boat use-days under Alternative 2 would be reduced from 565 to 70 boat use-days. Therefore, adverse impacts on boat traffic and congestion that would result from Project implementation would be greatly reduced.

Impact TRA-8: Change in Navigation Conditions on Delta Waterways Surrounding the Project Islands during Operation

Implementation of Alternative 2 would result in the construction of recreation facilities with floating boat docks and gangways that would extend into the channels. However, the floating boat docks and gangways would not extend more than one-third the horizontal distance across the channel and a navigation channel of not less than 100 feet would be maintained at all times. Additionally, the boat docks and gangways would be constructed in accordance with recommended standards of the 1991 Department of Boating and Waterways' Layout, Design and Construction Handbook for Small Craft Boat Launching Facilities. Therefore, this impact is considered less than significant.

Mitigation

No mitigation is required.

Impact TRA-9: Creation of Safety Conflicts on Delta Waterways during Construction

Implementation of Alternative 2 would result in a barge being permanently moored at the Project island where construction is occurring. This barge would have a crane on it and would be moored using long pilings that fit through openings in the base of the barge and are sunk into the riverbed (Jones & Stokes 2001). Tugboats would transport barges loaded with rock to the permanently moored barge for offloading and placement. Because of its size and the length of time that it would be located in adjacent channels, the barge is considered an obstruction and is a cause for safety concerns during construction. Therefore, this impact is considered significant.

Implementing Mitigation Measure TRA-MM-3 would reduce Impact TRA-9 to a less-than-significant level. This mitigation measure is the same as the one identified in the 2001 FEIR and 2001 FEIS.

Mitigation Measure TRA-MM-3: Clearly Mark the Barge and Notify the U.S. Coast Guard of Construction Activities

The construction contractor will ensure that the barge is well marked and lit in accordance with Title 14 of the California Code of Regulations, Section 7000 *et seq*. Additionally, the construction contractor will contact the U.S. Coast Guard 2 weeks before construction begins so that the Coast Guard can issue a notice to mariners alerting them to the presence of the barge and to construction activities occurring in the area. The contractor must inform the Coast Guard of the location and type of activity, whether night operations will be taking place, and whether there will be lights and buoys (Jones & Stokes 2001). These safety measures are common practice for contractors performing work in marine environments (Jones & Stokes 2001).

Impact TRA-10: Increase in the Potential for Safety Problem on Waterways Surrounding the Project Islands

Implementation of Alternative 2 would adversely affect boating safety on Delta waterways by increasing boat traffic, contributing to congestion, and adversely affecting navigation during Project construction. Therefore, this impact is considered significant.

Implementing Mitigation Measure TRA-MM-4 would reduce Impact TRA-10 to a less-than-significant level based on lessons learned from successful implementation at other sites. This mitigation measure is the same as the one identified in the 2001 FEIR and 2001 FEIS.

Mitigation Measure TRA-MM-4: Clearly Post Waterway Intersections, Speed Zones, and Potential Hazards in the Project Vicinity
Prior to operation of the Project recreation facilities, intersections will be assessed for speed requirements, poor visibility, and any unposted areas or potential hazards with respect to boating. If poor visibility or any potential boating hazards exist, these areas will be marked with buoys, waterway markers, and information signs in accordance with the California uniform waterway marking system or federal lateral waterway system. Speed requirements will be posted and enforced in accordance with local and state laws and ordinances. Regulations for boating activities proposed by local agencies must be submitted to, reviewed, and approved by the California Department of Boating and Waterways in accordance with the California Harbors and Navigation Code before they are adopted and implemented.

Air Traffic

No changes were made in the Project impacts and mitigation measures compared to the 2001 FEIR and 2001 FEIS with regard to air traffic from Bouldin Island. Under Alternative 2, the Bouldin Island airstrip would be available for maintenance and recreational activity on the Project islands. Hunters and other recreationists could fly to the island, and the Project would use the airstrip for habitat maintenance (e.g., seed dispersal, application of herbicide and pesticide). The HMP places restrictions on timing and frequency of takeoffs and landings from the airstrip during the waterfowl season (September 1 to March 31) to reduce disturbances to wildlife (see Appendix G3, "Habitat Management Plan for the Delta Wetlands Habitat Islands," of the 1995 DEIR/EIS). During other times of the year, no restrictions would be placed on use of the airstrip. However, the Project anticipates that the use of the airstrip would average up to 300 takeoffs and landings throughout the rest of the year, with approximately 50% of those flights occurring during summer. Combined with the limit of 100 takeoffs and landings during the hunt season, the number of flights generated from the airstrip under Alternative 2 would be less than current levels for agricultural activities. Although the season of peak airstrip use may change from existing conditions, implementing the Project would not substantially change operation of the airstrip. Therefore, no adverse effects on existing air traffic would occur.

Alternative 1

Impacts on traffic and navigation and mitigation measures for Alternative 1 are the same as those described for Alternative 2.

Alternative 3

Vehicle trips generated by the Project under Alternative 3 are almost the same as under Alternatives 1 and 2, as shown in Table 4.10-4. As a result, the peak-hour volumes are almost the same under Alternative 3 compared to Alternatives 1 and 2, as shown in Table 4.10-7. The resulting roadway LOS is exactly the same under Alternative 3 compared to Alternatives 1 and 2 (see Tables 4.10-12 and 4.10-13).

As far as navigation is concerned, Alternative 3 would generate the same number of boat use-days as Alternatives 1 and 2, except at Holland Tract, which would experience a slight increase of boat use-days during peak summer weekend conditions (120 boat use-days compared to 89). This is a relatively small increase of boat traffic, and overall navigation findings would remain unchanged.

Therefore, impacts on traffic and navigation and mitigation measures for Alternative 3 are the same as those described for Alternative 2.

No-Project Alternative

Increase in Traffic on Delta Roadways, Creation of Safety Conflicts on Delta Roadways, Decrease in Circulation on Delta Roadways

There would be fewer trips generated under the No-Project Alternative than under Alternatives 1 and 2 (see Tables 4.10-7 and 4.10-9). The resulting peak-hour volumes would be almost the same (slightly fewer) under the No-Project Alternative compared to Alternatives 1 and 2, and the roadway LOS would be exactly the same (see Tables 4.10-12 and 4.10-13). Therefore, impacts on traffic and traffic mitigation measures for the No-Project Alternative would be the same as those described for Alternative 2 during Project operations. The No-Project Alternative would not require any construction activities; therefore, there would be no impacts on traffic during construction.

As far as navigation is concerned, the No-Project Alternative would generate only a few additional agricultural boat trips (see Table 4.10-8). Because the No-Project Alternative would not include development of recreation facilities and boat docks and would not require construction activities, navigation conditions essentially would remain unchanged compared to existing conditions. Therefore, there would be no impacts under the No-Project Alternative.

Section 4.11
Cultural Resources

Introduction

This section describes recent changes to the existing environmental conditions and regulatory setting of the Project area, summarizes the unchanged affected environment, and describes changed environmental effects related to cultural resources for the Project. This section contains a review and update of the1995 DEIR/EIS cultural resources impact assessment, incorporated by reference in the 2001 FEIR. The cultural resources impacts of the Project were analyzed most recently in the 2001 FEIS, which also served as a basis for this analysis.

The 2001 FEIR and 2001 FEIS concluded that the Project alternatives would affect cultural resources on and in the vicinity of the four Project islands. Since that time, there have been minor changes in the affected environment and regulatory setting. However, there have been no changes in the Project that result in new significant environmental effects or a substantial increase in the severity of previously identified significant effects on cultural resources.

The 2001 FEIR and 2001 FEIS Cultural Resources analysis is updated to reflect current environmental conditions on and around the Project islands. The section includes expanded discussion of the importance of Piper soils, resources newly identified as California Register of Historical Resources (CRHR)–eligible, and changes in methods and circumstances since the 2001 FEIR and 2001 FEIS.

The Project will not have any direct effects on cultural resources in the places of use; the effects on cultural resources, if any, associated with the provision of Project water to the places of use are addressed in Chapter 5, "Cumulative Impacts," and Chapter 6, "Growth-Inducing Impacts."

Summary of Impacts

Table 4.11-1 provides a summary and comparison of the impacts and mitigation measures from the 2001 FEIR, 2001 FEIS, and this Place of Use EIR.

Table 4.11-1. Comparison between Delta Wetlands Project 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures for Cultural Resources

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
Alternatives 1 and 2	
Impact M-1: Disturbance of Buried Resources (If Present) in the Archaeologically Sensitive Piper Sands on Webb Tract (LTS-M) **Mitigation Measure M-1:** Prepare an HPMP to Provide for the Long-Term Monitoring and Treatment of Archaeologically Sensitive Areas on Webb Tract	**Impact CUL-2:** Disturbance to Archaeological Remains as a Result of Compaction, Inundation, Wave-Induced Erosion, or Habitat Development and Management (LTS-M) **Mitigation Measure CUL-MM-1:** Prepare and Implement a Historic Properties Treatment Plan The HPTP will include the following component in addition to those described for Impact CUL-1: **Mitigation Measure CUL-MM-1e:** Provide Methods and Guidance for Subsurface Testing in the Form of Remote Sensing and Excavation
Impact M-2: Disturbance of Intact Burials at CA-CCo-593 (If Present) on Holland Tract (LTS-M) **Mitigation Measure M-2:** Design Habitat Management and Enhancement Activities to Prevent Disturbance of CA-CCo-593 on Holland Tract	**Impact CUL-3:** Disturbance to Human Remains from Compaction as a Result of Inundation, Wave-Induced Erosion, Habitat Development and Management, or Vandalism (SU) **Mitigation Measure CUL-MM-1:** Prepare and Implement a Historic Properties Treatment Plan The HPTP will include the following component in addition to those described for Impact CUL-1: **Mitigation Measure CUL-MM-1f**: Negotiate, Prepare, and Implement a Preburial Agreement with the Most Likely Descendant (as Determined by the Native American Heritage Commission) of Potential Native American Interments Located in Webb Tract Piper Sands in the Project Area
Impact M-3: Disturbance of Intact Burials in CA-CCo-593 (If Present) Resulting from Vandalism on Holland Tract (LTS-M) **Mitigation Measure M-3:** Prepare an HPMP to Address Disturbance of Human Remains at CA-CCo-593 on Holland Tract	**Impact CUL-3:** Disturbance to Human Remains from Compaction as a Result of Inundation, Wave-Induced Erosion, Habitat Development and Management, or Vandalism (SU) **Mitigation Measure CUL-MM-1:** Prepare and Implement a Historic Properties Treatment Plan The HPTP will include the following component in addition to those described for Impact CUL-1: **Mitigation Measure CUL-MM-1f:** Negotiate, Prepare, and Implement a Preburial Agreement with the Most Likely Descendant (as Determined by the Native American Heritage Commission) of Potential Native American Interments Located in Webb Tract Piper Sands in the Project Area

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
Impact M-4: Disturbance of Buried Resources (If Present) in the Archaeologically Sensitive Piper Sands on Holland Tract (LTS-M) **Mitigation Measure M-4:** Prepare an HPMP to Provide for the Long-Term Monitoring and Treatment of Archaeologically Sensitive Areas on Holland Tract	**Impact CUL-2:** Disturbance to Archaeological Remains as a Result of Compaction, Inundation, Wave-Induced Erosion, or Habitat Development and Management (LTS-M) **Mitigation Measure CUL-MM-1:** Prepare and Implement a Historic Properties Treatment Plan The HPTP will include the following component in addition to those described for Impact CUL-1: **Mitigation Measure CUL-MM-1e:** Provide Methods and Guidance for Subsurface Testing in the Form of Remote Sensing and Excavation
Impact M-5: Demolition of the NRHP-Eligible Historic District on Bacon Island (SU) **Mitigation Measure M-5:** Prepare an HPMP and a Data Recovery Plan for Archaeological Deposits on Bacon Island **Mitigation Measure M-6:** Prepare a Videotape of Public Broadcasting System Quality of the NRHP-Eligible Historic District on Bacon Island **Mitigation Measure M-7:** Prepare a Popular Publication on Bacon Island Resources for Use by Museums, Cultural Centers, and Schools **Mitigation Measure M-8:** Complete Historic American Building Survey/Historic American Engineering Record Forms, Including Photographic Documentation, That Preserve Information about the NRHP-Eligible District on Bacon Island	**Impact CUL-1:** Destruction of Buildings and Structures from Demolition on Bacon Island (LTS-M) **Mitigation Measure CUL-MM-1:** Prepare and Implement a Historic Properties Treatment Plan **Mitigation Measure CUL-MM-1a:** Complete Historic Research, Measured Drawings, and Photographic Documentation of the Bacon Island Rural Historic District **Mitigation Measure CUL-MM-1b:** Prepare and Implement an Archaeological Resources Data Recovery Plan **Mitigation Measure CUL-MM-1c:** Produce a Publication to Disseminate Historical Information regarding the Bacon Island Rural Historic District to the Public **Mitigation Measure CUL-MM-1d:** Prepare a Video That Disseminates Historical Information and Explains the Character-Defining Features of the Bacon Island Rural Historic District to the Public
Impact M-6: Disturbance of Archaeological Site CA-SJo-208H on Bouldin Island (LTS-M) **Mitigation Measure M-9:** Prepare an HPMP and a Data Recovery Plan for Archaeological Deposits on Bouldin Island	**Impact CUL-2:** Disturbance to Archaeological Remains as a Result of Compaction, Inundation, Wave-Induced Erosion, or Habitat Development and Management (LTS-M) **Mitigation Measure CUL-MM-1:** Prepare and Implement a Historic Properties Treatment Plan The HPTP will include the following component in addition to those described for Impact CUL-1: **Mitigation Measure CUL-MM-1e:** Provide Methods and Guidance for Subsurface Testing in the Form of Remote Sensing and Excavation

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
Alternative 3	
Impact M-7: Disturbance of Buried Resources (If Present) in the Archaeologically Sensitive Piper Sands on Webb Tract (LTS-M) **Mitigation Measure M-1:** Prepare an HPMP to Provide for the Long-Term Monitoring and Treatment of Archaeologically Sensitive Areas on Webb Tract.	**Impact CUL-2:** Disturbance to Archaeological Remains as a Result of Compaction, Inundation, Wave-Induced Erosion, or Habitat Development and Management (LTS-M) **Mitigation Measure CUL-MM-1:** Prepare and Implement a Historic Properties Treatment Plan The HPTP will include the following components in addition to those described for Impact CUL-1: **Mitigation Measure CUL-MM-1e:** Provide Methods and Guidance for Subsurface Testing in the Form of Remote Sensing and Excavation **Mitigation Measure CUL-MM-1g:** Prepare and Implement an Archaeological Resources Data Recovery Plan for Site-Specific Resources
Impact M-8: Damage or Destruction of Known Archaeological Sites Resulting from Inundation, Wave Action and Erosion, or Vandalism on Holland Tract (SU) **Mitigation Measure M-10:** Prepare an HPMP and Conduct Data Recovery Excavations (Only Appropriate for CA-CCo-147) for Archaeological Materials on Holland Tract **Mitigation Measure M-11:** Cap Archaeological Sites on Holland Tract **Mitigation Measure M-12:** Construct Fencing or Other Barriers to Prevent Site Access on Holland Tract **Mitigation Measure M-13:** Construct Levees or Beach Slopes around Archaeological Sites to Decrease Wave Action and Erosion on Holland Tract **Mitigation Measure M-14:** Prepare an HPMP to Provide for the Long-Term Monitoring of Known Archaeological Sites on Holland Tract	**Impact CUL-2:** Disturbance to Archaeological Remains as a Result of Compaction, Inundation, Wave-Induced Erosion, or Habitat Development and Management (LTS-M) **Mitigation Measure CUL-MM-1:** Prepare and Implement a Historic Properties Treatment Plan The HPTP will include the following components in addition to those described for Impact CUL-1: **Mitigation Measure CUL-MM-1e:** Provide Methods and Guidance for Subsurface Testing in the Form of Remote Sensing and Excavation **Mitigation Measure CUL-MM-1g:** Prepare and Implement an Archaeological Resources Data Recovery Plan for Site-Specific Resources
Impact M-9: Disturbance of Buried Resources (If Present) in the Archaeologically Sensitive Piper Sands on Holland Tract (LTS-M) **Mitigation Measure M-4:** Prepare an HPMP to Provide for the Long-Term Monitoring and Treatment of Archaeologically Sensitive Areas on Holland Tract	**Impact CUL-2:** Disturbance to Archaeological Remains as a Result of Compaction, Inundation, Wave-Induced Erosion, or Habitat Development and Management (LTS-M) **Mitigation Measure CUL-MM-1:** Prepare and Implement a Historic Properties Treatment Plan The HPTP will include the following components in addition to those described for Impact CUL-1: **Mitigation Measure CUL-MM-1e:** Provide Methods and Guidance for Subsurface Testing in the Form of Remote Sensing and Excavation **Mitigation Measure CUL-MM-1g:** Prepare and Implement an Archaeological Resources Data Recovery Plan for Site-Specific Resources

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
Impact M-10: Disturbance of Unknown Resources on Unsurveyed Portions of Holland Tract (LTS-M) **Mitigation Measure M-15:** Survey Unsurveyed Portions of Holland Tract and Determine Eligibility for NRHP Listing and Appropriate Treatment	**Impact CUL-2:** Disturbance to Archaeological Remains as a Result of Compaction, Inundation, Wave-Induced Erosion, or Habitat Development and Management (LTS-M) **Mitigation Measure CUL-MM-1:** Prepare and Implement a Historic Properties Treatment Plan The HPTP will include the following components in addition to those described for Impact CUL-1: **Mitigation Measure CUL-MM-1e:** Provide Methods and Guidance for Subsurface Testing in the Form of Remote Sensing and Excavation **Mitigation Measure CUL-MM-1g:** Prepare and Implement an Archaeological Resources Data Recovery Plan for Site-Specific Resources
Impact M-11: Demolition of the CRHR-Eligible Historic District on Bacon Island (SU) **Mitigation Measure M-5:** Prepare an HPMP and a Data Recovery Plan for Archaeological Deposits on Bacon Island **Mitigation Measure M-6:** Prepare a Videotape of Public Broadcasting System Quality of the NRHP-Eligible Historic District on Bacon Island **Mitigation Measure M-7:** Prepare a Popular Publication on Bacon Island Resources for Use by Museums, Cultural Centers, and Schools **Mitigation Measure M-8:** Complete Historic American Building Survey/Historic American Engineering Record Forms, Including Photographic Documentation, That Preserve Information about the NRHP-Eligible District on Bacon Island	**Impact CUL-1:** Destruction of Buildings and Structures from Demolition on Bacon Island (LTS-M) **Mitigation Measure CUL-MM-1:** Prepare and Implement a Historic Properties Treatment Plan **Mitigation Measure CUL-MM-1a:** Complete Historic Research, Measured Drawings, and Photographic Documentation of the Bacon Island Rural Historic District **Mitigation Measure CUL-MM-1b:** Prepare and Implement an Archaeological Resources Data Recovery Plan **Mitigation Measure CUL-MM-1c:** Produce a Publication to Disseminate Historical Information regarding the Bacon Island Rural Historic District to the Public **Mitigation Measure CUL-MM-1d:** Prepare a Video That Disseminates Historical Information and Explains the Character-Defining Features of the Bacon Island Rural Historic District to the Public
Impact M-12: Disturbance of Archaeological Site CA-SJo-208H on Bouldin Island (LTS) **Mitigation Measure M-9:** Prepare an HPMP and a Data Recovery Plan for Archaeological Deposits on Bouldin Island	**Impact CUL-2:** Disturbance to Archaeological Remains as a Result of Compaction, Inundation, Wave-Induced Erosion, or Habitat Development and Management (LTS-M) **Mitigation Measure CUL-MM-1:** Prepare and Implement a Historic Properties Treatment Plan The HPTP will include the following components in addition to those described for Impact CUL-1: **Mitigation Measure CUL-MM-1e:** Provide Methods and Guidance for Subsurface Testing in the Form of Remote Sensing and Excavation **Mitigation Measure CUL-MM-1g:** Prepare and Implement an Archaeological Resources Data Recovery Plan for Site-Specific Resources

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
	Impact CUL-3: Disturbance to Human Remains from Compaction as a Result of Inundation, Wave-Induced Erosion, Habitat Development and Management, or Vandalism (SU) **Mitigation Measure CUL-MM-1:** Prepare and Implement a Historic Properties Treatment Plan The HPTP will include the following component in addition to those described for Impact CUL-1: **Mitigation Measure CUL-MM-1f:** Negotiate, Prepare, and Implement a Preburial Agreement with the Most Likely Descendant (as Determined by the Native American Heritage Commission) of Potential Native American Interments Located in Webb Tract Piper Sands in the Project Area **Mitigation Measure CUL-MM-1g:** Prepare and Implement an Archaeological Resources Data Recovery Plan for Site-Specific Resources

Note: SU = Significant and unavoidable; LTS = Less than significant; LTS-M = Less than significant with mitigation; B = Beneficial.

Summary of Changes, New Circumstances, and New Information

Changes in the affected environment, regulatory setting, and environmental effects of the Project related to cultural resources are described in the Existing Conditions section below. A summary of findings based on that consideration follows.

Substantial Changes in the Project

Since the 2001 FEIR and 2001 FEIS were completed, there have been no substantial changes in the Project resulting in new significant effects or substantial increase in the severity of effects on cultural resources.

New Circumstances

Since the 2001 FEIR and 2001 FEIS were completed, there have been no substantial new circumstances resulting in new significant effects or substantial increase in the severity of effects on cultural resources.

New Information

There is no new information of substantial importance that would result in an increase in severity of effects on cultural resources. However, since the publication of the 2001 FEIR and 2001 FEIS, new information and methods have been developed for identification of and consultation concerning cultural resources.

The key sources of new data and information used in the preparation of this section are:

- findings from updated records searches of the California Historical Resources Information System repositories;
- an updated reconnaissance-level survey of the built environment; and
- consultation with historical organizations, as well as federally and non-federally recognized Native American groups.

The new methods and practices used consist of changes in:

- the determination of cultural resource significance in consideration of the cultural values of indigenous groups, descendant groups, and historical entities;
- methods of identifying subsurface remains through remote sensing techniques;
- understanding of the types and depths of resources possible in Piper soils; and
- requirements in identifying the potential for deeply buried resources.

In assessing the significance of archaeological resources, cultural resource managers typically give the most weight to Criterion D/Criterion 4 of the NRHP/CRHR significance criteria (see Regulatory Setting below). Essentially, cultural resource managers consider primarily the scientific information potential of archaeological resources when evaluating resource significance. Whereas this is acceptable practice under federal and state cultural resources regulations, the application of Criterion D/Criterion 4 does not obviate the need to evaluate archaeological resources under Criteria A–C/1–3. Archaeological sites are often places where the ancestors of living communities are buried or where traditional activities are still carried out, the latter often qualifying the resource as a "traditional cultural property." Since the publication of works concerning the documentation of traditional cultural properties (King 2003; Parker and King 1998), it has become commonplace for cultural resource managers to find archaeological sites that contain human remains significant under Criterion A/1.

ICF updated the impacts and mitigation discussions to include remote-sensing investigations as a means of resource identification and evaluation, in light of advances made with instruments such as ground-penetrating radar since the 1990s. Properly employed, remote-sensing instruments are invaluable tools for cultural resources management in that the use of such instruments causes very little to no damage on cultural resources. (Conyers 2004; Conyers and Goodman 1997; Feder 1997:59–63.)

In light of these new methods and requirements, ICF Jones & Stokes conducted an updated investigation of the cultural resources in the Project area. Those efforts are reflected in an expanded discussion of Piper soils and an increase in the number of cultural resources determined eligible for the California Register of Historic Resources, among other findings. The archaeological potential of Piper soils in the Project area also addresses the potential for buried archaeological resources—that is, archaeological resources that are not evident on the present ground surface—in the Project area. This important issue is the focus of a recent archaeological study in the Project vicinity (Rosenthal and Meyer 2004).

Existing Conditions

This section discusses changes in the existing conditions or regulatory setting since the 2001 FEIR and 2001 FEIS.

Regulatory Setting

Federal

Section 106 of the National Historic Preservation Act

The Project requires a permit from the Corps under Section 404 of the CWA. As the federal permitting agency, the Corps is required to comply with Section 106 of the National Historic Preservation Act (NHPA) of 1966 as amended, and its implementing regulations (36 CFR Part 800).

Section 106 of the NHPA requires that, before beginning any federally permitted undertaking, the federal agency must take into account the effects of the undertaking on historic properties and afford the Advisory Council on Historic Preservation (ACHP) an opportunity to comment on these actions (the term *historic properties* is defined in the section below entitled National Register of Historic Places. The Section 106 process has five basic steps.

1. Initiate the Section 106 consultation process.
2. Identify and evaluate historic properties.
3. Assess effects of the undertaking on historic properties.
4. Resolve any adverse effects of the Project on historic properties in consultation with the State Historic Preservation Officer (SHPO), resulting in a Memorandum of Agreement (MOA) that spells out specific measures to avoid or mitigate impacts on the historic property.
5. Proceed in accordance with the MOA.

Specific regulations regarding compliance with Section 106 state that, although the tasks necessary to comply with Section 106 may be delegated to others, the federal agency (in this case, the Corps) is ultimately responsible for ensuring that the Section 106 process is completed according to statute.

Summary of Past Project Section 106 Compliance

Under circumstances defined at 36 CFR 800, a federal agency may execute and implement a programmatic agreement (PA) to satisfy the requirements of Section 106. Such an agreement document was executed among the Corps, the State Water Board, the SHPO, the ACHP, and the Project applicant regarding the implementation of the Project in December 1997. The PA calls for an inventory of the remaining unsurveyed area of the Project area, and the evaluation of any properties recorded as a result of this survey for National Register of Historic Places (NRHP) eligibility. The PA also calls for the development and implementation of a Historic Properties Management Plan (HPMP), which will call for, among other tasks, the development of monitoring plans and data recovery plans as necessary. Other subjects addressed in the PA include procedures for: changes in the Project or Project area; inadvertent discovery of cultural materials or human remains during Project implementation; participation of interested parties; review, consultation, and coordination among the Corps, the State Water Board, the SHPO, and the ACHP; curation and disposition of cultural and human remains; and dispute resolution.

National Register of Historic Places

Section 106 requires federal agencies, or those they fund or permit, to consider the effects of their actions on historic properties—that is, properties that may be eligible for listing or are listed in the NRHP. To determine whether an undertaking could affect NRHP-eligible properties, cultural resources (including archeological, historical, and architectural properties) must be inventoried and evaluated for the NRHP. To qualify for listing in the NRHP, a property must be at least 50 years old or, if less than 50 years old be of exceptional historic significance. It must represent a significant theme or pattern in history, architecture, archaeology, engineering, or culture at the local, state, or national level. A property must meet one or more of the four criteria listed below. The criteria for evaluation of the eligibility of cultural resources for listing in the NRHP are defined in 36 CFR 60.4 as follows:

> The quality of significance in American history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and
>
> (A) that are associated with events that have made a significant contribution to the broad patterns of our history; or
>
> (B) that are associated with the lives of persons significant in our past; or
>
> (C) that embody the distinctive characteristics of a type, period or method of construction, or that represent the work of a master, or that possess high artistic value, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
>
> (D) that have yielded, or may be likely to yield, information important in prehistory or history.

In addition to meeting the significance criteria, potentially historic properties must possess integrity to be considered eligible for listing in the NRHP. Integrity refers to a property's ability to convey its historic significance (National Park Service 1991). Integrity is a quality that applies to historic resources in seven specific ways: location, design, setting, materials, workmanship, feeling, and association. A resource must possess two, and usually more, of these kinds of integrity, depending on the context and the reasons the property is significant.

State

California Register of Historical Resources

The CRHR was created by the California State Legislature in 1992 and is intended to serve as an authoritative listing of historical and archaeological resources in California. Additionally, the eligibility criteria for the CRHR are intended to serve as the definitive criteria for assessing the significance of historical resources for purposes of CEQA compliance, establishing a consistent set of criteria for use by all public agencies statewide.

For a historical resource to be eligible for listing in the CRHR, it must be significant at the local, state, or national level under one or more of the following criteria from State CEQA Guidelines Section 15064.5(a)(3), Subsections (A)–(D).

- It is associated with events that have made a significant contribution to the broad patterns of California's history and cultural heritage (Criterion 1).
- It is associated with the lives of persons important in our past (Criterion 2).
- It embodies the distinctive characteristics of a type, period, region, or method of construction, or represents the work of an important creative individual or possesses high artistic values (Criterion 3).
- It has yielded, or may be likely to yield, information important in prehistory or history (Criterion 4).

Local

Bacon and Bouldin Islands are located in San Joaquin County, and Webb and Holland Tracts are located in Contra Costa County. The local regulations established by San Joaquin and Contra Costa Counties that pertain to the islands that fall within their respective boundaries are described below.

Contra Costa County General Plan

Contra Costa County's General Plan includes a historic and cultural resources element designed to assist the County in its objective to, "identify and preserve important archaeological and historic resources within the County." The following polices are noted in the General Plan:

1. Areas which have identifiable and important archaeological or historic significance shall be preserved for such uses, preferably in public ownership.
2. Buildings or structures that have visual merit and historic value shall be protected.
3. Development surrounding areas of historic significance shall have compatible and high quality design in order to protect and enhance the historic quality of the area.
4. Within the Southeast County area, applicants for subdivision or for land-use permits to allow nonresidential uses shall provide information to the County on the nature and extent of the archaeological resources that exist in the area. The County Planning Agency shall be responsible for determining the balance between the multiple uses of the land with the protection of resources.

San Joaquin County General Plan

San Joaquin County's General Plan includes a Heritage Resources element designed to assist the County in its objective to, "[p]rotect San Joaquin County's valuable architectural, historical, archaeological, and cultural resources." The following polices are noted in the General Plan:

1. The County shall continue to encourage efforts, both public and private, to preserve its historical and cultural heritage.
2. Significant archaeological and historical resources shall be identified and protected from destruction. If evidence of such resources appears after development begins, an assessment shall be made of the appropriate actions to preserve or remove the resources.
3. No significant architectural, historical, archaeological or cultural resources shall be knowingly destroyed through County action.
4. Reuse of architecturally interesting or historical buildings shall be encouraged.
5. The County shall promote public awareness of and support for historic preservation.

Affected Environment

Existing cultural resources conditions are, for the most part, as they were presented in the 2001 FEIR and 2001 FEIS and are hereby incorporated by reference. An updated cultural resources investigation resulted in the following minor changes to the affected environment.

California Register of Historical Resources–Eligible Resources

A number of CRHR-eligible resources have been identified in the Project area, as shown in Table 4.11-2. This section presents the CRHR-eligible resources on each island and discusses any changes that have occurred since the 2001 FEIR and 2001 FEIS. In each case of a CRHR-eligible resource, the criteria for which the resource is eligible are explained to assist in defining appropriate mitigation measures.

In addition, there are some resources that either have not been formally evaluated previously or cannot be until further extensive remote sensing and subsurface excavation are conducted. These are, for the purposes of this Project, presumed to be CRHR-eligible resources. These include known areas of Piper sand mounds and sites recently identified in the documentary record.

Table 4.11-2. Changes in Findings Regarding CRHR-Eligible Resources

CRHR-Eligible Resource	Island/Tract	CRHR Criteria
Bacon Island Rural Historic District	Bacon Island	1, 2, 4
CA-SJO-208H	Bouldin Island	4
CA-SJO-210H	Bouldin Island	4
CA-CCO-147	Holland Tract	1, 4
CA-CCO-593	Holland Tract	1
CA-CCO-678	Holland Tract	1
Piper Soils (approximately 100 acres)	Holland Tract	1, 4
Piper Soils (approximately 335 acres)	Webb Tract	1, 4

Bacon Island Rural Historic District

The Bacon Island Rural Historic District was identified in the 2001 FEIR and 2001 FEIS as having several important contributing elements, including the cultural landscape, water system, and the remaining architectural fabric of the camps, components of camp design, and archaeological remains. These remains are associated with ten labor camps that were determined eligible for the NRHP under Criteria A, B, C, and D.

However, since 2001, 20 buildings in the historic district have been destroyed through vandalism, fire, and deterioration, and one building was demolished during an emergency levee repair. Although the district retains integrity sufficient to convey significance under CRHR Criteria 1, 2, and 4, it no longer appears to retain sufficient integrity to convey its significance under Criterion 3. The built environment resources have suffered substantial loss of integrity through their complete demolition or their deterioration to the point of losing the materials and workmanship that illustrated the vernacular Craftsman architectural style for which they were deemed significant.

All of the cultural resources in the district are significant under CRHR Criteria 1 and 2 for their association with George Shima, a Japanese farmer influential in the development of Delta lands for agriculture following island reclamation. Mr. Shima employed Japanese tenant farmers during the early 1900s when laws prohibited Asians from owning land. Buildings and structures, although no longer contributing for their architectural integrity, still provide information regarding camp layout and function. Finally, seven known archaeological sites that contain material important to ongoing research on Japanese-American culture are present on the island (Criterion 4). Consequently, the Bacon Island Rural Historic District appears to be eligible under CRHR Criteria 1, 2, and 4, and therefore resources that compose the district are historical resources for the purposes of CEQA.

Archaeological Sites

CA-SJO-208H

CA-SJO-208H is a historic archaeological site located on Bouldin Island that is eligible for the CRHR under Criterion 4. No changes to the known existing conditions as of 2001 on Bouldin Island have been identified.

CA-SJO-210H

CA-SJO-210H is a historic archaeological site located on Bouldin Island consisting of the remains of George Shima's Camp #16, which was established in 1916 and used until World War II (Maniery and Wilcox 1988; Paterson et al. 1978). The records search data show this site was recorded by PAR & Associates as part of the Delta Wetlands Water Storage Project; it does not appear in the associated report (PAR & Associates 1989). Because no documentation exists indicating it was evaluated and found not eligible for either the NRHP or the CRHR, CA-SJO-210H is considered eligible for the CRHR under Criterion 4 for the purposes of this Place of Use EIR.

CA-CCO-147

CA-CCO-147 is a prehistoric archaeological site that contains intact human remains and appears to retain a substantial archaeological deposit. The site is eligible for listing in the CRHR under Criteria 1 and 4 because of its data potential (Criterion 4) and because of the importance that Native Americans place on burials (Criterion 1).

CA-CCO-593

CA-CCO-593 is a prehistoric archaeological site on Holland Tract that was determined not eligible for the NRHP because it lacks archaeological integrity. However, a number of disarticulated human skeletal remains were observed during the excavation. It is now common practice to consider sites that have human remains to be significant cultural resources (Parker and King 1998). Such sites therefore can be considered eligible for the CRHR because of their association with important events, specifically because they hold cultural importance to Native Americans. This renders the site now eligible for the CRHR under Criterion 1.

CA-CCO-678

CA-CCO-678 does not contain intact archaeological deposits and does not meet CRHR eligibility Criterion 4 for its archaeological value. However, intact human remains that have importance to Native Americans have been found at this site. It is now common practice to consider sites that have human remains eligible for the CRHR because of their association with important events, specifically because they hold cultural importance to Native Americans. Therefore, the site is eligible for the CRHR under Criterion 1.

Piper Soils

Among areas of greatest prehistoric archaeological sensitivity in the Delta region are those where Piper soils are located (Jones & Stokes 2007:20). The Piper sand mounds of the Delta are remnant soil formations typically associated with Early and Middle Horizon archaeological sites that once stood above the level of the surrounding tule marshes. Because of their elevation above the frequently inundated peat soils, these sand mounds often were used by prehistoric peoples for village and burial sites (Jones & Stokes 2007:20).

Numerous excavations in the Delta area have shown that Piper sand formations are indicators for buried prehistoric sites that include habitation debris and human burials. Typically, there is little to no superficial indication of these sites, and as a result, many of the archaeological finds were inadvertent discoveries associated with ground-disturbing grading or quarrying activities. (Jones & Stokes 2007:29–30.) It is possible more sites exist on the Project islands than have been discovered to date, although few portions of the islands are above sea level.

Several factors affect the visibility of Piper sand formation archaeological sites, including sea-level fluctuation, dune formation, and increases in sedimentation rates from human activities such as hydraulic mining in the Sierra Nevada foothills. Because of this, traditional methods of surface survey are not as effective for locating archaeological sites in the Delta region. The most successful archaeological studies of Piper sand sites have consisted of extensive subsurface exploration that has often been rewarded with a wealth of new data on the early inhabitants of this culturally and environmentally unique region. (Jones & Stokes 2007:29–30.)

Piper Soils on Holland Tract

There are 100 acres of Piper sand mounds on Holland Tract that would be affected by Alternative 3 only. These Piper sand mounds have not been surveyed because they are on property that is not owned or under the control of the Project applicant, and the current owner did not permit the area to be surveyed. These soils could contain significant archaeological resources and human burials. Because there is potential for significant buried resources, this soil component is considered eligible for the CRHR under Criteria 1 and 4 for the purposes of this Place of Use EIR.

Piper Soils on Webb Tract
No cultural resources have been identified on Webb Tract. However, 335 acres of Piper soil that could contain significant archaeological resources are present on the tract. These Piper sand mounds have been surveyed, but no archaeological resources were found. Because there is potential for significant buried resources, this soil component is considered eligible for the CRHR for the purposes of this Place of Use EIR.

Environmental Commitments

The environmental commitments, as described in Chapter 2, would not alter the impact findings related to cultural resources.

Environmental Effects

Methods

This analysis of environmental effects on cultural resources was prepared by applying the State CEQA Guidelines significance criteria to expected Project impacts. Also considered were procedural changes in cultural resources management, as outlined earlier under New Information, above.

Significance Criteria

The cultural resources impact analysis considered several criteria for determining the significance of impacts related to this resource. The analysis took into account both relevant criteria contained in Appendix G of the State CEQA Guidelines (Association of Environmental Professionals 2009) and Project-specific criteria developed by the lead agency to address potential impacts unique to the Project's location and elements.

State CEQA Guidelines Section 15064.5(a) dictates that a resource can qualify as a significant historical resource for the purposes of CEQA review if it meets any of the following criteria.

- It is listed in or determined eligible for listing in the CRHR.
- It is included in a local register of historical resources, as defined in Section 5020.1(k) of the California Public Resources Code, or identified as significant in a historical resource survey that meets the requirements of Section 5024.1(g) of the Public Resources Code, unless the preponderance of evidence demonstrates that it is not historically or culturally significant.
- The lead agency determines it is significant as supported by substantial evidence in light of the whole record.

For a historical resource to be eligible for listing in the CRHR, it must be significant at the local, state, or national level under one or more of the following criteria from State CEQA Guidelines Section 15064.5(a)(3)(A)–(D).

- It is associated with events that have made a significant contribution to the broad patterns of California's history and cultural heritage (Criterion 1).
- It is associated with the lives of persons important in our past (Criterion 2).
- It embodies the distinctive characteristics of a type, period, region, or method of construction, or represents the work of an important creative individual or possesses high artistic values (Criterion 3).
- It has yielded, or may be likely to yield, information important in prehistory or history (Criterion 4).

A project has a significant effect on the environment when it causes a "substantial adverse change in the significance of a historic resource," defined as the "…physical demolition, destruction, relocation, or alteration of the resource or its immediate surroundings such that the significance of a historic resource would be materially impaired." (State CEQA Guidelines Section 15064.5(b)(1).

Impacts and Mitigation Measures

Impacts on cultural resources resulting from implementing the Project were described in the 2001 FEIR and 2001 FEIS and are listed in Table 4.11-1. Where there have been no changes to the impact analysis or conclusions, the 2001 FEIR and 2001 FEIS is incorporated by reference, and the impact conclusions and mitigation measures are summarized briefly in the following section.

Proposed Project (Alternative 2)

Impact CUL-1: Destruction of Buildings and Structures from Demolition on Bacon Island

Because properties on Bacon Island are eligible for CRHR listing as a historic district, the effect of implementation of Alternative 2 on the district as a whole must be assessed.

The majority of the buildings contributing to the eligibility of the Bacon Island Rural Historic District would be affected by reconstruction of the levees and inundation as all buildings are planned for demolition. Most of the structures lie on the perimeters of the islands in areas that would be disturbed by reconstruction of levees. Structures on the sides or near the bases of levees would be subject to significant impacts resulting from fill placement.

This impact is considered significant; however, implementing Mitigation Measures CUL-MM-1a through CUL-MM-1d would reduce this impact to a less-than-significant level.

Affected Resources

- Bacon Island Rural Historic District

Mitigation Measure CUL-MM-1: Prepare and Implement a Historic Properties Treatment Plan

Prior to implementation of any Project activities, the lead agency will ensure that a Historic Properties Treatment Plan (HPTP) is prepared and implemented by individuals who meet the Secretary of Interior's Standards for Archaeology, History, and Architectural History. This HPTP will include specific detailed guidance and methods to mitigate impacts to a less-than-significant level. The HPTP will include the following components:

Mitigation Measure CUL-MM-1a: Complete Historic Research, Measured Drawings, and Photographic Documentation of the Bacon Island Rural Historic District. This documentation will meet the minimum requirements of the Historic American Building Survey/Historic American Engineering Record/Historic American Landscape Survey for resources with national significance. This component of the HPTP will be completed before components CUL-MM-1c and CUL-MM-1d so the results may be integrated into the products required by those components.

Mitigation Measure CUL-MM-1b: Prepare and Implement an Archaeological Resources Data Recovery Plan. This plan will specify how significant archaeological data will be recovered from the Bacon Island Rural Historic District, analyzed, and reported to professionals and the public. This component of the HPTP will be completed before components CUL-MM-1c and CUL-MM-1d so the results may be integrated into the products required by those components.

Mitigation Measure CUL-MM-1c: Produce a Publication to Disseminate Historical Information regarding the Bacon Island Rural Historic District to the Public. This document should combine historical photographs with information gathered from historical research and interviews to describe the history of Bacon Island and its relevance to modern society. The publication should be prepared for use by schools, historical societies, local museums, and the general public.

Mitigation Measure CUL-MM-1d: Prepare a Video That Disseminates Historical Information and Explains the Character-Defining Features of the Bacon Island Rural Historic District to the Public. This production should be prepared to meet the technical requirements for airing on the Public Broadcasting System (PBS), as specified in the PBS producers' handbook.

Impact CUL-2: Disturbance to Archaeological Remains as a Result of Compaction, Inundation, Wave-Induced Erosion, or Habitat Development and Management

Because the value of archaeological resources often depends on their integrity, Project activities that disturb buried resources could render them insignificant. If significant buried resources are disturbed by implementation of Alternatives 1, 2, or 3, such disturbance would be considered a significant impact. Implementing

Mitigation Measure CUL-MM-1 would reduce this impact to a less-than-significant level.

Affected Resources

- Piper sands on Webb Tract

Mitigation Measure CUL-MM-1: Prepare and Implement a Historic Properties Treatment Plan
The HPTP will include the following component in addition to those described above:

Mitigation Measure CUL-MM-1e: Provide Methods and Guidance for Subsurface Testing in the Form of Remote Sensing and Excavation. This testing will determine the presence or absence of significant archaeological remains within Piper soils in the Project area. If significant archaeological resources are identified, prepare and implement an archaeological resources data recovery plan that specifies how significant archaeological data will be recovered from the Piper soils in the Project area, analyzed, and reported to professionals and the public. Specify notification procedures in the event of discovery of cultural materials in the archaeologically sensitive Piper sand deposits. The HPMP will include a monitoring plan to address impacts resulting from inadvertent discovery of cultural resources during ongoing Project operations and will outline treatment and management requirements for these resources.

Impact CUL-3: Disturbance to Human Remains as a Result of Compaction, Inundation, Wave-Induced Erosion, Habitat Development and Management, or Vandalism

Ground-disturbing activities could uncover previously undiscovered burials within the Project area. Disturbance of intact burials would be considered a significant impact. Implementing CUL-MM-1 would reduce the severity of this impact but not to a less-than-significant level. This impact is significant and unavoidable.

Affected Resources

- Piper sands (Webb) (Alternatives 1, 2, 3)

Mitigation Measure CUL-MM-1 Prepare and Implement a Historic Properties Treatment Plan
The HPTP will include the following components in addition to those described under Impacts CUL-1 and CUL-2:

Mitigation Measure CUL-MM-1f: Negotiate, Prepare, and Implement a Preburial Agreement with the Most Likely Descendant (as Determined by the Native American Heritage Commission) of Potential Native American Interments Located in Webb Tract Piper Sands in the Project Area. Specific mitigation and/or treatment in relation to the potential for burials will be dependent upon this negotiation. Mitigation and/or treatment typically includes adoption of project design guidelines that minimize disturbance to sensitive areas as well as methods and guidance for: identifying intact interments; recovery, treatment, and reburial of interments; and the ultimate ownership of human remains and burial items. Mitigation and/or treatment also typically includes methods and guidance in the event of an inadvertent discovery of human remains.

Alternative 1

The impacts and mitigation measures for Alternative 1 are identical to those for Alternative 2, described above.

Alternative 3

Impact CUL-1: Destruction of Buildings and Structures from Demolition on Bacon Island

This impact is the same as described under Alternative 2.

Mitigation Measure CUL-MM-1: Prepare and Implement a Historic Properties Treatment Plan
These mitigation measures (CUL-MM-1a through CUL-MM-1d) are the same as described under Alternative 2.

Impact CUL-2: Disturbance to Archaeological Remains as a Result of Compaction, Inundation, Wave-Induced Erosion, or Habitat Development and Management

This impact and mitigation measure are the same as described under Alternative 2, with the exception that they apply to the resources in the bullet list below. Mitigation Measure CUL-MM-1g is added as well.

Affected Resources

- Piper sands on Webb Tract
- CA-SJO-208H on Bouldin Island
- CA-SJO-210H on Bouldin Island
- CA-CCO-147 on Holland Tract
- Piper sands on Holland Tract

Mitigation Measure CUL-MM-1: Prepare and Implement a Historic Properties Treatment Plan
The HPTP will include the following components in addition to those described under Alternative 2:

Mitigation Measure CUL-MM-1g: Prepare and Implement an Archaeological Resources Data Recovery Plan for Site-Specific Resources. This plan will specify how significant archaeological data will be identified; recovered from sites CA-SJO-208H, CA-SJO-210H, and CA-CCO-147; analyzed; and reported to professionals and the public.

Impact CUL-3: Disturbance to Human Remains as a Result of Compaction, Inundation, Wave-Induced Erosion, Habitat Development and Management, or Vandalism

This impact and associated mitigation measures are the same as described for Alternative 2, except that they apply to resources listed below.

Affected Resources

- Piper sands (Webb Tract)
- CA-CCO-593 (Holland Tract)
- CA-CCO-147 (Holland Tract)
- CA-CCO-678 (Holland Tract)
- Piper sands (Holland Tract)

Mitigation Measure CUL-MM-1 Prepare and Implement a Historic Properties Treatment Plan

The HPTP will include the following components in addition to those described under Alternative 2, above:

Mitigation Measure CUL-MM-1g: Prepare and implement an archaeological resources data recovery plan that specifies how significant archaeological data will be identified; recovered from sites CA-SJO-208H, CA-SJO-210H, and CA-CCO-147; analyzed; and reported to professionals and the public.

No-Project Alternative

Activities associated with the No-Project Alternative consist of intensified agricultural practices on all four islands, as well as an intensified for-fee hunting program. On Holland and Webb Tracts, any intensification of activities that affect Piper soils could increase the extent and severity of disturbance of prehistoric resources. Reintroduction of hog feeding could affect the Piper sand mounds if animals are concentrated in those areas. Grazing, plowing, and planting and levee construction and replenishment are activities associated with intensified agricultural practices, and all have the potential to disturb or destroy significant cultural resources on the islands. However, this result is not significantly different from continued present practice.

Because of the potential for unearthing Native American burials, the California Public Health and Safety Code and the Public Resources Code apply. If agreement between the landowner and the NAHC cannot be reached, the landowner nonetheless is required to re-inter the human remains and items associated with Native American burials with appropriate dignity on the property in a location not subject to further subsurface disturbance. Any disturbance or removal of human remains without authority of law is a felony under the California Public Health and Safety Code.

Damage to Historic Structures Resulting from Agricultural Practices, Hunting, and Continued Vandalism on Bacon Island

Under existing conditions or the No-Project Alternative, an indirect effect of agriculture on cultural resources results from the use of historic structures as boarding houses. Normal wear and tear and modification of the structures without concern for their historic integrity could reduce their significance. Continued use of the structures in this manner probably would result in a need for replacement, perhaps accompanied by demolition of the historic structures. Occupation of the historic structures provides some protection because they are less vulnerable to vandalism. Vandalism does occur currently, however, to some degree, and greater human presence as a result of increased hunting could slightly elevate that risk. The advanced stage of deterioration of the structures may be accelerating the normal wear and tear of neglect from the natural elements (e.g., rain, wind, sun, vegetation). Damage to historic structures resulting from agricultural practices and continued vandalism under the No-Project Alternative is not significantly changed from existing conditions.

Disturbance of Archaeological Resources or Human Remains as a Result of Agricultural Activities

Affected resources are: Piper sands on Webb Tract, CA-SJO-208H on Bouldin Island, CA-SJO-210H on Bouldin Island, CA-CCO-147 on Holland Tract, Piper sands on Holland Tract, CA-CCO-593 on Holland Tract, and CA-CCO-678 on Holland Tract. If the No-Project Alternative is selected, disturbance of archaeological resources or human remains as a result of agricultural activities is not significantly changed from existing conditions. Intact burials that are inadvertently discovered in known sites during agricultural activities should be treated as outlined above. Treatment could include removing the burials from the site and reburying them elsewhere, in consultation with the NAHC.

Section 4.12
Mosquitoes and Public Health

Introduction

This section describes recent changes to the existing environmental conditions and regulatory setting of the Project area, summarizes the unchanged affected environment, and describes changed environmental effects related to mosquitoes and public health for the Project. This section contains a review and update of the1995 DEIR/EIS mosquitoes and public health impact assessment, incorporated by reference in the 2001 FEIR. The mosquitoes and public health impacts of the Project most recently were analyzed in the 2001 FEIS, which also served as a basis for this analysis.

The 2001 FEIR and 2001 FEIS concluded that the Project alternatives would affect public health on and in the vicinity of the four Project islands. Since that time, there have been minor changes in the affected environment and regulatory setting. However, there have been no changes in the Project that result in new significant environmental effects or a substantial increase in the severity of previously identified significant effects on public health.

The 2001 FEIR and 2001 FEIS "Mosquitoes and Public Health" analysis has been updated here to reflect current environmental conditions on and around the Project islands. Information regarding mosquito breeding conditions and mosquito abatement activities on the Project islands has been updated, and a discussion of West Nile virus, which has emerged as a public health risk since the publication of the 2001 FEIR and 2001 FEIS, has been added. In addition, Mitigation Measure PH-1 has been updated to reflect guidelines for design and management of constructed wetlands recently published by the Central Valley Joint Venture, California Department of Health Services, and Sacramento-Yolo Mosquito and Vector Control District. These changes are minor and do not affect the results of the analysis reported in the 2001 FEIR and 2001 FEIS.

Identification of the Project's specific places of use as part of the affected Project environment does not affect mosquitoes and public health in any way that alters the conclusions of the 2001 FEIR and 2001 FEIS. The Project will not have any direct effects on mosquitoes and public health in the places of use; the effects on mosquitoes and public health, if any, associated with the provision of Project water to the places of use are addressed in Chapter 5, "Cumulative Impacts," and Chapter 6, "Growth-Inducing Impacts."

Summary of Impacts

Table 4.12-1 provides a summary and comparison of the impacts and mitigation measures for mosquitoes and public health from the 2001 FEIR, 2001 FEIS, and this Place of Use EIR.

Table 4.12-1. Comparison between Delta Wetlands Project 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures for Mosquitoes and Public Health

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
ALTERNATIVES 1 AND 2	
Impact N-1: Reduction or Elimination of Mosquito Abatement Activities during Full-Storage Periods on the Reservoir Islands (B) **Mitigation:** No mitigation is required.	**Impact PH-1:** Reduction or Elimination of Mosquito Abatement Activities during Full-Storage Periods on the Reservoir Islands (B and LTS) **Mitigation:** No mitigation is required. No change.
Impact N-2: Increase in Abatement Levels on the Habitat Islands and during Partial-Storage, Shallow-Storage, or Shallow-Water Wetland Periods on the Reservoir islands (LTS-M) **Mitigation Measure N-1:** Coordinate Project Activities with SJCMAD and CCMAD.	**Impact PH-2:** Increase in Abatement Levels on the Habitat Islands and during Partial-Storage, Shallow-Storage, or Shallow Water–Wetland Periods on the Reservoir Islands (LTS-M) **Mitigation Measure PH-MM-1:** Develop an Integrated Pest Management Program and Coordinate Project Activities with SJCMVCD and CCCMVCD This impact has not changed. The mitigation measure has been updated to conform to current guidelines regarding design and management of constructed wetlands.
Impact N-3: Increase in Potential Exposure of People to Wildlife Species that Transmit Diseases (LTS) **Mitigation:** No mitigation is required.	**Impact PH-3:** Increase in Potential Exposure of People to Wildlife Species that Transmit Diseases (LTS) **Mitigation:** No mitigation is required. No change.
ALTERNATIVE 3	
Impact N-4: Reduction or Elimination of Mosquito Abatement Activities during Full-Storage Periods on the Reservoir Islands (B) **Mitigation:** No mitigation is required.	**Impact PH-1:** Reduction or Elimination of Mosquito Abatement Activities during Full-Storage Periods on the Reservoir Islands (B and LTS) **Mitigation:** No mitigation is required. No change.
Impact N-5: Increase in Abatement Levels during Partial-Storage, Shallow-Storage, or Shallow-Water Wetland Periods on the Reservoir Islands and in the NBHA (LTS-M) **Mitigation Measure N-1:** Coordinate Project Activities with SJCMAD and CCMAD.	**Impact PH-2:** Increase in Abatement Levels during Partial-Storage, Shallow-Storage, or Shallow Water–Wetland Periods on the Reservoir Islands and in the NBHA (LTS-M) **Mitigation Measure PH-MM-1:** Develop an Integrated Pest Management Program and Coordinate Project Activities with SJCMVCD and CCCMVCD This impact has not changed. The mitigation measure has been updated to conform to current guidelines regarding design and management of constructed wetlands.
Note: SU = Significant and unavoidable; LTS = Less than significant; LTS-M = Less than significant with mitigation; B = Beneficial.	

Summary of Changes, New Circumstances, and New Information

Changes in the affected environment, regulatory setting, and environmental effects of the Project related to mosquitoes and public health are described in the Existing Conditions section below. A summary of findings based on that consideration follows.

Substantial Changes in the Project

Since the 2001 FEIR and 2001 FEIS were completed, there have been no substantial changes in the Project resulting in new significant effects or substantial increase in the severity of effects on public health.

New Circumstances

New circumstances pertinent to the public health analysis are related to the advent of West Nile virus as a human health risk and changed conditions on and around the Project islands.

West Nile Virus

Since the 2001 FEIR and 2001 FEIS, West Nile virus has emerged as a public health risk in the Project area. This mosquito-borne disease has sickened 2,765 humans, led to the death of 91 humans in California since 2003 (California Department of Public Health 2009a), and caused increased mosquito abatement activities throughout the state.

West Nile virus is now well established in all 58 counties of California. West Nile virus is a disease transmitted to humans, birds, horses, and other animals by infected mosquitoes. Mosquitoes get the disease from infected birds while taking blood, and can later transmit it when they bite humans or other animals. West Nile virus can cause encephalitis in humans. Most infections are mild, with flu-like symptoms. Severe infections may include neck stiffness, disorientation, coma, tremors, convulsions, muscle weakness, paralysis, and rarely, death. From 2006 through 2008, 45 cases of West Nile virus were reported in Contra Costa and San Joaquin Counties, with two deaths related to the virus in Contra Costa County and one death related to the virus in San Joaquin County (California Department of Public Health 2007, 2008, 2009b).

The advent of West Nile virus as a public health risk has affected the programs and operations of local mosquito and vector control districts (MVCDs). Tolerance thresholds for mosquitoes in populated areas are significantly lower, having been reduced in recent years by almost one-half (Sanabria pers. comm.).

The threat of West Nile virus has triggered MVCDs to increase surveillance, trapping, and adulticide application programs (Sanabria and Lucchesi pers. comm.). MVCDs in the Delta now have a heightened concern about two mosquito species in particular that are the chief vectors for West Nile virus in the Delta: *Culex pipiens* and *Culex tarsalis* (Lucchesi pers. comm.). Breeding conditions and other information for these species were described in the 2001 FEIR and 2001 FEIS and are hereby incorporated by reference.

Changes in Mosquito Breeding Habitat and Mosquito Abatement Activities

The 2001 FEIR and 2001 FEIS used 1988 conditions to describe baseline conditions on and around the islands and to analyze the Project's effects on public health. The analysis for this document is based on updated (2008) baseline conditions.

Mosquito habitat conditions and, consequently, mosquito abatement activities on some of the Project islands have changed since the publication of the 2001 FEIR and 2001 FEIS. This is primarily because cropping and land use patterns on the Project islands have changed. A summary of recent mosquito breeding conditions and abatement activities undertaken on each Project island in 2008 by the Contra Costa County and San Joaquin County MVCDs are described in the Existing Conditions section below.

Conditions in the areas around the Project islands also have changed. Population in the secondary zone of the Delta has increased significantly over the past 20 years, and new residential development has placed more humans within the range of mosquitoes originating on the Project islands. For example, the city of Brentwood's population increased from 7,563 to 48,907 between 1990 and 2007 (California Department of Water Resources 1995; Contra Costa County 2009). Much of the city of Brentwood is located within 5 miles of Holland Tract—5 miles being the distance some mosquitoes are able to travel from production areas.

New Information

There is no new information of substantial importance that would result in an increase in severity of effects on public health. However, since the publication of the 2001 FEIR and 2001 FEIS, new information and methods have been developed for mosquito management in constructed wetlands.

Public attitudes about wetlands have changed greatly in the last few decades, shifting from viewing wetlands as wasted land that should be reclaimed for commercial uses to recognizing the value of wetlands for habitat, recreational opportunities, and the benefits they provide in terms of flood control, water filtration, and groundwater recharge. This has led to a major increase in managed wetlands projects throughout California (Kwasny et al. 2004). To address public health concerns about mosquito production in these managed wetlands, several groups have developed guides and habitat management strategies to reduce mosquito production in managed wetlands, and to facilitate greater cooperation among wetland habitat managers and MVCDs. MVCDs now are encouraging "integrated pest management" (IPM), which incorporates multiple strategies to achieve effective control of mosquitoes. These strategies include:

- source reduction—designing wetlands and operations to be inhospitable to mosquitoes;
- monitoring—implementing monitoring and sampling programs to detect early signs of mosquito population problems;
- biological control—use of biological agents such as mosquitofish to limit larval mosquito populations;
- chemical control—larvicides and adulticides; and
- cultural control—changing the behavior of people so their actions prevent the development of mosquitoes or the transmission of vector-borne disease.

Mitigation Measure PH-1 has been updated pursuant to current IPM practices and calls for modifications to the Habitat Management Plan in coordination with the Contra Costa County Mosquito and Vector Control District (CCCMVCD) and the San Joaquin County Mosquito and Vector Control District (SJCMVCD). The key sources of new information pertaining to mosquito management strategies used in the update of Mitigation Measure PH-1 include:

- Guidelines for Wetland Development, Central Valley Joint Venture, 2004;
- Best Management Practices for Mosquito Control on California State Properties, California Department of Public Health, June 2008; and
- Mosquito Reduction Best Management Practices, Sacramento-Yolo Mosquito and Vector Control District, 2008.

Existing Conditions

This section discusses changes in the existing conditions or regulatory setting since the 2001 FEIR and 2001 FEIS.

Regulatory Setting

Bacon and Bouldin Islands are located in San Joaquin County, and Webb and Holland Tracts are located in Contra Costa County. Regulatory conditions, including local regulations regarding public health established by San Joaquin and Contra Costa Counties that pertain to the islands that fall within their respective boundaries, are, for the most part, as they were presented in the 2001 FEIR and 2001 FEIS and are hereby incorporated by reference. Little has changed in relation to the rights and powers of MVCDs since publication of the

2001 FEIR and 2001 FEIS (Lucchesi pers. comm.); however, some minor changes have occurred in the operations of the MVCDs and are noted here.

The 2001 FEIR and 2001 FEIS refers to "mosquito abatement districts"; however, mosquito abatement districts are now known as "mosquito and vector control districts" Bouldin and Bacon Islands are within the jurisdiction of the SJCMVCD, and Holland and Webb Tracts are within the jurisdiction of the CCCMVCD.

CCCMVCD's and SJCMVCD's primary sources of revenue are property taxes and benefit assessments. The 2001 FEIR and 2001 FEIS referred to Contra Costa's 1993 policy requiring landowners to either provide abatement or enter into a service contract with the District if abatement costs exceeded $500 per mosquito production source as the CCCMVCD's main enforcement tool. Today, the $500 limit still functions as a rough enforcement threshold, but in general, if the CCCMVCD spends more money performing abatement activities on a certain parcel than they receive in taxes and benefit assessments from that parcel, they will begin to seek compensation from that landowner. The CCCMVCD has administrative citation authority and can issue citations from $100 to $1,000 per day for public health violations. Though they have citation authority, the CCCMVCD does not resort to citations very often, as most landowners are willing to cooperate when faced with the possibility of citation (Sanabria pers. comm.).

The SJCMVCD follows a similar citation process. The abatement process begins when a landowner has been contacted by the SJCMVCD and informed that a condition exists causing mosquitoes to breed on his or her land. The SJCMVCD uses a three-step process. First, the landowner/lessee is provided an "information sheet" that details information on mosquito prevention requirements. Second, a "notice to comply" form is used should the landowner/lessee not respond to the information provided in the information sheet. Finally, the last step would be a citation, or official notice to abate the public nuisance pursuant to the California Health and Safety Code §2272. The citation states that the landowner has 24 hours from service of the citation to abate the mosquito breeding condition or face civil penalties of up to $1,000 per day for each day not in compliance. Usually the landowner is not charged for the mosquito control work being conducted; however, the SJCMVCD can recoup those costs during the "citation" phase should the Board of the SJCMVCD want to seek reimbursement (Lucchesi pers. comm.).

Affected Environment

Existing public health conditions are, for the most part, as they were presented in the 2001 FEIR and 2001 FEIS and are hereby incorporated by reference. However, some changes in mosquito breeding habitat have occurred on the Project islands. The majority of changed conditions in mosquito breeding habitat and abatement activities on the Project islands are attributable to changed cropping and land use patterns. As described in the 2001 FEIR and 2001 FEIS (hereby incorporated by reference), different cropping and land use patterns create differing amounts of suitable mosquito breeding habitat. The 2001 FEIR and 2001 FEIS used 1988 conditions to describe baseline conditions on the islands and to analyze the Project's effects on mosquito breeding conditions. Because cropping patterns and, consequently, mosquito breeding conditions have changed in 20 years, a baseline defined by 1988 conditions is no longer appropriate or relevant. Current cropping patterns on the islands in many cases are substantially different from 1988 patterns (see Table 4.8-2 in Section 4.8, Land Use and Agriculture). Changes in the affected environment since the 2001 FEIR and 2001 FEIS are presented below for each of the Project islands.

Bacon Island

Bacon Island continues to be intensively farmed, but cropping patterns have changed since 1988. Alfalfa, corn, and wheat made up nearly 90% of the crops grown on Bacon Island in 2008. Potatoes are no longer grown or processed on the island. In 1988, the production of seed potatoes on Bacon Island accounted for 52.5% of San Joaquin County's production of the crop, and the ponds receiving tailwater from potato processing were regularly treated for mosquito production by the SJCMVCD. However, seed potatoes have not been produced on Bacon Island since 2003, and the SJCMVCD no longer needs to treat the potato processing tailwater ponds as regularly for mosquitoes, although the ponds still exist and occasionally produce mosquito populations (Lucchesi pers. comm.).

As described in the 2001 FEIR and 2001 FEIS, the SJCMVCD still receives occasional service requests from the resorts around Bacon Island. However, the SJCMVCD does not consider Bacon Island a problem mosquito production area because the island is managed for agricultural production and water is not used in a way that normally causes mosquito breeding (Lucchesi pers. comm.).

Webb Tract

Corn production on Webb tract has nearly doubled since 1988. In 2008, 98% of the agricultural land on Webb Tract was planted in corn. During the winter months, fields on Webb Tract are flooded for duck habitat. However, the CCCMVCD still does not consider Webb Tract a problem mosquito source because the land manager takes precautions to minimize mosquito breeding habitat, like tilling the soil before flooding, which eliminates many of the conditions conducive to mosquito production. The CCCMVCD has a collaborative relationship with the land managers and is consulted regularly on how and when the fields are flooded. Webb Tract was inspected by the CCCMVCD 53 times in 2008, and required only one mosquito control treatment (Sanabria pers. comm.).

Bouldin Island

The majority of Bouldin Island is now farmed for corn and rice. These two crops accounted for nearly 77% of the island's agricultural acreage in 2008. The acreage devoted to corn production has almost doubled since 1988, and rice is a new crop on the island since that time. The rice fields require surveillance and subsequent treatment for mosquito production approximately six times per year (Lucchesi pers. comm.).

After harvest, the corn fields on Bouldin Island are flooded to attract migrating waterfowl. The corn stubble that is left in the fields after harvest can start to decay after flooding if the weather is still hot. This causes the water to become anaerobic and serve as good mosquito breeding habitat. The SJCMVCD works with the land managers on Bouldin Island to postpone the introduction of floodwater until late October to avoid prime mosquito breeding conditions.

The SJCMVCD still receives occasional service requests from the resorts around Bouldin Island. However, because the SJCMVCD has a cooperative working relationship with the land managers, and because the rice and corn fields are managed for agricultural production, mosquito treatment on Bouldin Island is predictable. The SJCMVCD does not consider Bouldin Island a problem mosquito production source (Lucchesi pers. comm.).

Holland Tract

Since 1988, all agricultural land on Holland Tract has been converted to pasture; corn and wheat are no longer grown on the island. During the period of 2002–2008, 2,884 acres of Holland Tract were used for pasture each year, an equivalent of approximately 60% of the island's total acreage; none of the island was used for crop production during this period (Delta Wetlands Properties 2008).

The CCCMVCD still considers certain areas of Holland Tract to be problem mosquito production areas, though the major problem areas on the island are not under Project applicant ownership. The CCCMVCD performs some mosquito abatement activities on Project applicant land, but does not consider those lands to be a problem mosquito source because the Project applicant collaborates with the CCCMVCD on timing and duration of flooding activities (Sanabria pers. comm.).

Other areas of Holland Tract produce problem numbers of mosquitoes, mainly because of the large amount of irrigated, non-leveled pasture. Non-leveled pastures can trap and hold water in depressions for long enough periods of time to create favorable mosquito breeding conditions. There is also a duck club on Holland Tract with very rudimentary flooding infrastructure that is occasionally a problem mosquito source area. Mosquitoes originating on Holland Tract have caused problems for residents of Bethel Island to the north of Holland Tract and for residents of Oakley to the west of Holland Tract. From January 1, 2008 through July 15, 2009, the CCCMVCD received 191 service request calls from locations within a 5-mile radius of Holland Tract (Sanabria pers. comm.). The increase in service calls over 2001 numbers is likely due to population growth in adjacent areas described in the "New Circumstances" section above.

Environmental Commitments

The environmental commitments, as described in Chapter 2, would not alter the impact findings related to mosquitoes or public health.

Environmental Effects

Methods and Significance Criteria

The mosquito and public health impact analysis considered several criteria for determining the significance of impacts related to these issues. The analysis took into account both relevant criteria contained in Appendix G of the State CEQA Guidelines (Association of Environmental Professionals 2009) and Project-specific criteria developed by the lead agency to address potential impacts unique to the Project's location and elements.

The analytical approach, impact mechanisms, and significance criteria remain as presented in the 2001 FEIR and 2001 FEIS and are hereby incorporated by reference. To summarize, an alternative would be considered to have a significant impact if Project-related activities or changes to habitat would necessitate increased levels of mosquito abatement programs compared to existing conditions in order to maintain mosquito populations at pre-Project levels. Habitat changes that could result in a substantial decline of available mosquito breeding habitat or greater efficiency of MVCD abatement programs are considered to be beneficial impacts.

An alternative also would be considered to result in a significant impact if it would substantially increase potential exposure of people to wildlife-transmitted diseases considered a high health risk in the Delta area by the California Department of Public Health.

Impacts and Mitigation Measures

The impacts on public health resulting from implementation of the Project were described in detail in the 2001 FEIR and 2001 FEIS and are briefly summarized in Table 4.12-1. Where there have been no changes to the impact analysis, the 2001 FEIR and 2001 FEIS is incorporated by reference. Although the baseline conditions for existing levels of mosquito abatement activities have changed in some cases, this does not substantially affect the severity of previously identified impacts. Certain changes in the affected environment, such as changes in mosquito breeding conditions, have been incorporated into an updated analysis where relevant and are discussed below. None of these changes has resulted in new significant environmental effects or a substantial increase in the severity of previously identified significant effects on public health.

Proposed Project (Alternative 2)

Alternative 2 involves storage of water on Bacon Island and Webb Tract (Reservoir Islands) and management of Bouldin Island and Holland Tract (Habitat Islands) primarily for wetlands and wildlife habitat. The Reservoir Islands would be managed primarily for water storage, with wildlife habitat and recreation constituting secondary uses.

As described in the 2001 FEIR and 2001 FEIS, impacts of Alternative 2 were analyzed for the period during which potential problem numbers of mosquitoes could be produced on the Project islands (May 1 through October 31). Because The Project applicant may rotate the sequence of filling the Reservoir Islands, the analysis was conducted for the Project operating regime that would create the greatest potential for production of problem numbers of mosquitoes.

The discussions of mosquito breeding conditions, relative changes in the need for mosquito abatement, and incidence of wildlife-transmitted diseases affecting humans under Alternative 2 presented in the 2001 FEIR and 2001 FEIS have not changed and are hereby incorporated by reference.

Impact PH-1: Reduction or Elimination of Mosquito Abatement Activities during Full-Storage Periods on the Reservoir Islands

This impact has not changed since the 2001 FEIR and 2001 FEIS. During full-storage periods, mosquito production on the Reservoir Islands would be minimal. At full storage, water depths would exceed 10 feet over most of the islands and, because the water level would be at the riprapped levee slopes, reservoir edges would lack emergent vegetation that could be used as breeding areas by problem numbers of mosquitoes. Deep, open-water habitats are poor mosquito breeding areas because the wave action generated over large water bodies disrupts the ability of larvae to penetrate the water surface and because vegetation necessary for egg laying and cover for larvae is lacking (U.S. Fish and Wildlife Service 1992b). Implementation of Alternative 2 would substantially reduce mosquito production and, subsequently, the need for abatement on the Reservoir Islands during full-storage periods. Therefore, this impact is considered beneficial and less than significant.

Mitigation

No mitigation is required.

Impact PH-2: Increase in Abatement Levels on the Habitat Islands and during Partial-Storage, Shallow-Storage, or Shallow Water–Wetland Periods on the Reservoir Islands

This impact has not changed since the 2001 FEIR and 2001 FEIS. Implementation of Alternative 2 would result in an increase in mosquito breeding habitat on both the reservoir and Habitat Islands, at least during certain times of the year. Therefore, an increase in mosquito production likely would occur on the Habitat Islands and, during some years, on the Reservoir Islands under partial-storage, shallow-storage, or shallow water–wetland conditions. Substantially more people would be exposed to mosquitoes as a result of the recreation programs for hunting, boating, and other uses on the Project islands than are exposed under existing conditions (see the Recreation and Visual Resources analysis in the 2001 FEIR and 2001 FEIS for details on the recreation program). Increased exposure of people to mosquitoes would result in an increased need for abatement. Therefore, this impact is considered significant.

Implementation of Mitigation Measure PH-MM-1 would reduce Impact PH-2 to a less-than-significant level.

Mitigation Measure PH-MM-1: Develop an Integrated Pest Management Program and Coordinate Project Activities with SJCMVCD and CCCMVCD

This mitigation measure has been updated to incorporate new information that has become available since the publication of the 2001 FEIR and 2001 FEIS—specifically, new guidelines for wetland design and management, described above in the New Information discussion. Implementation of this mitigation measure will reduce the likelihood that Project operations will require an increase in abatement activities by the local MVCDs.

The Project applicant, DFG, and the Habitat Management Advisory Council (HMAC) will consult and coordinate with the SJCMVCD and CCCMVCD during all phases of the Project, including design, implementation, and operations, and the Habitat Management Plan will be updated in accordance with the best management practices identified in the Central Valley Joint Venture's Technical guide to *Best Management Practices for Mosquito Control in Managed Wetlands* (Kwasny et al. 2004) and other guidelines listed above in the "New Information" discussion. The Project applicant will be responsible for coordination with SJCMVCD and CCCMVCD regarding mosquito control measures for the Reservoir Islands, and the Project applicant, DFG, and the HMAC will be responsible for coordination regarding the Habitat Islands.

Consultation and coordination with SJCMVCD and CCCMVCD will include the development of an IPM plan for mosquitoes that follows the guidelines of the *Best Management Practices for Mosquito Control in Managed Wetlands* (Kwasny et al. 2004) and other guidelines listed in the New Information section above, and contains a continual maintenance program. An example list of the types of BMPs that should be considered in the IPM plan follows.

Wetland Design Features

- Design water delivery and drainage systems to allow for rapid manipulation of water levels within the wetlands. This could include construction of swales sloped from inlet to outlet to allow the majority of the wetland to be drawn down quickly, and independent inlets and outlets for each wetland unit.
- Ensure that shorelines, which may be vacillating, do not isolate from the main body of water sections that create pockets where mosquitoes would be free of competition and predation.
- Create basins with a high slope index, variable depths, and shallow and deep regions that provide open water zones adjacent to shallow vegetated zones.
- Install cross-levees to facilitate more rapid flood-up.
- Excavate deep channels or basins to maintain permanent water areas (deeper than 2.5 feet) within a portion of seasonal wetlands to provide year-round habitat for mosquito predators that can inoculate seasonal wetlands when flooded.

Water Management Practices

- Delay flooding of some wetland units until later in the fall, and delay flooding units with greatest historical mosquito production and/or those closest to urban areas.
- Flood wetland units as quickly as possible.
- Ensure constant flow of water into wetlands to reduce water fluctuation from evaporation, transpiration, outflow, and seepage.
- Flood wetland as deep as possible at initial flood-up.
- Flood wetlands with water sources containing mosquitofish or other invertebrate predators. Water from permanent ponds can be used to passively introduce mosquito predators.
- Drain any irrigation water into locations with mosquito predators as opposed to adjacent seasonal wetland or dry fields.
- Avoid “pulses” of increased organic load to inhibit episodic fluctuation in mosquito population numbers during the months of April–October.
- Use flood and drain techniques as a method to eliminate larvae.

Vegetation Management Practices

- Avoid continuous stands of emergent vegetation. These stands generate microhabitats that support mosquito productivity by providing refuge from predation, accumulation and concentration of organic foods, and interference with water circulation and wave action.
- Maintain aquatic vegetation in islands surrounded by deeper water. This breaks up the uniform microhabitat and provides variable physical and biological constraints on the mosquito population.

- Avoid plants that tend to mat the water surface. Promote plants in islands such as bulrush and cattails, which function as substrate for mosquito predators. Plants such as sago pondweed for example, are completely submergent and contribute little to mosquito refuge while providing good predator refuge and even waterfowl food.

Wetlands Maintenance

- Maintain levees, water control structures, and ditches regularly.
- Manage vegetation through periodic harvesting, thinning, discing, or burning to maintain open areas.
- Remove silt and detritus periodically to maintain regular wetland depth.

Biological Controls

- Encourage on-site predator populations by providing permanent water sources for mosquitofish. Such “dry season” predator reservoirs should be 18 inches or more in depth to reduce predation of mosquitofish by herons and egrets.
- Avoid use of broad spectrum insecticides that not only kill mosquitoes, but also eliminate their natural predators.
- Ensure mosquitofish have access to each basin.

Consultation with CCCMVCD and SJCMVCD

- Consult with CCCMVCD and SJCMVCD during the Project design phase to incorporate design and operational elements of the reservoir and Habitat Islands to reduce the mosquito production potential of the Project.
- Consult with CCCMVCD and SJCMVCD on the timing of wetland flooding.
- Regularly consult with SJCMVCD and CCCMVCD to identify mosquito management problems, mosquito monitoring and abatement procedures, and opportunities to adjust operations to reduce mosquito production during problem periods.
- Develop an access plan with the CCCMVCD and SJCMVCD to allow for monitoring and control of mosquito populations on the Project islands.
- Work with CCCMVCD and SJCMVCD to understand pesticides used for mosquito abatement, and their costs and environmental impacts.

If it is necessary for SJCMVCD and CCCMVCD to increase mosquito monitoring and control programs beyond pre-Project levels, the Project applicant will share costs with CCCMVCD and SJCMVCD or otherwise participate in implementing mosquito abatement programs.

Impact PH-3: Increase in Potential Exposure of People to Wildlife Species that Transmit Diseases

This impact refers to wildlife disease vectors other than mosquitoes and has not changed since the 2001 FEIR and 2001 FEIS. According to area MVCDs, non-mosquito disease vectors still are not considered a significant public health risk in the Delta (Sanabria and Lucchesi pers. comm.).

Under Alternative 2, the populations of wildlife species known to serve as hosts of wildlife-transmitted diseases affecting humans could increase on the Habitat Islands. Increased recreational use of these areas would increase the potential exposure of people to these species. However, transmission of wildlife-transmitted diseases such as Lyme disease, bubonic plague, and rabies is not considered a significant risk to public health in the Delta, and the increase in risk under Alternative 2 would be minor. Therefore, the potential change in risk to public health from exposure to wildlife species on the Habitat Islands is considered less than significant.

Mitigation
No mitigation is required.

Alternative 1

As described in the 2001 FEIR and 2001 FEIS, Alternative 1 is very similar to Alternative 2, differing only with regard to operating criteria for diversion and discharge of stored water on the Reservoir Islands. The Reservoir Island operating criteria for Alternative 1 could lead to different frequencies of mosquito breeding habitat creation than under Alternative 2. The frequency with which mosquito breeding habitat would be created on Bacon Island probably would be decreased because partial-storage, shallow-storage, and shallow water–wetland periods would decrease. The frequency of these habitat conditions on Webb Tract probably would increase from May through August when the island could be managed for shallow-water wetlands, but decrease during September and October.

Although the frequency of creation of mosquito habitat could differ, impacts and mitigation measures under Alternative 1 are generally the same as those under Alternative 2. The impact associated with the incidence of wildlife-transmitted diseases would also be the same under Alternative 1.

Alternative 3

Alternative 3 would include storage of water on all four Project islands, with secondary uses for wildlife habitat and recreation. The portion of Bouldin Island north of SR 12 would be managed as a wildlife habitat area (the NBHA) and would not be used for water storage.

The discussions of mosquito breeding conditions, relative changes in the need for mosquito abatement, and incidence of wildlife-transmitted diseases affecting humans under Alternative 3 presented in the 2001 FEIR and 2001 FEIS have not changed and are hereby incorporated by reference. As described in the 2001 FEIR and 2001 FEIS, wildlife species that could transmit diseases to humans are not expected to be present on the Reservoir Islands under Alternative 3 because their habitats would be reduced substantially as a result of water storage. Habitats created on the NBHA may increase the populations of these species in that area, but that increase would be negligible relative to the reduction in populations resulting from water storage. Therefore, implementing Alternative 3 would not affect the incidence of wildlife-transmitted diseases affecting humans. The CCCMVCD and the SJCMVCD have confirmed that wildlife-transmitted diseases still are not considered a significant public health risk in the Delta (Sanabria and Lucchesi pers. comm.).

Impact PH-1: Reduction or Elimination of Mosquito Abatement Activities during Full-Storage Periods on the Reservoir Islands

This impact has not changed since the 2001 FEIR and 2001 FEIS. This impact is similar to Impact PH-1, described above under Alternative 2, although in the case of Alternative 3, all four Project islands would serve as Reservoir Islands. This impact is considered beneficial and less than significant.

Mitigation

No mitigation is required.

Impact PH-2: Increase in Abatement Levels during Partial-Storage, Shallow-Storage, or Shallow Water–Wetland Periods on the Reservoir Islands and in the NBHA

This impact has not changed since the 2001 FEIR and 2001 FEIS and is similar to Impact PH-2, described above. This impact is considered significant.

Implementation of Mitigation Measure PH-MM-1 would reduce Impact PH-4 to a less-than-significant level.

Mitigation Measure PH-MM-1: Develop an Integrated Pest Management Program and Coordinate Project Activities with SJCMVCD and CCCMVCD

This mitigation measure is described above under the impact analysis for Alternative 2.

No-Project Alternative

The No-Project Alternative analysis remains largely as it was presented in the 2001 FEIR and 2001 FEIS and is hereby incorporated by reference. It is briefly summarized below, with consideration of changed cropping patterns incorporated. A new discussion is incorporated at the end of this section, regarding the intensive, for-fee hunting program that would be implemented under the No-Project Alternative.

Analysis of the No-Project Alternative anticipates an increase in corn cultivation on Holland and Webb Tracts. The 2001 FEIR and 2001 FEIS identify this as a potential impact, as it could involve increased fall flooding to control weeds in the cornfields, which could result in increases in mosquito production. This is no longer considered an impact for Webb Tract, as corn production has already doubled on the island, with no substantial increase in mosquito abatement activities.

Populations of wildlife species that could transmit diseases to humans are not expected to increase under the No-Project Alternative. Increased agricultural production may reduce populations by disturbing or eliminating their habitats through plowing and removing vegetation. Therefore, implementing the No-Project Alternative would not affect the incidence of wildlife-transmitted diseases affecting humans.

An intensive, for-fee hunting program would be implemented under the No-Project Alternative, generating an additional 12,000 hunter-use days per year. The presence of an increased number of hunters on the Project islands is not anticipated to require increased mosquito abatement activities, as the hunting season does not generally coincide with mosquito season, and because mosquito production levels are anticipated to decline under the No-Project Alternative (see impact discussion below).

Reduction of Mosquito Abatement Activities because of Increased Agricultural Operations

Under the No-Project Alternative, more intensive agricultural operations would be implemented on the four Project islands. The No-Project Alternative would increase the acreage of land cultivated for annual grains, perennial crops, orchards, and vineyards and reduce the acreage of irrigated pasture and marsh habitats, which have the potential to produce problem numbers of mosquitoes. This would result in a reduction of existing mosquito breeding habitat and consequently, a reduction in mosquito abatement activities on the Project islands.

Section 4.13
Air Quality

Introduction

This section describes recent changes to the existing environmental conditions and regulatory setting of the Project area, summarizes the unchanged affected environment, and describes changed environmental effects related to air quality for the Project. This section contains a review and update of the1995 DEIR/EIS air quality impact assessment, incorporated by reference in the 2001 FEIR. The air quality impacts of the Project were analyzed most recently in the 2001 FEIS, which also served as a basis for this analysis.

The 2001 FEIR and 2001 FEIS concluded that the Project alternatives would affect air quality on and in the vicinity of the four Project islands. Since that time, there have been minor changes in the affected environment and regulatory setting. However, there have been no changes in the Project that result in new significant environmental effects or a substantial increase in the severity of previously identified significant effects on air quality.

The 2001 FEIR and 2001 FEIS air quality analyses have been updated here to reflect current environmental conditions on and around the Project islands. These changes are minor and do not affect the results of the analyses reported in the 2001 FEIR and 2001 FEIS.

Identification of the Project's specific places of use as part of the affected environment does not affect air quality in any way that alters the conclusions of the 2001 FEIR and 2001 FEIS. The Project will have direct effects on air quality due increased energy used to bank Project water in the Semitropic Groundwater Storage Bank and the Antelope Valley Water Bank. These effects have been fully analyzed in the Semitropic Groundwater Banking Project Final EIR (SCH#1993072024), Semitropic Groundwater Banking Project Stored Water Recovery Unit Final Supplemental EIR (SCH#1999031100) and Antelope Valley Water Bank Final EIR (SCH#2005091117) and are not analyzed in this Place of Use EIR.

Indirect effects on air quality at the places of use may result from increased energy used as a result of removing a barrier to growth in the places of use. Such effects are fully analyzed by the urban water management plan EIR of each affected place of use, the analysis of which has been incorporated herein, where necessary. The indirect effects on air quality, if any, associated with the provision of Project water to the places of use are also addressed in Chapter 5, "Cumulative Impacts," and Chapter 6, "Growth-Inducing Impacts."

Summary of Impacts

Table 4.13-1 provides a summary and comparison of the impacts and mitigation measures from the 2001 FEIR, 2001 FEIS, and this Place of Use EIR.

Table 4.13-1. Comparison between Delta Wetlands Project 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures for Air Quality

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
ALTERNATIVES 1 AND 2	
Impact O-1: Increase in CO Emissions on the Project Islands during Construction (LTS) **Mitigation Measure O-1:** Perform Routine Maintenance of Construction Equipment **Mitigation Measure O-2:** Choose Borrow Sites Close to Fill Locations **Mitigation Measure O-3:** Prohibit Unnecessary Idling of Construction Equipment Engines	**Impact Air-1:** Increase in CO Emissions on the Project Islands during Construction (LTS) Mitigation is not required, but the following will reduce Project impacts: **Mitigation Measure Air-MM-1:** Perform Routine Maintenance of Construction Equipment **Mitigation Measure Air-MM-2:** Choose Borrow Sites Close to Fill Locations **Mitigation Measure Air-MM-3:** Prohibit Unnecessary Idling of Construction Equipment Engines No change.
Impact O-2: Increase in CO Emissions on the Project Islands during Project Operation (LTS) **Mitigation:** No mitigation is required.	**Impact Air-2:** Increase in CO Emissions on the Project Islands during Project Operation (LTS) **Mitigation:** No mitigation is required No change.
Impact O-3: Increase in ROG Emissions on the Project Islands during Construction (SU) **Mitigation Measure O-1:** Perform Routine Maintenance of Construction Equipment **Mitigation Measure O-2:** Choose Borrow Sites Close to Fill Locations **Mitigation Measure O-3:** Prohibit Unnecessary Idling of Construction Equipment Engines	**Impact Air-3:** Increase in ROG Emissions on the Project Islands during Construction (SU) **Mitigation Measure Air-MM-1:** Perform Routine Maintenance of Construction Equipment **Mitigation Measure Air-MM-2:** Choose Borrow Sites Close to Fill Locations **Mitigation Measure Air-MM-3:** Prohibit Unnecessary Idling of Construction Equipment Engines **Mitigation Measure REC-MM-1:** Reduce the Size or Number of Recreation Facilities No change.

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
Impact O-4: Increase in NO_X Emissions on the Project Islands during Construction (SU) **Mitigation Measure O-1:** Perform Routine Maintenance of Construction Equipment **Mitigation Measure O-2:** Choose Borrow Sites Close to Fill Locations **Mitigation Measure O-3:** Prohibit Unnecessary Idling of Construction Equipment Engines	**Impact Air-5:** Increase in NO_X Emissions on the Project Islands during Construction (SU) **Mitigation Measure Air-MM-1:** Perform Routine Maintenance of Construction Equipment **Mitigation Measure Air-MM-2:** Choose Borrow Sites Close to Fill Locations **Mitigation Measure Air-MM-3:** Prohibit Unnecessary Idling of Construction Equipment Engines **Mitigation Measure REC-MM-1:** Reduce the Size or Number of Recreation Facilities No change.
Impact O-5: Increase in ROG Emissions on the Project Islands during Project Operation (SU) **Mitigation Measure RJ-1:** Reduce the Number of Outward Boat Slips Located at Recreation Facilities **Mitigation Measure O-4:** Coordinate with Local Air Districts to Reduce or Offset Emissions	**Impact Air-4:** Increase in ROG Emissions on the Project Islands during Operation (LTS-M) **Mitigation Measure REC-MM-1:** Reduce the Size or Number of Recreation Facilities **Mitigation Measure Air-MM-4:** Coordinate with the SJVAPCD and BAAQMD to Reduce or Offset Emissions Reduced impact.
Impact O-6: Increase in NO_X Emissions on the Project Islands during Project Operation (SU) **Mitigation Measure RJ-1:** Reduce the Number of Outward Boat Slips Located at Recreation Facilities **Mitigation Measure O-4:** Coordinate with Local Air Districts to Reduce or Offset Emissions	**Impact Air-6:** Increase in NO_X Emissions on the Project Islands during Operation (LTS-M) **Mitigation Measure REC-MM-1:** Reduce the Size or Number of Recreation Facilities **Mitigation Measure Air-MM-4:** Coordinate with the SJVAPCD and BAAQMD to Reduce or Offset Emissions **Mitigation Measure Air-MM-5:** Use Electrically Powered Pumps in Lieu of Diesel Powered Pumps Reduced impact.
Impact O-7: Increase in PM10 Emissions on the Project Islands during Construction (SU) **Mitigation Measure O-1:** Perform Routine Maintenance of Construction Equipment **Mitigation Measure O-2:** Choose Borrow Sites Close to Fill Locations **Mitigation Measure O-3:** Prohibit Unnecessary Idling of Construction Equipment Engines **Mitigation Measure O-5:** Implement Construction Practices That Reduce Generation of Particulate Matter.	**Impact Air-7:** Increase in PM10 Emissions on the Project Islands during Construction (LTS-M) **Mitigation Measure Air-MM-6:** Implement Construction Practices that Reduce Generation of Particulate Matter Reduced impact.
Impact O-8: Increase in PM10 Emissions on the Project Islands during Project Operation (B) **Mitigation:** No mitigation is required.	**Impact Air-8:** Increase in PM10 Emissions on the Project Islands during Operation (B and LTS) **Mitigation:** No mitigation is required No change.

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
ALTERNATIVE 3	
Impact O-9: Increase in CO Emissions on the Project Islands during Construction (LTS) **Mitigation Measure O-1:** Perform Routine Maintenance of Construction Equipment **Mitigation Measure O-2:** Choose Borrow Sites Close to Fill Locations **Mitigation Measure O-3:** Prohibit Unnecessary Idling of Construction Equipment Engines	**Impact Air-1:** Increase in CO Emissions on the Project Islands during Construction (LTS) Mitigation is not required, but the following will reduce Project impacts: **Mitigation Measure Air-MM-1:** Perform Routine Maintenance of Construction Equipment **Mitigation Measure Air-MM-2:** Choose Borrow Sites Close to Fill Locations **Mitigation Measure Air-MM-3:** Prohibit Unnecessary Idling of Construction Equipment Engines No change.
Impact O-10: Increase in CO Emissions on the Project Islands during Project Operation (LTS) **Mitigation:** No mitigation is required.	**Impact Air-2:** Increase in CO Emissions on the Project Islands during Project Operation (LTS) **Mitigation:** No mitigation is required No change.
Impact O-11: Increase in ROG Emissions on the Project Islands during Construction (SU) **Mitigation Measure O-1:** Perform Routine Maintenance of Construction Equipment **Mitigation Measure O-2:** Choose Borrow Sites Close to Fill Locations **Mitigation Measure O-3:** Prohibit Unnecessary Idling of Construction Equipment Engines	**Impact Air-3:** Increase in ROG Emissions on the Project Islands during Construction (SU) **Mitigation Measure Air-MM-1:** Perform Routine Maintenance of Construction Equipment **Mitigation Measure Air-MM-2:** Choose Borrow Sites Close to Fill Locations **Mitigation Measure Air-MM-3:** Prohibit Unnecessary Idling of Construction Equipment Engines **Mitigation Measure REC-MM-1:** Reduce the Size or Number of Recreation Facilities No change.
Impact O-12: Increase in NO_X Emissions on the Project Islands during Construction (SU) **Mitigation Measure O-1:** Perform Routine Maintenance of Construction Equipment **Mitigation Measure O-2:** Choose Borrow Sites Close to Fill Locations **Mitigation Measure O-3:** Prohibit Unnecessary Idling of Construction Equipment Engines	**Impact Air-5:** Increase in NO_X Emissions on the Project Islands during Construction (SU) **Mitigation Measure Air-MM-1:** Perform Routine Maintenance of Construction Equipment **Mitigation Measure Air-MM-2:** Choose Borrow Sites Close to Fill Locations **Mitigation Measure Air-MM-3:** Prohibit Unnecessary Idling of Construction Equipment Engines **Mitigation Measure REC-MM-1:** Reduce the Size or Number of Recreation Facilities No change.
Impact O-13: Increase in ROG Emissions on the Project Islands during Project Operation (SU) **Mitigation Measure RJ-1:** Reduce the Number of Outward Boat Slips Located at Recreation Facilities **Mitigation Measure O-4:** Coordinate with Local Air Districts to Reduce or Offset Emissions	**Impact Air-4:** Increase in ROG Emissions on the Project Islands during Operation (LTS-M) **Mitigation Measure REC-MM-1:** Reduce the Size or Number of Recreation Facilities **Mitigation Measure Air-MM-4:** Coordinate with the SJVAPCD and BAAQMD to Reduce or Offset Emissions to Less than the Significance Threshold Reduced impact.

2001 FEIR and 2001 FEIS Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR and 2001 FEIR and 2001 FEIS Impacts and Mitigation Measures
Impact O-14: Increase in NO_X Emissions on the Project Islands during Project Operation (SU) **Mitigation Measure RJ-1:** Reduce the Number of Outward Boat Slips Located at Recreation Facilities **Mitigation Measure O-4:** Coordinate with Local Air Districts to Reduce or Offset Emissions	**Impact Air-6:** Increase in NO_X Emissions on the Project Islands during Operation (LTS-M) **Mitigation Measure REC-MM-1:** Reduce the Size or Number of Recreation Facilities **Mitigation Measure Air-MM-4:** Coordinate with the SJVAPCD and BAAQMD to Reduce or Offset Emissions to Less than the Significance Threshold **Mitigation Measure Air-MM-5:** Use Electrically Powered Pumps in lieu of Diesel Powered Pumps Reduced impact.
Impact O-15: Increase in PM10 Emissions on the Project Islands during Construction (SU) **Mitigation Measure O-1:** Perform Routine Maintenance of Construction Equipment **Mitigation Measure O-2:** Choose Borrow Sites Close to Fill Locations **Mitigation Measure O-3:** Prohibit Unnecessary Idling of Construction Equipment Engines **Mitigation Measure O-5:** Implement Construction Practices That Reduce Generation of Particulate Matter	**Impact Air-7:** Increase in PM10 Emissions on the Project Islands during Construction (LTS-M) **Mitigation Measure Air-MM-6:** Implement Construction Practices that Reduce Generation of Particulate Matter Reduced impact.
Impact O-16: Decrease in PM10 Emissions on the Project Islands during Project Operation (B) **Mitigation:** No mitigation is required.	**Impact Air-8:** Increase in PM10 Emissions on the Project Islands during Operation (B and LTS) **Mitigation:** No mitigation is required No change.

Note: SU = Significant and unavoidable; LTS = Less than significant; LTS-M = Less than significant with mitigation; B = Beneficial.

Summary of Changes, New Circumstances, and New Information

Changes in the affected environment, regulatory setting, and environmental effects of the Project related to air quality are described in the Existing Conditions section below. A summary of findings based on that consideration follows.

Substantial Changes in the Project

Since the 2001 FEIR and 2001 FEIS were completed, there have been no substantial changes in the Project resulting in new significant effects or substantial increase in the severity of effects on air quality.

New Circumstances

Since the 2001 FEIR and 2001 FEIS, there have been no new circumstances that result in new significant effects or substantial increase in the severity of effects on air quality. However, several of the national ambient air quality standards (NAAQS) and California ambient air quality standards (CAAQS) have been updated and are discussed below. Additionally, the updated environmental effects subsection discusses revision of the air quality significance thresholds established by the Bay Area Air Quality Management District (BAAQMD) and the San Joaquin Valley Air Pollution Control District (SJVAPCD); as well as the most recent nonattainment status for the Project site with regard to its location in both the San Francisco Bay Area Air Basin (SFBAAB) and the San Joaquin Valley Air Basin (SJVAB). Lastly, because the nonattainment status has changed for both the SFBAAB and the SJVAB, the applicable general conformity threshold levels also have changed. These newer significance thresholds and conformity thresholds were used to evaluate the Project's air quality–related environmental effects.

New Information

There is no new information of substantial importance that would result in an increase in severity of effects on air quality. However, the most recent air quality monitoring data for the monitoring stations located closest to the Project islands have been included in the air quality impact analysis for discussion. The environmental effects discussion also includes recalculated baseline and alternatives activity levels, with the activity levels used in the 2001 FEIR and 2001 FEIS reviewed and updated as necessary.

Using the updated activity levels, the Project's emissions were estimated. The emission estimates were based on the updated activity levels and emission factors and emission factor models that have been updated since the 2001 FEIR and 2001 FEIS.

Existing Conditions

This section discusses changes in the existing conditions or regulatory setting since the 2001 FEIR and 2001 FEIS. Project construction (i.e., earthwork and operation of construction equipment) as well as operation (i.e., recreation-generated vehicle and boat trips, agricultural activities, and operation of pumps) would be the primary source of air pollutant emissions during Project operations.

Sources of Information

This section describes the air quality environment in the Project vicinity for 2008–2009, which represents the baseline period. The information used to describe existing air quality conditions was derived from many sources, including the California Air Resources Board (ARB), the SJVAPCD, and the BAAQMD. Bacon and Bouldin Islands are located in San Joaquin County, which is within the jurisdiction of the SJVAPCD. Holland and Webb Tracts are located in Contra Costa County, which is within jurisdiction of the BAAQMD. The SJVAPCD is located within the SVAB, and the BAAQMD is located within the BAAB. Because the Project is located within multiple air districts with separate and distinct thresholds of significance, Project significance is evaluated using both air district thresholds of significance. The local regulations established by San Joaquin and Contra Costa Counties that pertain to the islands that fall within their respective boundaries are described below.

NAAQS and CAAQS are described below for each criteria pollutant of concern to provide context for the discussion of existing air quality conditions in the Project area. The pollutants of most concern include the ozone precursors (reactive organic gases [ROG] and oxides of nitrogen [NO_X]), carbon monoxide (CO), and particulate matter (both 10 microns or less in diameter [PM10] and 2.5 microns or less in diameter [PM2.5]). Information on sulfur dioxide (SO_2) and lead were not included in this chapter. Although both are criteria pollutants, SO_2 and lead are emitted primarily by industrial sources and neither is considered a pollutant of concern in the Project area. Nitrogen dioxide (NO_2) is usually not discussed separately from other NO_X compounds in analyses of nonindustrial projects because high NO_2 concentrations most often are associated with industrial combustion sources. Consequently, this air analysis focuses on NO_X compounds only as precursors to ozone.

Regulatory Setting

The following section describes new regulations affecting air quality relative to the Project and summarizes previously identified regulations.

Federal

No changes have been made to the CO NAAQS since the 2001 FEIR and 2001 FEIS. However, the NAAQS for both ozone and particulate matter have been modified since 2001. Table 4.13-2 shows the most recent NAAQS for all criteria pollutants. For ozone, the 1-hour NAAQS have been replaced by an 8-hour standard of 0.075 parts per million (ppm). Also, the annual PM10 standard has been dropped and new PM2.5 NAAQS have been developed for the 24-hour and annual averaging periods.

Table 4.13-2. Ambient Air Quality Standards Applicable in California

Pollutant	Averaging Time	CAAQS[a]	NAAQS[b]
Ozone (O_3)	1 hour	**0.09 ppm**	–
	8 hour	**0.070 ppm**	0.075 ppm
Carbon monoxide (CO)	1 hour	20 ppm	35 ppm
	8 hour	9.0 ppm	9 ppm
Nitrogen dioxide (NO_2)	1 hour	0.18 ppm	–
	Annual	0.030 ppm	0.053 ppm
Sulfur dioxide (SO_2)	1 hour	0.25 ppm	–
	3 hour	–	0.5 ppm
	24 hour	0.04 ppm	0.14 ppm
	Annual	–	0.03 ppm
Inhalable particulate matter (PM10)	24 hour	50 $\mu g/m^3$	150 $\mu g/m^3$
	Annual	**20 $\mu g/m^3$**	–
Fine particulate matter (PM2.5)	24 hour	–	**35 $\mu g/m^3$**
	Annual	**12 $\mu g/m^3$**	**15 $\mu g/m^3$**
Sulfates	24 hour	25 $\mu g/m^3$	–
Lead (Pb)	30 day	1.5 $\mu g/m^3$	–
	Calendar quarter	–	1.5 $\mu g/m^3$
	Rolling 3-month average	–	0.15 ppm
Hydrogen sulfide	1 hour	0.03 ppm	–
Vinyl chloride	24 hour	0.010 ppm	–

Source: California Air Resources Board 2008.
ppm = parts per million by volume.
$\mu g/m^3$ = micrograms per cubic meter.
NA = not applicable.
[a] The California ambient air quality standards (CAAQS) for O_3, CO, SO_2 (1-hour and 24-hour), NO_2, PM10, and PM2.5 are values not to be exceeded. All other California standards shown are values not to be equaled or exceeded.
[b] The national ambient air quality standards (NAAQS), other than O_3 and those based on annual averages, are not to be exceeded more than once a year. The O_3 standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above the standard is equal to or less than 1.

Pursuant to the 1990 federal Clean Air Act amendments, the EPA classifies air basins (or portions thereof) as "attainment" or "nonattainment" for each criteria air pollutant, based on whether or not the national standards have been achieved. The Project islands are located in Contra Costa County and San Joaquin County and are within the boundaries of the SJVAB and the SFBAAB. All urban areas within the SJVAB and the SFBAAB are classified as maintenance areas, while the nonurbanized areas, including the Project islands, are classified as attainment for the CO NAAQS.

The SJVAB is classified as a serious nonattainment area for the ozone NAAQS and a nonattainment area for the PM2.5 NAAQS, but is in attainment for the PM10 NAAQS (the San Joaquin Valley planning area is classified as a serious maintenance area for the NAAQS). The SJVAB is classified as a moderate maintenance area for the CO NAAQS. The SFBAAB is classified as a marginal nonattainment area for the ozone NAAQS and a nonattainment area for the PM2.5 NAAQS, but is in attainment for the PM10 NAAQS. The SFBAAB is classified as a moderate maintenance area for the CO NAAQS. (Table 4.13-3.)

Table 4.13-3. Federal and State Attainment Status for the SJVAB and SFBAAB

Pollutant	San Joaquin Valley Air Basin		San Francisco Bay Area Air Basin	
	Federal	State	Federal	State
1-hour O_3	NA[1]		NA[1]	
8-hour O_3	Serious nonattainment	NA[2]	Marginal nonattainment	NA[2]
CO	Moderate maintenance		Moderate maintenance	
PM10	Serious maintenance		Unclassified/attainment	
PM2.5	Nonattainment		Nonattainment	

[1] Previously in non-attainment area; no longer subject to the 1-hour standard due to EPA revocation of the 1-hour standard on June 15, 2005.

[2] The ARB approved the 8-hour ozone standard on April 28, 2005 and it became effective on May 17, 2006. However, the ARB has not yet designated areas for this standard.

Appendix C, Tables C-1 and C-2 show air quality monitoring data for 2006 through 2008. Data are included for the closest Delta air quality monitoring stations at 5551 Bethel Island Road, Bethel Island, and 583 West 10th Street, Pittsburg, both in Contra Costa County. Currently, monitoring is conducted for ozone, CO, and PM10, but not for PM2.5. There were no violations of the CO or PM10 NAAQS at either station. However, during this 3-year period, there were 25 violations of the federal 8-hour ozone NAAQS.

Conformity with State Implementation Plans

Projects involving federal funding or federal approval are required to show conformity with EPA's general conformity rule (40 CFR, Part 51, Subpart W) if they would result in emissions exceeding certain levels of nonattainment and maintenance pollutants. These pollutant threshold levels, called *de minimis* emission levels, vary from pollutant to pollutant and depend on the attainment status of individual air basins. Based on the NAAQS maintenance and nonattainment designations for the SJVAB and SFBAAB (Table 4.13-4), the applicable *de minimis* levels for this Project are 100 tons per year (tpy) of ROG and NO_X in the SFBAAB, 50 tpy of ROG and NO_X in the SJVAB, 70 tpy of PM10 in the SJVAB, and 100 tpy of PM2.5 in the SFBAAB.

Table 4.13-4. Federal *de minimis* thresholds for the SJVAB and SFBAAB

Tons per year	ROG and NO_X	PM10	PM2.5
SFBAAB	100	–	100
SJVAB	50	70	–

If the Project would result in total direct and indirect emissions in excess of the *de minimis* emission rates, it must be demonstrated through conformity determination procedures that the emissions conform to the applicable State Implementation Plans for each affected pollutant.

State

No changes have been made to the CO CAAQS since the 2001 FEIR and 2001 FEIS. However, the CAAQS for both ozone and particulate matter have been modified since 2001. Table 4.13-2 shows the most recent CAAQS for all criteria pollutants. For ozone, the 1-hour CAAQS has been reduced to 0.09 ppm and an 8-hour standard of 0.070 has been established. Also, the annual PM10 standard has been reduced to 20 micrograms per cubic meter ($\mu g/m^3$), and a new PM2.5 standard has been developed for the annual averaging period.

Appendix C, Tables C-1 and C-2 also show no violations of the CO CAAQS at either station. However, during this 3-year period, there were 18 violations of the state 1-hour ozone CAAQS and 16 violations of the state 24-hour PM10 CAAQS.

Under the California Clean Air Act, which has been patterned after the federal Clean Air Act, areas are designated as attainment or nonattainment with respect to the state standards. The SJVAB is classified as a severe nonattainment area for the ozone CAAQS and a nonattainment area for the PM10 and PM2.5 CAAQS, but is in attainment for the CO CAAQS. The SFBAAB is classified as a serious nonattainment area for the ozone CAAQS and a nonattainment area for the PM10 and PM2.5 CAAQS, but is in attainment for the CO CAAQS.

Appendix C, Tables C-1 and C-2 show no violations of the CO CAAQS at either station. However, during this 3-year period (2006–2008), there were 18 violations of the state 1-hour ozone CAAQS and 16 violations of the state 24-hour PM10 CAAQS.

Local

The BAAQMD has issued several updates to its air quality plan since the 2001 FEIR and 2001 FEIS. They include:

- 2009 Bay Area Clean Air Plan (in progress)
- 2005 Bay Area Ozone Strategy (BAAQMD 2006),

- 2001 Ozone Attainment Plan (BAAQMD 2001), and
- Particulate Matter Implementation Schedule (BAAQMD 2005).

There are no aspects of the Project that would cause it to be inconsistent with these plans and strategies.

The SJVAPCD has issued several updates to its air quality plans since the 2001 FEIR and 2001 FEIS. They include:

- 2007 Ozone Plan (SJVAPCD 2007),
- 2004 Extreme Ozone Demonstration Plan (SJVAPCD 2004),
- SB 656 Report (SJVAPCD 2005)
- 2003 PM10 Plan (SJVAPCD 2003),
- 2006 PM10 Plan (SJVAPCD 2006), and
- 2007 PM10 Maintenance Plan (SJVAPCD 2007).

There are no aspects of the Project that would cause it to be inconsistent with these plans and strategies. However, since 1991 the SJVAPCD has strengthened its Regulation 8, which limits dust from construction activities. The Project would be required to comply with the latest version of the SJVAPCD's Regulation 8, which includes preparation of a dust control plan.

Affected Environment

Summary of Affected Environment

The four Project islands are located in the Delta, a flat, sea-level area with moderate temperatures and rainfall. The Delta is upwind from major population centers in the SJVAB and the Sacramento Valley Air Basin. Pollutants generated in the Delta are transported to these areas, and the Delta receives pollutant transport from the Bay Area.

Changes since the 2001 FEIR and 2001 FEIS

Existing air quality conditions are, for the most part, as they were presented in the 2001 FEIR and 2001 FEIS and are hereby incorporated by reference. The only changes involve more recent air pollution monitoring data, changes in the regulatory environment, and changes due to new air quality models. The updated air pollution concentrations, based upon the most recent air pollution monitoring data and changes to the attainment/nonattainment pollutant status for the SFBAAB and the SJVAB, are summarized in Appendix C, Tables C-1 and C-2, and are discussed in the Regulatory Setting subsection above.

Environmental Commitments

The environmental commitments, as described in Chapter 2, would not alter the impact findings related to air quality.

Environmental Effects

Methods

The methods used to estimate air emissions in the 2001 FEIR and 2001 FEIS were based on the level of existing activity on each island, estimates of future activity on each island assuming no project, and estimates of expected activity on each island for each Project alternative based on the published BAAQMD and SJVAB CEQA guidance. A similar methodology was used for this analysis. However, the emission estimates reflect updated estimates of activity levels for existing and future conditions. The activity levels for existing conditions, future no-project (2020), and Alternatives 2 and 3 are shown in Appendix C, Tables C-3, C-4, C-5, and C-6, respectively. The activity levels for Alternatives 2 and 1 are assumed to be identical for this analysis.

This analysis assumes that the future No-Project Alternative has a slightly lower amount of recreational activity than in the 2001 FEIR and 2001 FEIS. It further assumes that the future No-Project Alternative will have the same level of agricultural activity under as in the 2001 FEIR and 2001 FEIS, except that the amount of existing agricultural activity will increase slightly on Bacon and Bouldin Islands and drop for Webb and Holland Tracts.

This analysis also assumes that Alternative 2 and 1 would require approximately the same level of construction activity as in the 2001 FEIR and 2001 FEIS, except that Bacon Island would require more borrow material and Bouldin Island and Holland Tract would require less borrow material.

This analysis assumes that operation of Alternative 2 or 1 would have the same amount of agricultural activity as in the 2001 FEIR and 2001 FEIS. However, based on Mitigation Measure REC-MM-1, the construction of recreation facilities will be significantly reduced; the Project will reduce the total number and size of recreation facilities proposed by removing all 22 facilities proposed for construction from Bacon Island and Webb Tract, and reducing the number or size of proposed facilities on Bouldin Island and Holland Tract by 70%. This mitigation will result in an overall 86.8% reduction in recreation facilities.

This analysis assumes that Alternative 3 would require the same level of construction and operational activity as in the 2001 FEIR and 2001 FEIS.

Once the activity levels were estimated, the emissions associated with each alternative's activity level were calculated using the most recent emission factor models available. These models, which included EMFAC2007 and OFFROAD2007, were not available for the 2001 FEIR and 2001 FEIS.

Construction-Related Impact Assessment Methods

Construction-related emissions were calculated only for Alternatives 2 and 3 because Project-related construction does not occur under existing conditions or under the No-Project Alternative. Alternative 1 construction emissions would be the same as those of Alternative 2.

The average amount of CO, ROG, NO_X, PM10, and PM2.5 that would be emitted on each island during construction was calculated based on the average number of vehicles and boat trips expected to take place each day, as well as the number of hours of rock placement and the number of cubic yards of earth moved per day. All trips referred to in this chapter are one-way trips, rather than round trips to avoid confusion.

Operational Impact Assessment Methods

Emissions were estimated for three distinct operational activities: water pumping, recreational trips, and agricultural operations. The 2001 FEIR and 2001 FEIS considered periodic levee maintenance and improvement. However, these activities were dismissed, as they did not result in a calculable impact. The methods used to estimate emissions for each of these categories are as follows.

Pumping

Emissions generated during pumping were calculated only for Alternatives 2 and 3 because discharge pumping of stored water is not conducted under existing conditions or the No-Project Alternative. Although the amount of discharge under Alternative 1 would be slightly different from the amount of discharge under Alternative 2, Alternative 1 is similar enough to Alternative 2 that little variation in pumping emissions is expected to occur. The Project's pumps could be either electrically or diesel-powered. Criteria pollutant pumping emissions were estimated only for the diesel-powered pump scenario.

Recreation

Recreation-related air emissions were calculated for existing conditions, Alternative 2, Alternative 3, and the No-Project Alternative. Recreation emissions for Alternative 1 were assumed to be identical to those of Alternative 2. Recreational trips include on-road vehicles and boats traveling to the Project islands.

Agriculture

Agriculture emissions were calculated for existing conditions, Alternative 2, and the No-Project Alternative. Agriculture emissions under Alternative 1 would be identical to those of Alternative 2. No agricultural use of the Project islands would occur under Alternative 3. Agriculture emission sources include agricultural equipment, nonharvest vehicles, and their associated fuel use. Also, the amount of disturbed acreage is used to estimate fugitive PM10 and PM2.5 emissions.

Significance Criteria

The air quality impact analysis considered several criteria for determining the significance of impacts related to this resource. The analysis took into account both relevant criteria contained in Appendix G of the State CEQA Guidelines (Association of Environmental Professionals 2009) and Project-specific criteria developed by the lead agency to address potential impacts unique to the Project's location and elements.

Because Project-related emissions cannot be readily quantified in terms of concentration, they are quantified in terms of mass emissions per unit time. Therefore, significance is determined based on threshold quantities rather than by the CAAQS and NAAQS. Table 4.13-5 summarizes the emission thresholds used in this analysis.

In the SJVAB, the SJVAPCD has established thresholds of 10 tpy of ROG and NO_X for operational emissions. The SJVAPCD has not established thresholds for construction. The SJVAPCD's approach to CEQA analyses of construction PM10 impacts is to require implementation of effective and comprehensive control measures rather than to require detailed quantification of emissions. The SJVAPCD has determined that compliance with its Regulation 8 for all sites constitutes sufficient mitigation to reduce PM10 impacts to a level considered less than significant. Large construction projects lasting many months may exceed the SJVAPCD's annual threshold for NO_X emissions (SJVAB 2002). Because construction of either Project alternative would require several months, the SJVAPCD's operational thresholds of 10 tpy of ROG and NO_X are also used to evaluate the significance of each alternative's construction emissions. The SJVAPCD has not established significance thresholds for CO or PM2.5.

Similarly, in the SFBAAB, the BAAQMD has established thresholds for project operation but not for project construction. The BAAQMD's operational thresholds equal 15 tpy and 80 pounds per day (ppd) for ROG, NO_X, and PM10 (BAAQMD 1999). The BAAQMD has identified a set of feasible PM feasible control measures that can be reasonably implemented to significantly reduce PM10 emissions for construction activities. Some measures should be implemented at all construction sites (Basic Measures), regardless of size. Additional measures should be implemented at larger construction sites (greater than 4 acres) where PM10 emissions generally will be higher (Enhanced

Measures) (BAAQMD 1999). Construction equipment emits CO and ozone precursors; however, these emissions are included in emission inventory that is the basis for regional air quality plans, and are not expected to impede attainment or maintenance of ozone and CO standards in the SFBAAB (BAAQMD 1999).

Table 4.13-5 also shows the applicable federal general conformity thresholds. Those thresholds are 50 tpy for ROG and NO_X in the SJVAB, and 100 tpy for ROG and NO_X in the SFBAAB. Both the SJVAB and the SFBAAB have a 100 tpy CO conformity threshold. The SFBAAB is in attainment for the federal PM10 and PM2.5 thresholds. Consequently, it does not have a conformity threshold. In contrast, the SJVAB has a conformity threshold of 100 tpy for PM10.

For this analysis, rather than segregate emissions by air basin, the Project's total emissions are calculated and compared to the most stringent of either the SJVAPCD or BAAQMD thresholds.

Table 4.13-5. Air Quality Thresholds of Significance

	ROG	NO_X	CO	PM2.5	PM10
Construction—SJVAPCD	10 tpy	10 tpy	N/A	Comply with Regulation 8	Comply with Regulation 8
Construction—BAAQMD	None	None	None	Comply with enhanced mitigation measures	Comply with enhanced mitigation measures
Operation—SJVAPCD	10 tpy	10 tpy	N/A	None	None
Operation—BAAQMD	80 ppd, 15 tpy	80 ppd, 15 tpy	N/A	None	80 ppd, 15 tpy
Conformity—SJVAB	50 tpy	50 tpy	N/A	N/A	100 tpy
Conformity—SFBAAB	100 tpy	100 tpy	N/A	100 tpy	Not applicable

Impacts and Mitigation Measures

As in the 2001 FEIR and 2001 FEIS, this analysis identifies eight impacts related to construction and operational activities that produce CO, ROG, NO_X, PM2.5 and PM10. Two mitigation measures, Mitigation Measure O-4, now Mitigation Measure Air-MM-4, and REC-MM-1, differ from those in the 2001 FEIR and 2001 FEIS.

This analysis finds significant and unavoidable construction-related NO_X impacts for each alternative, which is the same as in the 2001 FEIR and 2001 FEIS. However, for operational NO_X emissions, this analysis finds that, for either alternative, using electrically powered pumps would result in a less-than-significant operational NO_X impact, while using diesel-powered pumps would result in a significant NO_X impact. The previous analysis found that operational NO_X impacts would be significant and unavoidable for either electrically powered or diesel-powered pumps. This analysis finds that emission offsets or electrically powered pumps can be used to mitigate the NO_X emission impacts from the use of diesel-powered pumps to a less-than-significant level. An increased reduction in recreation facilities, leading to reduced recreational boating and boating-related vehicle trips, also will offset part of the NO_X emission impacts from the use of diesel-powered pumps.

The 2001 FEIR and 2001 FEIS found that construction-related PM10 impacts were significant and unavoidable for each alternative. In contrast, this analysis finds that PM10 impacts are significant, but can be mitigated to a less-than-significant level through implementation of SJVAPCD and BAAQMD required fugitive dust control measures. This changed finding is attributable primarily to newer PM10 significance thresholds that have been adopted by the SJVAPCD and BAAQMD since the 2001 FEIR and 2001 FEIS. This analysis concludes that operation of the Project would result in beneficial PM10 impacts.

For Alternatives 2, 1, and 3, this analysis finds that PM2.5 impacts would be less than significant for construction and operation. Implementation of SJVAPCD and BAAQMD required fugitive dust control measures would reduce construction-related fugitive dust emissions to less than significant.

Proposed Project (Alternative 2)

Carbon Monoxide Emissions

Alternative 2 involves storage of water on Bacon Island and Webb Tract (Reservoir Islands), with Bouldin Island and Holland Tract (Habitat Islands) managed primarily as wildlife habitat. The impacts of Alternative 2 on air quality conditions are described below, along with any changes to the impacts identified in the 2001 FEIR and 2001 FEIS.

Appendix C, Tables C-7 through C-10 show ROG, NO_X, CO, PM10, and PM2.5 emissions for Alternative 2 in detail.

Impact Air-1: Increase in CO Emissions on the Project Islands during Construction

As shown in Appendix C, Tables C-7 and C-8, Alternative 2 would increase CO emissions during construction by 876 ppd and 109.5 tpy. This represents a higher level of CO emissions than was estimated for the 2001 FEIR and 2001 FEIS, primarily because the construction activity levels are higher and because more recent emission factors have been used for this analysis. However, as in the 2001 FEIR and 2001 FEIS, the Project's CO emissions are considered less than significant because the Project is in a CO attainment area under state and federal CO standards. Implementation of the four mitigation measures identified in the 2001 FEIR and 2001 FEIS and repeated below are not required for CO impacts but would reduce the quantity of CO generated during construction.

Mitigation Measure Air-MM-1: Perform Routine Maintenance of Construction Equipment

During construction under Alternative 2, the primary source of CO emissions and other pollutants, including ROG and NO_X, is the exhaust generated by earthmoving equipment and other construction and transport vehicles. Therefore, construction crews will be required to perform routine maintenance of earthmoving equipment, as well as all other construction and transport vehicles. Routine maintenance involves oil changes and tune-ups performed at least as frequently as recommended by the manufacturers. This measure will be included as a condition of the construction contract and will be enforced through weekly inspection by the Project proponent.

Mitigation Measure Air-MM-2: Choose Borrow Sites Close to Fill Locations

Construction crews will be required to take borrow material from appropriate sites located closest to intended fill locations. This measure would reduce the overall amount of equipment and vehicle operation, thereby reducing exhaust emissions of CO and other pollutants, including ROG, NO_X, and PM10. This measure also would reduce the amount of PM10 emitted into the air by vehicles traveling over unpaved or dusty surfaces, the main source of PM10 emissions during construction. This measure will be included as a condition of the construction contract and will be enforced through weekly inspection.

Mitigation Measure Air-MM-3: Prohibit Unnecessary Idling of Construction Equipment Engines

Construction crews will be prohibited from leaving construction equipment or other vehicle engines idling when not in use for more than 5 minutes. This measure would reduce the amount of CO and other pollutants, including ROG, NO_X, and PM10, emitted in engine exhaust. This measure will be included as a condition of the construction contract and will be enforced through weekly inspection.

Impact Air-2: Increase in CO Emissions on the Project Islands during Project Operation

Appendix C, Tables C-7 and C-8 show CO emissions during operation of Alternative 2 assuming that water is pumped onto and out of the island reservoirs using diesel powered pumps. The tables show that compared to future no-project conditions, Alternative 2 would increase CO emissions by 6,666 ppd, or by 1,427 tpy. As described in the 2001 FEIR and 2001 FEIS, because the Project area is a CO attainment area under state and federal standards, this impact is considered less than significant.

Mitigation Measure

No mitigation is required.

Ozone Precursor Emissions

This section summarizes the Project's ROG and NO_X emissions for Alternative 2.

Impact Air-3: Increase in ROG Emissions on the Project Islands during Construction

As shown in Appendix C, Tables C-7 and C-8, construction of Alternative 2 would generate 188 ppd and 23.5 tpy of ROG. These emissions are less than the conformity thresholds of 50 tpy. Although these emission estimates are slightly less than in the 2001 FEIR and 2001 FEIS, ROG emissions would exceed the SJVAPCD's annual threshold of 10 tpy. This is considered a significant and unavoidable impact. Implementation of the following mitigation measures will reduce this impact, but not to a less-than-significant level.

Mitigation Measure Air-MM-1: Perform Routine Maintenance of Construction Equipment

This mitigation measure is described above, under Impact AIR-1.

Mitigation Measure Air-MM-2: Choose Borrow Sites Close to Fill Locations

This mitigation measure is described above, under Impact AIR-1.

Mitigation Measure Air-MM-3: Prohibit Unnecessary Idling of Construction Equipment Engines

This mitigation measure is described above, under Impact AIR-1.

Mitigation Measure Rec-MM-1: Reduce the Size or Number of Recreation Facilities

The Project will reduce the total number or size of recreation facilities proposed by removing all 22 facilities proposed for construction on Bacon Island and Webb Tract, and reducing the number or size of proposed facilities on Bouldin Island and Holland Tract by 70%. This would reduce ROG emissions attributable to Project construction of recreation facilities, but would not reduce all construction-related ROG emissions to a less-than-significant level.

Impact Air-4: Increase in ROG Emissions on the Project Islands during Operation

As shown in Appendix C, Tables C-7 and C-8, Alternative 2's net increase in operational ROG emissions would be 410 and 77 tpy. These emissions exceed the conformity threshold of 50 tpy applicable in the SJVAB and exceed the 80 ppd BAAQMD ROG threshold and the 10 tpy SJVAPCD ROG threshold. Therefore, this impact is considered significant. Implementing Mitigation Measures REC-MM-1 and AIR-MM-4 would reduce this impact to a less-than-significant level (as shown in Appendix C, Tables C-9 and C-10).

Mitigation Measure REC-MM-1: Reduce the Size or Number of Recreation Facilities

The Project will reduce the total number or size of recreation facilities proposed by removing all 22 facilities proposed for construction on Bacon Island and Webb Tract, and reducing the number or size of proposed facilities on Bouldin Island and Holland Tract by 70%. This would reduce the number of permanent docking spaces provided by the recreation facilities from 2,508 to 330 slips. This reduction is sufficient to reduce emissions while still providing for viable recreation. The reduction in the number of boating-related vehicle trips and reduction in boat use would reduce projected emissions from automobile and boat engines. Therefore, the increase in ROG emissions attributable to Project operations would be reduced to a less-than-significant level.

Mitigation Measure Air-MM-4: Coordinate with the SJVAPCD and BAAQMD to Reduce or Offset Emissions
The Project will coordinate with the SJVAPCD and the BAAQMD to implement measures to reduce or offset ROG and NO_X emissions of the Project operations. These measures may include implementing a voluntary emission reduction agreement (VERA). The SJVAPCD has encouraged use of a VERA as a means to reduce emissions from CEQA projects.

Mitigation Measure Air-MM-5: Use Electrically Powered Pumps in Lieu of Diesel Powered Pumps
In the event that Mitigation Measure Air-MM-4 is not sufficient to reduce emissions to less than significant, electrically powered pumps will be used in lieu of diesel-powered pumps, which would reduce the increase in operational NO_X emissions to less than the daily and annual significance thresholds.

Impact Air-5: Increase in NO_X Emissions on the Project Islands during Construction

As shown in Appendix C, Tables C-7 and C-8, construction of Alternative 2 would generate 1,538 ppd and 192.3 tpy of NO_X. These emissions exceed the conformity threshold of 50 tpy. Although these estimates are slightly less than in the 2001 FEIR and 2001 FEIS, NO_X emissions would also exceed the SJVAPCD's annual threshold of 10 tpy. This is considered a significant and unavoidable impact. Implementation of the following mitigation measures will reduce this impact, but not to a less-than-significant level

Mitigation Measure Air-MM-1: Perform Routine Maintenance of Construction Equipment
This mitigation measure is described above, under Impact AIR-1.

Mitigation Measure Air-MM-2: Choose Borrow Sites Close to Fill Locations
This mitigation measure is described above, under Impact AIR-1.

Mitigation Measure Air-MM-3: Prohibit Unnecessary Idling of Construction Equipment Engines
This mitigation measure is described above, under Impact AIR-1.

Impact Air-6: Increase in NO_X Emissions on the Project Islands during Operation

As shown in Appendix C, Tables C-7 and C-8, Alternative 2's net increase in operational NO_X emissions would be 1,042 ppd and 78 tpy. These emissions exceed the BAAQMD and SJVAPCD thresholds. Therefore, this impact is considered significant. Implementation of Mitigation Measure Rec-MM-1 would reduce Project operation NOx emissions from recreational boating. When combined with Air-MM-4 or AIR-MM-5, this mitigation would reduce the impacts of Project operations to a less-than-significant level (as shown in Appendix C, Tables C-9 and C-10).

Mitigation Measure Rec-MM-1: Reduce the Size or Number of Recreation Facilities
This mitigation measure is described above, under Impact AIR-1.

Mitigation Measure Air-MM-4: Coordinate with the SJVAPCD and BAAQMD to Reduce or Offset Emissions
This mitigation measure is described above, under Impact AIR-4.

Mitigation Measure Air-MM-5: Use Electrically Powered Pumps in Lieu of Diesel Powered Pumps
This mitigation measure is described above, under Impact AIR-5. As shown in Appendix C, Tables C-9 and C-10, the use of electrically powered pumps, in combination with other mitigation, would result in a net decrease in operational NO_X emissions.

PM10 and PM2.5 Emissions

This section summarizes the PM10 and PM2.5 impacts resulting from construction and operation of Alternative 2. When the 2001 FEIR and 2001 FEIS was prepared, ambient standards had not yet been set for PM2.5. Since 2001, both state and federal ambient standards have been set for PM2.5 and the standards for PM10 have been tightened. Although state and federal ambient standards have now been established, neither the BAAQMD nor SJVAPCD have yet established PM2.5 significance thresholds. Consequently, the following evaluation uses the PM10 significance thresholds.

Impact Air-7: Increase in PM10 Emissions on the Project Islands during Construction

As shown in Appendix C, Tables C-7 and C-8, construction of Alternative 2 would generate 746 ppd and 93.2 tpy of PM10. Both the SJVAPCD and the BAAQMD have stated that construction-related PM10 emissions are considered significant, but can be reduced to a less-than-significant level with implementation of appropriate mitigation measures. Although the Project's emissions are less than the conformity thresholds of 100 tpy, this is considered a significant impact that can be reduced to a less-than-significant level with implementation of the following group of measures developed by the SJVAPCD and the BAAQMD.

Mitigation Measure Air-MM-6: Implement Construction Practices that Reduce Generation of Particulate Matter
Construction crews will be required to implement the following measures throughout the construction period to reduce generation of particulate matter in the vicinity of construction sites:

- Pave, apply water three times daily, or apply soil stabilizers on all unpaved access roads, parking areas, and staging areas at construction sites.
- Use appropriate dust control measures, including effective application of water or presoaking, during land preparation and excavation.

- Cover or water all soil transported offsite to prevent excessive dust release.
- Sprinkle all disturbed areas, including soil piles left for more than 2 days, onsite unpaved roads, and offsite unpaved access roads, with water to sufficiently control windblown dust and dirt.
- Sweep daily (with water sweepers) all paved access roads, parking areas, and staging areas at construction sites.
- Hydroseed or apply soil stabilizers to inactive construction area (previously graded areas inactive for ten days or more).
- Install sandbags or other erosion control measures to prevent silt runoff to public roadways.
- Replant vegetation in disturbed areas as quickly as possible.
- Install wheel washers for all exiting trucks or wash off the tires or tracks of all trucks and equipment leaving the site.
- Install wind breaks or plant trees/vegetation wind breaks at windward side(s) of construction areas.
- Limit construction vehicle speeds to 15 mph on unpaved surfaces.
- Prohibit dust-producing construction activities when wind speeds reach or exceed 20 mph.
- All areas used for storage of construction vehicles, equipment, and materials will comply with the measures described above.
- Comply with all relevant components of the SJVAPCD's Regulation 8.

These measures will be included as a condition of the construction contract and will be enforced through weekly inspection by the Project proponent.

Impact Air-8: Increase in PM10 Emissions on the Project Islands during Operation

As shown in Appendix C, Tables C-7 and C-8, Alternative 2's net decrease in operational PM10 emissions would be 8,511 ppd. This decrease results because the drop in agricultural activity more than offsets the increase in Alternative 2's operational emissions. Due to the number and distribution of working days, the Alternative would result in a net increase of 1 tpy, but would not exceed the SJVPACD's threshold of 15 tpy. Therefore, this impact is considered less than significant.

Mitigation

No mitigation is required

Alternative 1

The only difference between Alternative 1 and Alternative 2 is the quantity and frequency of water diversions and discharges. Although pumping operations would be slightly different than Alternative 2, even with the slight difference in pumping emissions, Alternative 1 would have nearly identical impacts to those discussed under Alternative 2.

Alternative 3

Under Alternative 3, the four Project islands would be used as reservoirs with limited compensation wetland habitat on Bouldin Island.

Carbon Monoxide Emissions

The impacts of Alternative 3 on air quality conditions are described below, along with any changes to the impacts identified in the 2001 FEIR and 2001 FEIS.

Appendix C, Tables C-7 through C-10 show detailed estimates of ROG, NO_X, CO, PM10, and PM2.5 for Alternative 3.

Impact Air-1: Increase in CO Emissions on the Project Islands during Construction

As shown in Appendix C, Tables C-7 and C-8, Alternative 3 would increase CO emissions during construction by 2,220 ppd and 277.5 tpy. This represents a higher level of CO emissions than was estimated for the 2001 FEIR and 2001 FEIS, primarily because the construction activity levels are higher and more recent emission factors have been used for this analysis. However, as in the 2001 FEIR and 2001 FEIS, the Project's CO emissions are considered less than significant because the Project is in a CO attainment area under state and federal CO standards. Implementation of the four mitigation measures O-1 through O-3 identified in the 2001 FEIR and 2001 FEIS are not required for CO but would reduce the quantity of CO generated during construction.

Mitigation Measure Air-MM-1: Perform Routine Maintenance of Construction Equipment
This mitigation measure is described above, under Alternative 2.

Mitigation Measure Air-MM-2: Choose Borrow Sites Close to Fill Locations
This mitigation measure is described above, under Alternative 2.

Mitigation Measure Air-MM-3: Prohibit Unnecessary Idling of Construction Equipment Engines
This mitigation measure is described above, under Alternative 2.

Mitigation Measure REC-MM-1: Reduce the Size or Number of Recreation Facilities
This mitigation measure is described above, under Alternative 2.

Impact Air-2: Increase in CO Emissions on the Project Islands during Project Operation

Appendix C, Tables C-7 and C-8 show CO emissions during operation of Alternative 3 assuming that water is pumped onto and out of the island reservoirs used diesel-powered pumps. The tables show that Alternative 3 would increase CO emissions by 6,673 ppd, or by 1,489 tpy. This level of CO emissions is comparable to the operational CO emission estimates included in the 2001 FEIR and 2001 FEIS. And as described in the 2001 FEIR and 2001 FEIS, because the Project area is a CO attainment area under state and federal standards, this impact is considered less than significant.

Mitigation

No mitigation is required.

Ozone Precursor Emissions

This section summarizes the Project's ROG and NO_X emissions for Alternative 3.

Impact Air-3: Increase in ROG Emissions on the Project Islands during Construction

As shown in Appendix C, Tables C-7 and C-8, construction of Alternative 3 would generate 514 ppd and 64.3 tpy of ROG. Although these estimates are slightly less than in the 2001 FEIR and 2001 FEIS, ROG emissions would still exceed the SJVAPCD's annual threshold of 10 tpy. In addition, ROG emissions would exceed the conformity thresholds of 50 tpy. This is considered a significant and unavoidable impact. Implementation of the following mitigation measures would reduce this impact, but not to a less-than-significant level.

Mitigation Measure REC-MM-1: Reduce the Size or Number of Recreation Facilities

This mitigation measure is described above, under Alternative 2.

Mitigation Measure Air-MM-1: Perform Routine Maintenance of Construction Equipment

This mitigation measure is described above, under Alternative 2.

Mitigation Measure Air-MM-2: Choose Borrow Sites Close to Fill Locations

Mitigation Measure Air-MM-3: Prohibit Unnecessary Idling of Construction Equipment Engines

This mitigation measure is described above, under Alternative 2.

Impact Air-4: Increase in ROG Emissions on the Project Islands during Operation

As shown in Appendix C, Tables C-7 and C-8, Alternative 3's net increase in operational ROG emissions would range be 344 ppd and from 81 tpy. This increase exceeds the 80 ppd BAAQMD ROG threshold and the 10 tpy SJVAPCD ROG threshold. The Project would also exceed the 50 tpy conformity threshold.

Therefore, this impact is considered significant. Implementation of the following measures would reduce this impact to a less-than-significant level.

Mitigation Measure REC-MM-1: Reduce the Size or Number of Recreation Facilities
This mitigation measure is described above, under Alternative 2.

Mitigation Measure Air-MM-4: Coordinate with the SJVAPCD and BAAQMD to Reduce or Offset Emissions
This mitigation measure is described above, under Alternative 2.

Impact Air-5: Increase in NO_X Emissions on the Project Islands during Construction.

As shown in Appendix C, Tables C-7 and C-8, construction of Alternative 3 would generate 4,302 ppd and 537.7 tpy of NO_X. This emission level would exceed the 50 tpy conformity threshold. Although these estimates are slightly less than in the 2001 FEIR and 2001 FEIS, NO_X emissions would still exceed the SJVAPCD's annual threshold of 10 tpy. This is considered a significant and unavoidable impact. Implementation of the following measures would reduce this impact, but not to a less-than-significant level.

Mitigation Measure REC-MM-1: Reduce the Size or Number of Recreation Facilities
This mitigation measure is described above, under Alternative 2.

Mitigation Measure Air-MM-1: Perform Routine Maintenance of Construction Equipment
This mitigation measure is described above, under Alternative 2.

Mitigation Measure Air-MM-2: Choose Borrow Sites Close to Fill Locations
This mitigation measure is described above, under Alternative 2.

Mitigation Measure Air-MM-3: Prohibit Unnecessary Idling of Construction Equipment Engines
This mitigation measure is described above, under Alternative 2.

Impact Air-6: Increase in NO_X Emissions on the Project Islands during Operation

As shown in Appendix C, Tables C-7 and C-8, Alternative 3's net increase in operational NO_X emissions would range be 44 ppd and 99 tpy. These emissions would exceed the 80 ppd BAAQMD NO_X threshold and the 10 tpy SJVAPCD NO_X threshold. This is a significant impact. Implementation of the following mitigation measures would reduce this impact to a less-than-significant level.

Mitigation Measure REC-MM-1: Reduce the Size or Number of Recreation Facilities
This mitigation measure is described above, under Alternative 2.

Mitigation Measure Air-MM-4: Coordinate with the SJVAPCD and BAAQMD to Reduce or Offset Emissions
This mitigation measure is described above, under Alternative 2.

Mitigation Measure Air-MM-5: Use Electrically Powered Pumps in Lieu of Diesel Powered Pumps
As shown in Appendix C, Tables C-9 and C-10, the use of electrically powered pumps, in combination with other mitigation, would result in a net decrease in operational NO_X emissions.

PM10 and PM2.5 Emissions

This section summarizes the PM10 and PM2.5 impacts resulting from construction and operation of Alternative 3. When the 2001 FEIR and 2001 FEIS was prepared, ambient standards had not yet been set for PM2.5. Since 2001, both state and federal ambient standards have been set for PM2.5 and the standards for PM10 have been tightened. Although state and federal ambient standards have now been established, neither the BAAQMD nor SJVAPCD have yet established PM2.5 significance thresholds. Consequently, the following evaluation uses significance thresholds of 10 tons PM10 per year and 80 pounds PM10 per day.

Impact Air-7: Increase in PM10 Emissions on the Project Islands during Construction

As shown in Appendix C, Tables C-7 and C-8, construction of Alternative 3 would generate 993 ppd and 124.2 tpy of PM10. This exceeds the 100 tpy conformity threshold. Both the SJVAPCD and the BAAQMD have stated that construction-related PM10 emissions are considered significant, but can be reduced to a less-than-significant level with implementation of appropriate mitigation measures. This is considered a significant impact. The following measures can be used to reduce impacts to a less-than-significant level.

Mitigation Measure Air-MM-6: Implement Construction Practices that Reduce Generation of Particulate Matter
This mitigation measure is described above, under Alternative 2.

Impact Air-8: Increase in PM10 Emissions on the Project Islands during Operation

As shown in Appendix C, Tables C-7 and C-8, Alternative 3's operational PM10 emissions would decrease PM10 by 9,234 ppd. This decrease results because the drop in agricultural activity more than offsets the increase in Alternative 3's operational emissions. Due to the number and distribution of working days, the Alternative would result in a net increase of 8 tpy, however would not exceed the SJVPACD's threshold of 15 tpy. Therefore, this impact is considered less than significant.

Mitigation
No mitigation is required.

No-Project Alternative

Because the No-Project Alternative would not involve any construction, only operational impacts are discussed in this section. Operation of the No-Project Alternative in 2020 includes increases in agricultural activity and recreational uses compared to existing conditions. Appendix C, Tables C-3 and C-4 compare the agricultural and recreational use assumptions for existing conditions and future no-project (2020) conditions.

Carbon Monoxide Emissions

Increase in CO Emissions on the Project Islands

Appendix C, Tables C-7 and C-8 compare CO emissions for the No-Project Alternative to existing conditions. Under the No-Project Alternative, CO emissions would increase to 3,526 ppd and to 440 tpy. This increase is attributable to the increase in recreational and agricultural activities associated with the No-Project Alternative.

Ozone Precursor Emissions

Increase in ROG Emissions on the Project Islands

Appendix C, Tables C-7 and C-8 compare ROG emissions for the No-Project Alternative to existing conditions. Under the No-Project Alternative, ROG emissions would increase to 150 ppd and to 18.6 tpy. This increase is attributable to the increase in recreational and agricultural activities associated with the No-Project Alternative.

Increase in NO_X Emissions on the Project Islands

Appendix C, Tables C-7 and C-8 compare NO_X emissions for the No-Project Alternative to existing conditions. Under the No-Project Alternative, NO_X emissions would increase to 441 ppd and to 55 tpy. This increase is attributable to the increase in recreational and agricultural activities associated with the No-Project Alternative.

PM10 Emissions

Increase in PM10 Emissions on the Project Islands

Appendix C, Tables C-7 and C-8 compare PM10 emissions for the No-Project Alternative to existing conditions. Under the No-Project Alternative, PM10 emissions would increase to 6,836 ppd and to 22.4 tpy. This increase is attributable to the increase in recreational and agricultural activities associated with the No-Project Alternative.

PM2.5 Emissions

Increase in PM2.5 Emissions on the Project Islands

Appendix C, Tables C-7 and C-8 compare PM2.5 emissions for the No-Project Alternative to existing conditions. Under the No-Project Alternative, PM2.5 emissions would increase to 1,673 ppd and to 9 tpy. This increase is attributable to the increase in recreational and agricultural activities associated with the No-Project Alternative.

Section 4.14
Climate Change

Introduction

This section describes the existing environmental conditions and regulatory setting of the Project area, summarizes the affected environment, and describes environmental effects to the Project, and of the Project, regarding climate change. The effects of and to global climate change were not discussed in the 2001 FEIR and 2001 FEIS.

The Project will not have any direct effects on climate change in the places of use; the effects on climate change, if any, associated with the provision of Project water to the places of use are addressed in Chapter 5, "Cumulative Impacts," and Chapter 6, "Growth-Inducing Impacts."

Summary of Impacts

Table 4.14-1 provides a summary of the potential impacts and mitigation measures for climate change from this Place of Use EIR.

Table 4.14-1. Delta Wetlands Project 2010 Place of Use EIR Impacts and Mitigation Measures for Climate Change

2010 Place of Use EIR Impacts and Mitigation Measures
ALTERNATIVES 1 AND 2
Impact CC-1: Increase in CO_2e Emissions on Project Islands during Construction (LTS) **Mitigation:** No mitigation is required
Impact CC-2: Increase in CO_2e Emissions on Project Islands during Operation (LTS) **Mitigation:** No mitigation is required
ALTERNATIVE 3
Impact CC-1: Increase in CO_2e Emissions on Project Islands during Construction (LTS) **Mitigation:** No mitigation is required
Impact CC-2: Increase in CO_2e Emissions on Project Islands during Operation (LTS) **Mitigation:** No mitigation is required
Note: SU = Significant and unavoidable; LTS = Less than significant; LTS-M = Less than significant with mitigation; B = Beneficial.

Existing Conditions

This section discusses the existing conditions and regulatory setting.

Sources of Information

Several sources of information were used in developing this report. Three climate change reports prepared for the Project were used (ICF Jones & Stokes 2007, 2008; Horne 2009). In addition, construction and operational activity levels for each alternative were used to estimate greenhouse gas (GHG) emissions.

Regulatory Setting

Executive Order S-3-05

Executive Order S-3-05 was signed by California Governor Schwarzenegger in June 2005. This Executive Order was significant because of its clear declarative statements that climate change poses a threat to the state of California. The Executive Order states that California is "particularly vulnerable" to the impacts of climate change and that climate change has the potential to reduce Sierra snowpack (a primary source of drinking water), exacerbate existing air quality problems, adversely affect human health, threaten coastal real estate and habitat by causing sea level rise, and affect crop production. The Executive Order also states that "mitigation efforts will be necessary to reduce GHG emissions."

To address the issues described above, the Executive Order established emission reduction targets for the state: reduce GHG emissions to 2000 levels by 2010, to 1990 levels by 2020, and to 80% below 1990 levels by 2050. The Secretary of the California Environmental Protection Agency was named as coordinator for this effort, and the Executive Order required a progress report by January 2006 and biannually thereafter. As a result, the California Environmental Protection Agency created the Climate Act Team. The Climate Act Team released the first report, which proposed to meet the emissions targets through voluntary compliance and state incentive and regulatory programs, in March 2006.

Assembly Bill 32

In September 2006, Assembly Bill (AB) 32 was signed by California Governor Schwarzenegger. AB 32 requires that California GHG emissions be reduced to 1990 levels by the year 2020, just like Executive Order S-3-05. However, AB32 is a comprehensive bill that requires the California Air Resources Board (ARB) to adopt regulations requiring the reporting and verification of statewide GHG emissions, and it establishes a schedule of action measures. AB32 also requires that a list of emission-reduction strategies be published to achieve emissions reduction goals. AB 32 requires reductions in California's GHG emissions to 1990 levels by 2020, a roughly 25% reduction under business as usual (BAU) estimates.

Senate Bill 97

Senate Bill (SB) 97, signed in August 2007, acknowledges that climate change is an important environmental issue that requires analysis under CEQA. The bill directed the California Office of Planning and Research (OPR) to prepare, develop, and transmit to the Resources Agency guidelines for the feasible mitigation of GHG emissions or the effects of GHG emissions, by July 1, 2009. The Resources Agency is required to certify or adopt those guidelines by January 1, 2010. On July 3, 2009, the Resources Agency commenced the Administrative Procedure Act rulemaking process for certifying and adopting these amendments pursuant to Public Resources Code Section 21083.05.

The Natural Resources Agency proposed revisions to the text of the proposed State CEQA Guidelines amendments after a 55-day public comment period and delivered its rulemaking package to the Office of Administrative Law for their review on December 31, 2009. The Office of Administrative Law approved the amendments, and filed them with the Secretary of State for inclusion in the California Code of Regulations on February 16, 2010, and the amendments became effective on March 18, 2010. The guidelines apply retroactively to any incomplete EIR, negative declaration, mitigated negative declaration, or other related document.

The Resources Agency has asked the ARB for assistance in developing CEQA significance thresholds for GHGs. On October 27 and on December 9, 2008, the ARB held public workshops in which they described recommended approaches for setting interim significance thresholds for GHGs under CEQA (California Air Resources Board 2008). Currently, the ARB has not yet finalized the recommended approaches released at their October 27 and December 9, 2008 public workshops.

Actions Taken by the California Office of Planning and Research

In June 2008, the OPR issued a Technical Advisory on CEQA and Climate Change (California Office of Planning and Research 2008). This document recommends that, for projects subject to CEQA, emissions be calculated and mitigation measures be identified to reduce those emissions. The OPR report does not identify emission thresholds for GHGs but instead recommends that each lead agency develop its own thresholds.

Actions Taken by California Attorney General's Office

The California Attorney General (AG) has filed comment letters under CEQA about a number of proposed projects. The AG also has filed several complaints and obtained settlement agreements for CEQA documents covering general plans and individual projects that the AG found either failed to analyze GHG emissions or failed to provide adequate GHG mitigation. The AG's office has prepared a report that lists measures that local agencies should consider under CEQA to offset or reduce global warming impacts. The AG's office also has prepared a chart of modeling tools to estimate GHG emissions impacts of projects and plans. Information on the AG's actions can be found on the California Department of Justice Office of Attorney General web site (California Department of Justice 2009).

California Air Pollution Control Officers Association Guidance

The California Air Pollution Control Officers Association (CAPCOA) released a report in January 2008 that describes methods to estimate and mitigate GHG emissions from projects subject to CEQA. The CAPCOA report evaluates several GHG thresholds that could be used to evaluate the significance of a project's GHG emissions. The CAPCOA report, however, does not recommend any single threshold. Instead, the report is designed as a resource for public agencies as they establish agency procedures for reviewing GHG emissions from projects subject to CEQA (California Air Pollution Officers Association 2008).

Affected Environment

Introduction to Climate Change and Global Warming

The average surface temperature of the Earth has risen by about 1 degree Fahrenheit (°F) in the past century, with most of that occurring during the past two decades (World Meteorological Organization 2005). Correspondingly, the probable increases in average temperatures of between 3 and 8°F (Cayan et al. 2006a) may appear noticeable, but still insignificant. In July, the average high temperature in the region is 94°F. This number is created by averaging temperatures over decades, not just for one particular year. Although the average is 94°F, the individual days and weeks making up that average are as much as 20° warmer or cooler in the extreme cases and up to 10° warmer or cooler on a more regular basis. Therefore, applying an average increase of 8° in a strictly linear way (omitting forcing effects) would mean that the *average* July temperature in the region would be 102°F, and that temperatures could get as hot as 122°F in an extreme event (the current record is 114°F) and could regularly reach 112°F.

The principal GHGs that enter the atmosphere because of human activities are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases. From 1750 to 2004, concentrations of CO_2, CH_4, and N_2O have increased globally by 35%, 143%, and 18%, respectively. Other GHGs, such as fluorinated gases, are created and emitted solely through human activities (U.S. Environmental Protection Agency 2008). CO_2 is referenced most frequently when discussing climate change because it is the most commonly emitted gas. However, some less commonly emitted GHGs have a greater climate-forcing effect per molecule.

Global warming potential (GWP) is a measure of how much a given mass of GHGhttp://en.wikipedia.org/wiki/Greenhouse_gas is estimated to contribute to global warming. It is a relative scale that compares the gas in question to that of the same mass of CO_2 (whose GWP is by definition 1). In this analysis, CH_4 is assumed to have a GWP of 21 and N_2O has a GWP of 310 (California Climate Action Registry 2009). Consequently, using each pollutant's GWP, emissions of CO_2, CH_4, and N_2O can be converted into CO_2 equivalence, also denoted as CO_2e.

Greenhouse Gas Pollutants

Carbon Dioxide

CO_2 emissions are associated mainly with combustion of carbon-bearing fossil fuels such as gasoline, diesel, and natural gas used in mobile sources and energy generation–related activities. The EPA estimates that CO_2 emissions accounted for 84.6% of GHG emissions in the United States in 2004 (U.S. Environmental Protection Agency 2008). The California Energy Commission (CEC) estimates that CO_2 emissions account for 84% of California's anthropogenic (human-made) GHG emissions, nearly all of which is associated with fossil fuel combustion (California Energy Commission 2005). Total CO_2 emissions in the United States increased by 20% from 1990 to 2004 (U.S. Environmental Protection Agency 2008).

Methane

CH_4 has both natural and anthropogenic sources. The major sources of methane are landfills, natural gas distribution systems, agricultural activities, fireplaces and wood stoves, stationary and mobile fuel combustion, and gas and oil production fields (U.S. Environmental Protection Agency 2008). The EPA estimates that CH_4 emissions accounted for 7.9% of total GHG emissions in the United States in 2004 (U.S. Environmental Protection Agency 2008). The CEC estimates that CH_4 emissions from various sources represent 6.2% of California's total GHG emissions (California Energy Commission 2005). Total CH_4 emissions in the United States decreased by 10% from 1990 to 2004 (U.S. Environmental Protection Agency 2008).

Nitrous Oxide

N_2O is produced by microbial processes in soil and water, including those reactions that occur in fertilizers that contain nitrogen. The global concentration of N_2O in 1998 was 314 parts per billion (ppb), and in addition to agricultural sources for the gas, some industrial processes (fossil fuel–fired power plants, nylon production, nitric acid production, and vehicle emissions) contribute to its atmospheric load (U.S. Environmental Protection Agency 2008).

The EPA estimates that N_2O emissions accounted for 5.5% of total GHG emissions in the United States in 2004 (U.S. Environmental Protection Agency 2008). The CEC estimates that nitrous oxide emissions from various sources represent 6.6% of California's total GHG emissions (California Energy Commission 2005). Total N_2O emissions in the United States decreased by 2% from 1990 to 2004 (U.S. Environmental Protection Agency 2008).

Fluorinated Gases (HFCs, PFCs, and SF_6)

Fluorinated gases, such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6), are powerful GHGs that are emitted from a variety of industrial processes. The primary sources of fluorinated gas emissions in the United States include the HCFC-22 production, electrical transmission and distribution systems, semiconductor manufacturing, aluminum production, and magnesium production and processing. The EPA estimates that fluorinated gas (HFC, PFC, and SF_6) emissions accounted for 2.0% of total GHG emissions in the United States in 2004 (U.S. Environmental Protection Agency 2008). The CEC estimates that fluorinated gas emissions from various sources represent 3.4% of California's total GHG emissions (California Energy Commission 2005). Total fluorinated gas emissions in the United States increased by 58% from 1990 to 2004 (U.S. Environmental Protection Agency 2008).

Environmental Commitments

The environmental commitments, as described in Chapter 2, would not alter the impact findings related to climate change.

Environmental Effects

Global climate change is a complex phenomenon that is influenced by many environmental factors. There are also many different climate or hydrologic modeling tools available, each with strengths and weaknesses. While changes to the existing climate landscape can be demonstrated by looking at the historical record, it becomes challenging to predict future trends. The process must be simplified to some extent. Climatologists and others who model climate change must make certain assumptions, such as establishing a fixed rate of temperature change, in order to proceed with modeling. Therefore, scientists involved in these modeling efforts do not try to be absolutely predictive, but instead use different model types with different sets of assumptions to capture a range of possible scenarios. It is also necessary to update the model with the latest available data on a regular basis in order to synchronize the models with current conditions. There is no single, certain prediction related to the probability of environmental effects. Scenarios are rated *very likely* if many different models come up with very similar results, and *uncertain* if many different models report very different results. The sections below rely on information from several different published sources and provide a qualitative analysis of potential impacts as they affect North America, California, Contra Costa and San Joaquin Counties, and the places of use.

Temperature Change

Significant increases in the frequency, intensity, and duration of summertime extreme heat days, defined as the 10% warmest days of summer, are projected as a result of climate change (Miller et al. 2007). Temperature change is the driver for climate change, affecting environmental processes that in turn will affect human life. There is strong agreement that many of the most damaging effects of climate change will begin to occur after temperatures increase beyond 3.6°Fahrenheit into the 5.4° and above range. The Intergovernmental Panel on Climate Change (IPCC) Working Group III report determined that reductions in GHG emissions of 50 to 80% would be needed by 2050 in order to stabilize temperature rise at no more than 2°C (Intergovernmental Panel on Climate Change 2007b). The reductions set forth in Executive Order S-3-05 and in AB32 mirror this research.

For California as a whole, the total number of days of extreme heat (summertime temperatures that are substantially hotter and/or more humid than average for location at that time of year) is projected to double relative to the historical mean of 12 days per summer, to an average of 23–24 days per summer by 2034 based on current GHG levels. By 2064, this is projected to increase to 27–39 days.

Various research papers and technical studies have been produced that look specifically at climate impacts in California. One of these is a white paper titled "Climate Scenarios for California," sponsored by the CEC, which used many of the same assumptions and scenarios as the IPCC reports, but scaled the modeling down to the California level. This paper postulates that the average temperature change from the 1961–1990 historic period to the 2070–2099 future period will be more marked during the summer months than during the winter months (Cayan et al. 2006a).

Higher temperatures would have direct effects on the health of many organisms, including humans. It is probable that rising temperatures would cause an increase in the number of humans who die or become ill as a result of heat waves, change the range (geographically or seasonally) of various infectious disease vectors (such as mosquitoes), and increase cardio-respiratory disease prevalence and mortality associated with ground-level ozone (Intergovernmental Panel on

Climate Change 2007a). Many individual plants also may die or become damaged during heat waves; even if there is ample water in the soil, water loss through the leaves may outpace the ability of the plant to draw water from the soil. Warmer winters would bring some benefits to some parts of California, where cold-related deaths and illnesses during the winter could be reduced (Cayan et al. 2006b). However, the Project area does not typically experience extreme cold under current conditions, leading to the expectation that the stated negative effects would outweigh this positive effect.

Water Supply Changes and Increased Flooding

According to the IPCC 2007 report, the annual mean warming in North America is likely to exceed the global mean warming in most areas, and snow season length and snow depth are very likely to decrease in most of North America (Intergovernmental Panel on Climate Change 2007a). These trends already have been observed, as the snowpack in the Sierra Nevada and the Cascade Range has been declining over the last few decades of record, and the average temperature in California has increased 1°F over the past 50 years (Cayan et al. 2006a). However, while there is high model agreement on warming trends, the agreement among precipitation and hydrologic trend models is not nearly as strong.

The "Climate Scenarios for California" white paper modeled changes in snow water equivalent as of April 1, when the snow season begins to taper off. Snow water equivalent is the amount of water contained within the snowpack. As compared to the 1961–1990 period of record, the net change in snow water equivalent ranges from +6% to -29% (for the 2005–2034 period), from -12% to -42% (for 2035–2064), and from -32% to -79% (for the 2070–2099 period). These results highlight the lack of agreement found among hydrologic models. The ranges of projected change vary widely, and in the near term some modeling even predicts an increase in snow water equivalent. However, in the long term all of the models do agree that snow water equivalent will be reduced, even though further refinement of the modeling will need to be completed to narrow down the range of reductions (Cayan et al. 2006a).

The modeling results indicate that snow losses have the greatest impact in relatively warm low-middle and middle elevations between about 3,280 feet and 6,560 feet (losses of 60% to 93%) and between about 6,560 feet and 9,840 feet (losses of 25% to 79%). The central and northern portions of the Sierra Nevada contain large portions of these low-middle and middle elevations and are subject to the greatest reductions in snow accumulation. (Cayan et al. 2006a.)

The changes in snowmelt described above are not projected because significantly less precipitation is expected to fall, but rather because the snowpack will melt earlier and more precipitation will fall as rain than as snow. If in future conditions more of the precipitation in the watersheds falls as rain than as snow, runoff into the rivers and creeks will increase and the potential for flooding will increase. The effect of climate change on flooding will depend on several factors, including whether storms increase in severity, duration, or frequency. Although strong model agreement has not been reached, it is probable that flooding regimes will alter in the Delta region. Current floodplain locations could expand or contract, changing the number of people in the region that would be affected by flood events, and floods could increase in number, increasing the frequency of negative effects on residents.

The effect of climate change on future demand of water supply remains uncertain (California Department of Water Resources 2006), but changes in water supply are expected and are discussed at greater length in Section 4.1, Water Supply. DWR has sponsored or published a number of papers on the interaction between climate change and water supply and has a Climate Change Portal on the DWR website (www.climatechange.water.ca.gov). Climate change was addressed in the 2009 California Water Plan update. Adaptation (e.g., expanding reservoirs, changing water release schedules, etc.) is expected to play a key role in addressing the effects of climate change on water supply.

Reduction in Surface Water Quality

Water quality is affected by several variables, including the physical characteristics of the watershed, water temperature, and runoff rate and timing. A combination of a reduction in snowmelt, and/or shifts in volume and timing of runoff flows, and the increased temperature in lakes and rivers could affect a number of natural processes that eliminate pollutants in water bodies. For example, although there may be more flood events, the overall streamflow decrease from a lack of summer snowpack potentially could concentrate pollutants and prevent the flushing of contaminants from point sources. The increased storm flows could tax urban water systems and cause greater flushing of pollutants to the Delta and coastal regions (Kiparsky and Gleick 2003). Still, considerable work remains to determine the potential effect of global climate change on water quality.

Effects to Fisheries and Aquatic Resources

The health of river ecosystems is heavily dependent on water temperatures and streamflows. The IPCC Working Group II report recites a litany of temperature and flow effects on fisheries that already have been observed: the sea-run salmon stocks are in steep decline throughout much of North America (Gallagher and Wood 2003), Pacific salmon have been appearing in Arctic rivers (Babaluk et al. 2000), and salmonid species have been affected by warming in U.S. streams (O’Neal 2002). It is probable that increases in average temperatures in the state would cause corresponding increases in water temperatures. Rates of fish-egg development and mortality increase with temperature rise within species-specific tolerance ranges (Kamler 2002). Many fish species migrate into Delta waterways during specific seasons to breed, and these fish rely on late-fall and early winter flows in order to complete the migration. If increased flows are delayed, possibly as a result of lessened groundwater recharge or shifts in the onset of the rainy season, this would be a barrier to migration. These potential effects could further endanger the sustainability of aquatic populations that are already listed under the federal or California ESA or could cause non-listed species to require listing.

Increased Rate of Sea Level Rise

As global temperatures rise due to climate change, the increased temperatures are anticipated to accelerate the rate at which sea levels rise. The IPCC Working Group I report contains a thorough discussion of the current understanding of sea level rise and climate change. While there is strong model agreement that sea levels will continue to rise and that the rate of rise will increase, the ultimate amount of rise is uncertain (Intergovernmental Panel on Climate Change 2007a). A white paper entitled “Projecting Future Sea Level,” published by the California Climate Change Center, estimated a sea level rise from 4 to 35 inches every century (0.3 to 2.9 feet), depending on the model and assumptions used (Cayan et al. 2006b).

The Delta region is hydrologically connected to San Francisco Bay and will be directly influenced by sea level rise. Among the more critical potential effects of sea level rise in the Delta are threats to flood protection and increased salinity in the Delta (Kiparsky and Gleick 2003). In recognition of this concern, California passed a bond measure intended to finance the process of stabilizing and improving California’s levee systems. DWR also is continuing to study the issue to determine what other system improvements may be necessary to adapt to changes in water surface elevations.

Water for the SWP and the federal CVP is taken from the south Delta. If salt water from San Francisco Bay backs upward through the Delta system, freshwater supplies could be degraded. There are potential solutions to this problem, should it occur, that continue to be examined by DWR. A purification process could be implemented, but extracting salt from water tends to be costly. A peripheral canal that would bypass the Delta is another option that was originally suggested in the early 1980s but remains highly controversial.

Rapid Climate Change

Most global climate models project that anthropogenic climate change will be a continuous and fairly gradual process through the end of this century (California Department of Water Resources 2006). California is expected to be able to adapt to the water supply challenges posed by climate change, even under some of the warmer and dryer projections for change. Sudden and unexpected changes in climate, however, could leave many of the agencies responsible for management of vulnerable sectors (water supply, levees, health, etc.) unprepared and in extreme situations would have significant implications for California and the health and safety of its residents. For example, there is speculation that some of the recent droughts that occurred in California and the western United States could have been attributable, at least in part, to oscillating oceanic conditions resulting from climatic changes. The exact causes of these events are, however, unknown, and evidence suggests such events have occurred during at least the past 2,000 years (California Department of Water Resources 2006).

Impacts and Mitigation Measures

The following section first evaluates the potential impacts of global climate change on the Project, then the potential impacts of the Project on climate change.

Potential Effects of Climate Change on the Project

As mentioned above, potential effects of climate change include:

- temperature change,
- water supply changes and increased flooding,
- reduction of surface water quality,
- effects to fisheries and aquatic resources,
- increased rate of sea level rise, and
- rapid climate change.

Although many of these changes are speculative, they do represent possible effects of climate change that would require adaptation. The Project would enable California to adapt to increases in temperatures and resulting shortages in water supply by providing additional water storage. Increased diversion capacity resulting from implementation of the Project would help to accommodate increased winter runoff scenarios resulting from climate change. In addition, added storage allows for flexibility between the timing of diversion and timing of use, which is necessary due to limited pumping opportunities.

Of these potential impacts, sea level increases have the potential to cause the largest impact on the Project. If sea level increases dramatically, it could require the Project levees to be raised periodically to withstand the higher sea levels. Refer to Section 4.3, Flood Control and Levee Stability, for a discussion of levee design elements that address anticipated sea level rise.

Potential Impacts of the Project on Climate Change

Significance Criteria

The climate change impact analysis considered several criteria for determining the significance of impacts related to this issue. The analysis took into account both relevant criteria contained in Appendix G of the State CEQA Guidelines

(Association of Environmental Professionals 2009) and Project-specific criteria developed by the lead agency to address potential impacts unique to the Project's location and elements.

As previously discussed, the State CEQA Guidelines were amended to address greenhouse gas emissions. The State CEQA Guidelines, as amended in 2010, require lead agencies to analyze a project's GHG emissions. The guidelines confirm the discretion of lead agencies to determine appropriate significance thresholds but require the preparation of an EIR if "there is substantial evidence that the possible effects of a particular project are still cumulatively considerable notwithstanding compliance with adopted regulations or requirements" (§15064.4). With regards to establishing significance criteria for the determination of significance of greenhouse gas emissions, lead agencies are given discretion to perform either a quantitative or a qualitative analysis in determining the significance of a project's greenhouse gas emissions, although the lead agency must base its analysis "to the extent possible on scientific and factual data." (§15064.4) In addition, a lead agency may consider thresholds of significance previously adopted or recommended by other public agencies or recommended by experts, provided the decision of the lead agency to adopt such thresholds is supported by substantial evidence (§15064.7).

For most projects, there is no clear or established method to determine whether a particular project will negatively affect the ability of the state to meet emissions goals. At the time of this writing, a host of white papers on the subject has been published, and many conferences and workshops are being held each month. While all conclude that actions must be taken, the subject of significance criteria is a matter of great debate.

The Bay Area Air Quality Management District (BAAQMD) has not yet established significance criteria for GHGs, although it recently has begun a process to revise and update significance criteria and has issued their draft CEQA guidance for public comment and review. These revisions will include a significance threshold for GHGs (Tholen pers. comm.). Although it is clear that emissions throughout the state must be reduced in order to meet reduction targets, the San Joaquin Valley Air Pollution Control District (SJVAPCD) is the only air district in California that has identified a significance threshold for GHG emissions. In December 2009, the SJVAPCD formally adopted the region's first GHG thresholds for determining significant climate change impacts in the SJVAPCD. The guidance is intended to streamline CEQA review by pre-quantifying emissions reductions that would be achieved through the implementation of Best Performance Standards (BPS). BPS are developed by the SJVAPCD and are based on current technologies, operating principles, and energy efficiency tactics. According to the December 2009 report, stationary source projects failing to implement BPS or demonstrate a 29% reduction in GHG emissions relative to BAU conditions are considered to have a significant impact on climate change. The GHG thresholds apply only to stationary source projects that would result in increased GHG emissions, of which the SJVAPCD is the lead agency. (San Joaquin Valley Air Pollution Control District 2009.) The new SJVAPCD guidance is not applicable to the Proposed Project.

Greenhouse Gas Emissions Estimation Methods

The approach used to evaluate each alternative's GHG impacts involved estimating GHG emissions for construction, existing conditions, the future No-Project Alternative, and Alternatives 1 and 3. Alternative 2's GHG emissions were assumed equal to Alternative 1.

Table 4.14-2 summarizes existing GHG emissions on the Project islands. Emissions are shown for three primary sources; peat soil oxidation represents the largest GHG emissions source, following by farming and recreation activities Recreation activities include vehicle trips associated with hunting and boating activities, as well as boating emissions.

Existing and future no-project GHG emissions are generated by three primary sources: peat oxidation, farming, and recreation. Peat oxidation emissions involve oxidation of peat soil organic matter that produces CO_2 and methane. Exposed peat soils are oxidized continuously when not moist. The agricultural oxidation rate would be reduced by almost 90% if converted to reservoirs or wetlands (ICF Jones & Stokes 2007, 2008).

Farming emissions are based on existing estimates of farming activity and associated gasoline and diesel fuel use. Recreation emissions are based on the number of vehicle trips associated with various recreational uses.

Table 4.14-2. Existing Greenhouse Gas Emissions

Emission Source	CO_2e (metric tons/yr)	CO_2 (tons/yr)	CH_4 (tons/yr)	N_2O (tons/yr)
Peat oxidation	231,737	255,374	–	–
Farming	2,267	2,488	0.5	–
Recreation	18	20	–	–
Total	234,021	257,882	0.5	–

Notes: Estimates of peat oxidation based on emission factors included in ICF Jones & Stokes reports (2007 and 2008) and assume 15,022 acres with emissions of 17 tons CO_2 per acre per year. Farming and recreation emissions based on activity levels as specified in Appendix C, Table C-3.

Proposed Project (Alternative 2)

Impact CC-1: Increase in CO_2e Emissions on Project Islands during Construction

Table 4.14-3 shows construction emissions for Alternatives 1, 2, and 3. Alternative 2 would generate approximately 2,313 metric tons of CO_2e per year for construction. Impacts associated with GHGs are long-term climatic changes, which are beyond the regulatory purview of the individual air districts. GHGs tend to accumulate in the atmosphere because of their relatively long lifespan. As a result, their impact on the atmosphere is mostly independent of the point of emission; GHG emissions are more appropriately evaluated on a regional, state, or even national scale than on an individual project level. Impacts related to climate change are considered less than significant, as climate change would not occur with Project implementation.

Table 4.14-3. Construction Emissions for Alternatives 1, 2, and 3

Alternative	CO_2e (metric tons/yr)	CO_2 (tons/yr)	CH_4 (tons/yr)	N_2O (tons/yr)
Alternatives 1 and 2	2,313	2,339	0.3	0.7
Alternative 3	4,020	4,112	0.5	1.0

Notes: Construction emissions based on activity levels as specified in Appendix C, Tables C-5 and C-6.

Mitigation

No mitigation required.

Impact CC-2: Increase in CO_2e Emissions on Project Islands during Operation

Table 4.14-4 shows Alternative 2 GHG emissions assuming electricity is used to pump water onto and off of the islands. Table 4.14-5 shows Alternative 2 GHG emissions assuming diesel-fueled pumps are used instead of electrically powered pumps. For both scenarios, peat oxidation constitutes the largest percentage of emissions, followed by recreation emissions, methane flux, and pumping. Methane flux estimates are based on a white paper prepared specifically for the Project (Horne 2009). Methane flux emissions are produced primarily from the reduction of CO_2 under anaerobic conditions. Alternative 2 would generate 141,876 metric tons CO_2e per year. However, compared to existing conditions, Alternative 2 would reduce emissions by 92,145 metric tons CO_2e. Compared to No-Project Conditions, Alternative 2 would reduce emissions by 99,335 metric tons CO_2e. This is a beneficial and less than significant impact, and no mitigation is required.

As shown in Table 4.14-5, if diesel fuel is used to power the water pumps, the net GHG benefit would be reduced slightly compared to using electrically powered pumps. However, there still would be a substantial GHG benefit under the diesel powered–pump scenario. This benefit is attributable primarily to the reduction in peat oxidation GHG emissions.

Table 4.14-4. Alternative 2 Greenhouse Gas Emissions with Electricity Used for Pumping

Emission Source	CO_2e (metric tons/yr)	CO_2 (tons/yr)	CH_4 (tons/yr)	N_2O (tons/yr)
Peat oxidation	125,825	138,659	–	–
Farming	2,214	2,436	0.2	–
Recreation	9,739	10,058	3.7	1.9
Pumping	1,097	1,207	0.0	0.0
Methane flux	3,001	–	157.5	–
Total	141,876	152,361	161	2
Net change from existing	(92,145)	(105,521)	161	2
Net change from Future No-Project	(99,335)	(113,163)	160	1

Notes: Estimates of peat oxidation based on ICF Jones & Stokes reports (2007 and 2008). Farming, recreation, and pumping emissions based on activity levels as specified in Appendix C, Table C-5. Methane flux based on report by Alex Horne, Ph.D. (2009). Assumes electricity used to pump water. GHG emissions associated with electricity used for pumping based on emission factors provided by the California Climate Action Registry (2009). Alternatives 1 and 2 assume 3 million kilowatt-hours per year required to pump water. Alternative 3 assumes 6 million kilowatt-hours per year required for pumping. On-road vehicle trip emissions estimated with URBEMIS2007, version 9.2.4. Agricultural emissions estimated with OFFROAD2007.

Table 4.14-5. Alternative 2 Greenhouse Gas Emissions with Diesel Fuel Used for Pumping

Emission Source	CO_2e (metric tons/yr)	CO_2 (tons/yr)	CH_4 (tons/yr)	N_2O (tons/yr)
Peat oxidation	125,825	138,659	–	–
Farming	2,214	2,436	0.2	–
Recreation	9,739	10,058	3.7	1.9
Pumping	1,549	1,697	0.2	0.0
Methane flux	3,001	–	157.5	–
Total	142,328	152,851	161.6	1.9
Net change from existing	(91,693)	(105,031)	161.1	1.9
Net change from Future No-Project	(98,883)	(112,673)	160.4	1.1

Notes: Estimates of peat oxidation based on ICF Jones & Stokes report (2007 and 2008). Farming, recreation, and pumping emissions based on activity levels as specified in Appendix C, Table C-5. Methane flux based on report by Alex Horne, Ph.D. (2009). Assumes diesel fuel used to pump water. GHG emissions associated with diesel fuel used for pumping based on emission factors provided by the California Climate Action Registry (2009). Alternatives 1 and 2 assume 3 million kilowatt-hours per year required to pump water. Alternative 3 assumes 6 million kilowatt-hours per year required for pumping. On-road vehicle trip emissions estimated with URBEMIS2007, version 9.2.4. Agricultural emissions estimated with OFFROAD2007.

Mitigation

No mitigation required.

Alternative 1

Under Alternative 1, GHG emissions and associated impacts would be similar to those discussed under Alternative 2.

Alternative 3

Impact CC-1: Increase in CO_2e Emissions on Project Islands during Construction

Table 4.14-3 shows construction emissions for Alternatives 1, 2, and 3. Alternative 3 would generate approximately 4,020 metric tons of CO_2e per year for construction. As previously discussed, GHG emissions are more appropriately evaluated on a regional, state, or even national scale than on an individual project level. Impacts related to climate change are considered less than significant, as climate change would not occur with Project implementation..

Mitigation
No mitigation required.

Impact CC-2: Increase in CO_2e Emissions on Project Islands during Operation

Table 4.14-6 shows Alternative 3 GHG emissions assuming electricity is used to pump water onto and off of the islands. Table 4.14-7 shows Alternative 3 GHG emissions assume diesel-fueled pumps are used instead of electrically powered pumps. For both scenarios, peat oxidation constitutes the largest percentage of emissions, followed by recreation emissions, methane flux, and pumping. Methane flux estimates are based on a white paper prepared specifically for the Project (Horne 2009). Methane flux emissions are produced primarily from the reduction of CO_2 under anaerobic conditions. Alternative 3 would generate 45,338 metric tons of CO_2e per year, assuming electrically powered pumps (Table 4.14-5). However, compared to existing conditions, Alternative 3 would reduce emissions by 188,683 metric tons CO_2e. Compared to No-Project Conditions, Alternative 3 would reduce emissions by 195,873 metric tons CO_2e. This is a beneficial and less-than-significant impact, and no mitigation is required.

As shown in Table 4.14-7, if diesel fuel is used to power the water pumps, the net GHG benefit would be reduced slightly as compared to using electrically powered pumps. However, there still would be a substantial GHG benefit under the diesel powered–pump scenario. This benefit, though, is attributable primarily to the reduction in peat oxidation GHG emissions.

Table 4.14-6. Alternative 3 Greenhouse Gas Emissions with Electricity Used for Pumping

Emission Source	CO_2e (metric tons/yr)	CO_2 (tons/yr)	CH_4 (tons/yr)	N_2O (tons/yr)
Peat oxidation	27,263	30,044	–	–
Farming	–	–	–	–
Recreation	10,254	10,590	3.9	2.0
Pumping	2,194	2,414	0.0	0.0
Methane flux	5,628	–	295.3	–
Total	45,338	43,048	299	2
Net change from existing	(188,683)	(214,834)	298.8	2.0
Net change from Future No-Project	(195,873)	(222,476)	298.0	1.2

Notes: Estimates of peat oxidation based on ICF Jones & Stokes reports (2007 and 2008). Farming, recreation, and pumping emissions based on activity levels as specified in Appendix C, Table C-5. Methane flux based on report by Alex Horne, Ph.D. (2009). Assumes electricity used to pump water. GHG emissions associated with electricity used to pump water based on emission factors provided by the California Climate Action Registry (2009). Alternative 3 assumes 6 million kilowatt-hours per year required for pumping. On-road vehicle trip emissions estimated with URBEMIS2007, version 9.2.4. Agricultural emissions estimated with OFFROAD2007.

Table 4.14-7. Alternative 3 Greenhouse Gas Emissions with Diesel Fuel Used for Pumping

Emission Source	CO_2e (metric tons/yr)	CO_2 (tons/yr)	CH_4 (tons/yr)	N_2O (tons/yr)
Peat oxidation	27,263	30,044	–	–
Farming	–	–	–	–
Recreation	10,254	10,590	3.9	2.0
Pumping	2,324	2,546	0.4	0.0
Methane flux	5,628	–	295.3	–
Total	45,468	43,180	299.5	2.1
Net change from existing	(188,553)	(214,702)	299.1	2.1
Net change from Future No-Project	(195,743)	(222,344)	298.3	1.2

Notes: Estimates of peat oxidation based on ICF Jones & Stokes reports (2007 and 2008). Farming, recreation, and pumping emissions based on activity levels as specified in Appendix C, Table C-6. Methane flux based on report by Alex Horne, Ph.D. (2009). Assumes diesel fuel used to pump water. GHG emissions associated with diesel fuel used to pump water based on emission factors provided by the California Climate Action Registry (2009). On-road vehicle trip emissions estimated with URBEMIS2007, version 9.2.4. Agricultural emissions estimated with OFFROAD2007.

Mitigation

No mitigation required.

No-Project Alternative

Table 4.14-8 shows future (2020) no-project GHG emissions for the Project islands. Since the No-Project Alternative would not involve any construction, only operational GHG emissions are discussed in this section. The No-Project Alternative is similar to existing conditions in that peat oxidation represents the largest source of emissions, followed by farming and recreation. As compared to existing conditions, peat oxidation emissions would remain relatively unchanged, while farming and recreational activity and emissions would increase.

Table 4.14-8. Future No-Project Greenhouse Gas Emissions

Emission Source	CO_2e (metric tons/yr)	CO_2 (tons/yr)	CH_4 (tons/yr)	N_2O (tons/yr)
Peat oxidation	231,737	255,374	–	–
Farming	9,357	10,020	1.2	0.9
Recreation	117	129	–	–
Total	241,211	265,523	1.2	0.9
Net change from existing	7,190	7,642	0.8	0.9

Notes: Estimates of peat oxidation based on emission factors included in ICF Jones & Stokes reports (2007 and 2008) and assume 15,022 acres with emissions of 17 tons CO_2 per acre per year. Farming and recreation emissions based on activity levels as specified in Appendix C, Table C-4.

Section 4.15
Noise

Introduction

This section describes the existing environmental conditions and regulatory setting of the Project area, summarizes the affected environment, and describes environmental effects of the Project regarding noise. The effects of noise attributable to the Project were not discussed in the 2001 FEIR and 2001 FEIS. Potential noise impacts of the Project alternatives are summarized below.

The Project will not have any direct effects on noise in the places of use; the effects on noise, if any, associated with the provision of Project water to the places of use are addressed in Chapter 5, "Cumulative Impacts," and Chapter 6, "Growth-Inducing Impacts."

Summary of Impacts

Table 4.15-1 provides a summary of the impacts and mitigation measures on noise from this Place of Use EIR.

Table 4.15-1. Delta Wetlands Project 2010 Place of Use EIR Impacts and Mitigation Measures for Noise

2010 Place of Use EIR Impacts and Mitigation Measures
ALTERNATIVES 1, 2, AND 3
Impact NOI-1: Exposure of Sensitive Receptors to Noise from Recreational Activities (LTS) **Mitigation:** No mitigation is required.
Impact NOI-2: Exposure of Sensitive Receptors to Construction-Related Noise (LTS-M) **Mitigation Measure NOI-MM-1:** Limit Construction Hours and Comply with all Applicable Local Noise Standards
Impact NOI-3: Exposure of Sensitive Receptors to Operational Equipment Noise (LTS) **Mitigation:** No mitigation is required.
Impact NOI-4: Exposure of Sensitive Receptors to Noise from Ongoing Maintenance and Habitat Conservation Activities (LTS) **Mitigation:** No mitigation is required.
Note: SU = Significant and unavoidable; LTS = Less than significant; LTS-M = Less than significant with mitigation; B = Beneficial.

Existing Conditions

This section discusses the existing conditions and regulatory setting.

Sources of Information

Key sources of information used in the preparation of this section were:

- Contra Costa County General Plan (Contra Costa County 2005)
- San Joaquin County General Plan (San Joaquin County 1992)
- San Joaquin County noise ordinance (San Joaquin County 1995)
- Sacramento County noise ordinance (Sacramento County 1976)

Regulatory Setting

State

No state noise standards apply directly to the Project. California Government Code Section 65302(f) requires that cities and counties include a noise element in their general plans. The purpose of the noise element is to provide a guide for establishing a pattern of land uses that minimizes the exposure of community residents to excessive noise. The *General Plan Guideline* published by the Governor's Office of Planning and Research include recommendations for maximum noise exposure based on type of land use. These recommendations are available for counties and cities to adopt as part of their state-mandated requirement in establishing policies and standards in their general plans regarding incompatibility issues between land uses related to noise exposure.

Local

Bacon and Bouldin Islands are located in San Joaquin County and Webb and Holland Tracts are located in Contra Costa County. The local regulations established by San Joaquin and Contra Costa Counties that pertain to the islands that fall within their respective boundaries are described below.

County of Contra Costa Noise Element

The main goal of the Noise Element of the Contra Costa County General Plan is to improve the overall environment in the county by reducing annoying and physically harmful noise for existing and future residents and for all land uses. Of the policies of the Noise Element, the following pertain to the Project:

Policy 11-7: Public projects shall be designed and constructed to minimize long-term noise impacts on existing residents.

Policy 11-8: Construction activities shall be concentrated during the hours of the day that are not noise-sensitive for adjacent land uses and should be commissioned to occur during normal work hours of the day to provide relative quiet during the more sensitive evening and early morning periods.

Policy 11-11: Noise impacts upon the natural environment, including impacts on wildlife, shall be evaluated and considered in review of development projects.

In addition, the Contra Costa County Noise Element establishes acceptable levels of community noise exposure for its noise-sensitive land uses, including a "normally acceptable" standard of day-night noise level/community noise equivalent level (L_{dn}/CNEL) 60 A-weighted decibels (dBA) for residential uses. Contra Costa County has not established maximum allowable noise level standards for stationary noise sources (such as pumps). Noise from construction activities in Contra Costa County is considered exempt from applicable standards during daytime hours, although the County has not defined "daytime" or "normal work hours" for construction noise. Instead, the County uses project-specific conditions of approval to regulate construction noise levels for projects that require County approvals.

County of San Joaquin Noise Element

The primary objective of the Noise Element of the San Joaquin County General Plan is to ensure acceptable noise environments for each land use. Of the policies of the Noise Element, the following pertain to the Project, as the Project could affect nearby residential land uses:

Policy 1c: The hourly equivalent sound level from stationary sources shall be 50 decibels (dB) during the daytime and 45 dB during the nighttime for outdoor activity areas for residential development; transient lodging, hospitals, nursing homes, and similar health-related facilities; churches, meeting halls, and similar community assembly facilities; office buildings; schools; libraries; museums; and day-care centers.

Policy 1d: The maximum sound level from stationary noise sources shall be 70 dB during the daytime and 65 dB during the nighttime for outdoor activity areas for residential development; transient lodging, hospitals, nursing homes, and similar health-related facilities; churches, meeting halls, and similar community assembly facilities; office buildings; schools; libraries; museums; and day-care centers.

It should be noted that the County of San Joaquin is in the process of a General Plan update.

County of San Joaquin Noise Ordinance

The San Joaquin County noise ordinance is the primary enforcement tool for the operation of locally regulated noise sources, such as construction activity, and is set forth in Title 9, Section 9-1025.9 of the San Joaquin County Code. Table 4.15-2 summarizes maximum allowable noise level standards for sensitive land uses affected by stationary sources (i.e., non-transportation sources). Noise associated with construction, provided that such activities do not take place before 6:00 a.m. or after 9:00 p.m. on any day, is exempted from the provisions of the County noise ordinance.

Table 4.15-2. San Joaquin County Maximum Allowable Noise Exposure—Stationary Sources

	Outdoor Activity Areas	
	Daytime (7 a.m. to 10 p.m.)	Nighttime (10 p.m. to 7 a.m.)
Hourly equivalent sound level (L_{eq}), dB	50	45
Maximum sound level (L_{max}), dB	70	65

Source: San Joaquin County 1995.

Note: Each of the noise level standards specified shall be reduced by 5 dB for impulsive noise, single tone noise, or noise consisting primarily of speech or music.

County of Sacramento Noise Element

The primary objective of the Sacramento County Noise Element is to protect the citizens of Sacramento County from the harmful and annoying effects of exposure to excessive noise. Although the Project is outside of Sacramento County, the noise from the proposed Project could affect land uses located within Sacramento County. Of the policies of the Noise Element, the following pertain to the Project:

Policy NO-2: Noise created by new non-transportation noise sources [such as pumps] shall be mitigated so as not to exceed any of the noise level standards of Table II-1 [Table 4.15-3], as measured immediately within the property line of any affected residentially designated lands or residential land use situated in the unincorporated areas.

Table 4.15-3 [Table II-1]. Sacramento County Noise Level Performance Standards—Non-Transportation Noise Sources

	Exterior Noise Level Standards (dBA)	
Statistical Noise Level	Daytime (7 a.m. to 10 p.m.)	Nighttime (10 p.m. to 7 a.m.)
L_{50}	50	45
L_{max}	70	65

Source: County of Sacramento 1993.

Notes: These standards are for planning purposes and may vary from the standards of the County noise ordinance, which is for enforcement purposes.

These standards apply to new or existing residential areas affected by new or existing non-transportation sources.

The Noise Element further states that each of the noise standards in Table II-1 [Table 4.15-3] should be decreased by 5 dBA for simple tone (or pure tone) noises, which are from sources that emit noise that is dominated by a single frequency (Hz), or tone, and is often the case for operational equipment such as pumps.

County of Sacramento Noise Ordinance

The Sacramento County noise ordinance is set out in Title 6, Chapter 6.68 of the Sacramento County Code. Table 4.15-4 summarizes exterior noise standards for sensitive uses. Noise associated with construction activities, provided that such activities do not take place between the hours of 8:00 p.m. and 6:00 a.m. on weekdays and 8:00 p.m. and 7:00 a.m. on weekends, is exempted from the provisions of the County noise ordinance.

Table 4.15-4. Sacramento County Exterior Noise Standards

Cumulative Duration of the Intrusive Sound in Any One Hour	Daytime[1] (7:00 a.m. to 10:00 p.m.)	Nighttime[1] (10:00 p.m. to 7:00 a.m.)
30 Minutes	55	50
15 Minutes	60	55
5 Minutes	65	60
1 Minute	70	65
Level not to be exceeded for any time per hour	75	70

Source: County of Sacramento 1976.

Notes:

Each of the noise limits specified shall be reduced by 5 dBA for impulsive or simple tone noise, or for noises consisting of speech or music.

If the ambient noise level exceeds that permitted by any of the first four noise-limit categories, the allowable noise limit shall be increased in 5 dBA increments in each category to encompass the ambient noise level. If the ambient noise level exceeds the fifth noise level category, the maximum ambient noise level shall be the noise limit for that category.

[1] A-weighted decibels, dBA.

Affected Environment

Introduction to Noise

Sound is mechanical energy transmitted by pressure waves in a compressible medium such as air. Noise can be defined as unwanted sound. Sound is characterized by various parameters that include the rate of oscillation of sound waves (frequency), the speed of propagation, and the pressure level or energy content (amplitude). In particular, the sound pressure level is the most common descriptor used to characterize the loudness of an ambient sound level. The decibel (dB) scale is used to quantify sound intensity. Because sound pressure can vary enormously within the range of human hearing, the logarithmic dB scale used to measure and control sound intensity numbers at a convenient and manageable level.

The human ear is not equally sensitive to all frequencies in the entire spectrum, so noise measurements are weighted more heavily for frequencies to which humans are sensitive in a process called *A-weighting* (dBA). Because humans are less sensitive to low frequency sound than to high frequency sound, dBA sound levels de-emphasize low frequency sound energy to represent better how humans hear. Table 4.15-5 summarizes typical dBA sound levels.

Table 4.15-5. Typical A-Weighted Sound Levels

Common Outdoor Activities	Noise Level (dBA)	Common Indoor Activities
	110	Rock band
Jet flyover at 1,000 feet		
	100	
Gas lawnmower at 3 feet		
	90	
Diesel truck at 50 feet at 50 mph		Food blender at 3 feet
	80	Garbage disposal at 3 feet
Noisy urban area, daytime		
Gas lawnmower, 100 feet	70	Vacuum cleaner at 10 feet
Commercial area		Normal speech at 3 feet
Heavy traffic at 300 feet	60	
		Large business office
Quiet urban, daytime	50	Dishwasher in next room
Quiet urban, nighttime	40	Theater, large conference room (background)
Quiet suburban, nighttime		
	30	Library
Quiet rural, nighttime		Bedroom at night, concert hall (background)
	20	
		Broadcast/recording studio
	10	
	0	

Source: California Department of Transportation 1998.

Different types of measurements are used to characterize the time-varying nature of sound. These measurements include the equivalent sound level (L_{eq}), the minimum and maximum sound levels (L_{min} and L_{max}), percentile-exceeded sound levels (L_{xx}), the day-night sound level (L_{dn}), and the community noise equivalent level (CNEL). Below are brief definitions of these measurements and other terminology used in this section:

Sound. A vibratory disturbance created by a vibrating object, which, when transmitted by pressure waves through a medium such as air, is capable of being detected by a receiving mechanism, such as the human ear or a microphone.

Noise. Sound that is loud, unpleasant, unexpected, or otherwise undesirable.

Ambient Noise. The composite of noise from all sources near and far in a given environment exclusive of particular noise sources to be measured.

Decibel (dB). A unitless measure of sound on a logarithmic scale that indicates the squared ratio of sound pressure amplitude to a reference sound pressure amplitude. The reference pressure is 20 micro-pascals.

A-Weighted Decibel (dBA). An overall frequency-weighted sound level in decibels that approximates the frequency response of the human ear.

Equivalent Sound Level (L_{eq}). The average of sound energy occurring over a specified period, typically one hour, in terms of a single numerical value. In effect, L_{eq} is the steady-state sound level that, in a stated period, would contain the same acoustical energy as the time-varying sound that actually occurs during the same period. In essence, it is an averaged sound level over a specific time period that in which the sound level “peaks” and “valleys” have been removed.

Exceedance Sound Level (L_{XX}). The sound level exceeded XX% of the time during a sound-level measurement period or duration. For example L_{90} is the sound level exceeded 90% of the time and L_{10} is the sound level exceeded 10% of the time. L_{90} typically is considered to represent the ambient noise level.

Maximum and Minimum Sound Levels (L_{max} and L_{min}). The maximum or minimum sound level measured during a measurement period.

Day-Night Level (L_{dn}). The energy average of the A-weighted sound levels occurring during a 24-hour period, with 10 dBA added to the A-weighted sound levels occurring during the period from 10:00 p.m. to 7:00 a.m. (nighttime) to take into account the greater annoyance of nighttime noises.

Community Noise Equivalent Level (CNEL). The energy average of the A-weighted sound levels occurring during a 24-hour period with 5 dBA added to the A-weighted sound levels occurring during the period from 7:00 p.m. to 10:00 p.m. (evening hours) and 10 dBA added to the A-weighted sound levels occurring during the period from 10:00 p.m. to 7:00 a.m. (nighttime hours).

L_{dn} and CNEL values rarely differ by more than 1 dBA. As a matter of practice, L_{dn} and CNEL values are considered to be equivalent and are treated as such in this assessment. In general, human sound perception is such that a change in sound level of 3 dBA is just noticeable, a change of at least 5 dBA is required before any noticeable change in human response would be expected, and a change of 10 dBA is perceived as doubling or halving sound level.

For a point source such as a stationary compressor, sound attenuates based on geometry at rate of 6 dBA per doubling of distance. For a line source such as free-flowing traffic on a freeway, sound attenuates at a rate of 3 dBA per doubling of distance. Atmospheric conditions such as wind, temperature gradients, and humidity can change how sound propagates over distance and can affect the level of sound received at a given location. The degree to which the ground surface absorbs acoustical energy also affects sound propagation. Sound that travels over an acoustically absorptive surface such as grass attenuates at a greater rate than sound that travels over a hard surface such as pavement. The increased attenuation is typically in the range of 1 to 2 dBA per doubling of distance. Barriers such as buildings and topography that block the line of sight between a source and receiver also increase the attenuation of sound over distance.

Auditory and non-auditory effects can result from excessive or chronic exposure to elevated noise levels. Auditory effects of noise on people can include temporary or permanent hearing loss. Non-auditory effects of exposure to elevated noise levels include sleep disturbance, speech interference, and physiological effects, such as annoyance. Land use compatibility standards for noise typically are based on research related to these auditory effects.

Environmental Setting

The effects of noise attributable to the Project were not discussed in the 2001 FEIR and 2001 FEIS and, therefore, the environmental setting, with regard to noise, is discussed below.

Noise-sensitive land uses are those locations where noise can interfere with primary activities. These uses include places where people sleep, such as residences and hospitals. Other noise-sensitive uses are schools, libraries, places of worship, and areas of recreation during hours of normal human use.

Noise-sensitive land uses in the Project vicinity are primarily residential, with residences located to the west of Holland Tract on Hotchkiss Tract and to the northwest of Holland Tract on Bethel Island, both in Contra Costa County; to the southwest of Bacon Island in the Town of Discovery Bay (Contra Costa County); and to the east of Bouldin Island in the community of Terminous (San Joaquin County). Additionally, several lodging areas or mobile home parks exist north of Webb Tract and west of Bouldin Island in Sacramento County. As mentioned above, the nearest noise-sensitive land uses to the two proposed pump stations are residences located on Bethel Island (in Contra Costa County), approximately 2.5 miles from the proposed pump station on Webb Tract. Primary noise sources in the Project vicinity are agricultural operations, recreational land use such as hunting, vehicular travel on local roads and highways and occasional aircraft flyovers.

Population density and ambient noise levels tend to be closely correlated. Areas that are not urbanized are relatively quiet, while more urbanized areas are subjected to higher noise levels from roadway traffic, industrial activities, and other human activities. Table 4.15-6 summarizes typical ambient noise level based on population density.

Table 4.15-6. Population Density and Associated Ambient Noise Levels

	dBA, L_{dn}
Rural	40–50
Small town or quiet suburban residential	50
Normal suburban residential	55
Urban residential	60
Noisy urban residential	65
Very noisy urban residential	70
Downtown, major metropolis	75–80
Adjoining freeway or near a major airport	80–90
Sources: Hoover and Keith 2008.	

As land use classifications and densities vary somewhat throughout the Project vicinity, so does the existing noise environment. Existing noise levels generally are relatively low in rural/suburban areas (40–55 L_{dn}), such as those areas surrounding the Project.

Environmental Commitments

The environmental commitments, as described in Chapter 2, would not alter the impact findings related to noise.

Environmental Effects

Methods

This analysis focuses on the potential construction-related and operational noise impacts associated with the Project and its alternatives. The applicable local planning documents and noise ordinances, CEQA Guidelines thresholds of significance discussed below, as well as noise prediction modeling methods as recommended by Federal Transit Administration 2006 (for stationary equipment), were used in the determination of the significance of Project impacts.

Significance Criteria

The noise impact analysis considered several criteria for determining the significance of impacts related to noise. The analysis took into account both relevant criteria contained in Appendix G of the State CEQA Guidelines (Association of Environmental Professionals 2009) and Project-specific criteria developed by the lead agency to address potential impacts unique to the Project's location and elements.

For the purposes of this analysis, a noise impact is considered to be significant if:

- Construction activity occurs outside of the hours of 7:00 a.m. to 8:00 p.m.
- Operation of the proposed pump stations results in exterior noise levels in excess of L_{eq} 40 dBA during nighttime hours or 45 dBA during daytime hours (as measured on the receiving noise-sensitive property line), per the San Joaquin and Sacramento County noise standards for stationary noise sources (with a 5 dBA penalty applied for simple tone noise sources). Adherence to this criterion also would ensure compliance with the Contra Costa County guideline of L_{dn}/CENL 60 dBA for residential uses.
- Ongoing maintenance and conservation activities would unreasonably disturb noise-sensitive uses.

Impacts and Mitigation Measures

The following section evaluates the potential impacts of the Project on noise.

Proposed Project (Alternative 2)

Implementation of the Project would involve the improvement and strengthening of levees on all four islands, which will involve the use of heavy construction equipment. The Project also would involve the installation and operation of one discharge pump station on the southeast corner of Bacon Island and one discharge pump station on the southern end of Webb Tract.

Impact NOI-1: Exposure of Sensitive Receptors to Noise from Recreational Activities

It is anticipated that implementation of the Project would result in effects on recreational boating, hunting, and traffic.

Traffic

Table 4.10-7 from the Section 4.10, Traffic and Navigation, summarizes peak hour traffic volumes on roadways in the Project area that are generated by the Project. In addition, Tables 4.10-8 and 4-10-9 from Section 4.10, Traffic and Navigation, summarize future no project peak hour traffic volumes on roadways in the Project area, while Tables 4.10-10 and 4-10-11 summarize future with project peak hour traffic volumes on roadways in the Project area. Based on the data found in Tables 4.10-7 through 4.10-11, it is anticipated that traffic volumes would increase by 62% on Bacon Island Road at the Bacon Island Road Bridge and 79% on Jersey Island Road north of Cypress Road. This would equate to a noise increase of approximately 2 dB on Bacon Island Road and 3 dB on Jersey Island Road. As previously indicated, a change in sound level of 3 dBA is just noticeable, while a change of at least 5 dBA is required before any noticeable change in human response would be expected. Because the increase in traffic noise levels along these roadway segments is barely perceptible, this impact is considered less than significant.

Recreational Boating

Implementation of the Project is anticipated to result in increases in recreational boating use-days in and around the Project islands because of the addition of recreation facilities, including boat slips. However, these increases are not anticipated to result in any increases in the exposure of noise-sensitive land uses to noise from boating activities, as the Project would not locate these activities closer to any noise sensitive land uses. Consequently, this impact is considered less than significant. Implementation of Mitigation Measure REC-MM-1 would reduce boat slips by 86.8%, and further reduce any impact.

Hunting

Implementation of the proposed Project is anticipated to result in increases in recreation use-days for hunting in the Delta. However, these increases are not anticipated to result in any increases in the exposure of noise-sensitive land uses to noise from hunting activities, as the Project would not locate these activities any closer to any noise-sensitive land uses. Consequently, this impact is considered less than significant.

Mitigation

No mitigation is required.

Impact NOI-2: Exposure of Sensitive Receptors to Construction-Related Noise

Construction of the Project would result in a temporary increase in noise levels in the Project vicinity, which could affect nearby noise-sensitive uses. Construction noise occurring between the hours of 7:00 a.m. and 8:00 p.m. would be considered less than significant. Noise from construction activities that occur outside of these hours would be considered significant. It is anticipated that noise levels would attenuate to imperceptible levels at the nearest noise-sensitive land use due to distance from construction activities. However, in the event that construction activities occur near a noise sensitive land use outside of these hours, a significant noise impact could occur. Implementation of Mitigation Measure NOI-MM-1 would reduce this impact to a less-than-significant level.

It is anticipated that groundborne vibration and noise from construction activities would not be perceptible at the nearest noise-sensitive land used due to distance from construction activities, as groundborne vibration and noise attenuate more dramatically when compared to airborne noise.

Mitigation Measure NOI-MM-1: Limit Construction Hours and Comply with all Applicable Local Noise Standards

In addition to complying with all applicable local noise standards, the Project applicant will limit construction activities that create noise near sensitive use areas to the hours between 7:00 a.m. and 8:00 p.m.

Impact NOI-3: Exposure of Sensitive Receptors to Operational Equipment Noise

The only permanent noise-generating components of the Project are four discharge pump stations, two on Bacon Island and two on Webb Tract. Pump noise will vary depending on several factors, including pump type (electric or diesel), drive motor horsepower, speed (revolutions per minute), and the distance to the nearest noise-sensitive receptor. According to reference source levels in Hoover & Keith (2008), pumps can generate noise levels of up to 80 dBA at a distance of 50 feet.

To provide a worst-case scenario for noise impacts attributable to the proposed pump stations, it is assumed that a given pump potentially could operate continuously for a full hour during nighttime hours (10 p.m. to 7 a.m.). With the nearest sensitive land uses (residential) to either of the two proposed pump stations located on Bethel Island (in Contra Costa County), approximately 2.5 miles from the proposed pump station on Webb Tract, and based on the reference source level provided above, noise from the operation of the closest pump station is projected to attenuate to a noise level of 17 dBA and is not be anticipated to be audible over the existing ambient noise at any noise-sensitive land uses in the Project vicinity. This impact is considered less than significant.

Mitigation
No mitigation is required.

Impact NOI-4: Exposure of Sensitive Receptors to Noise from Ongoing Maintenance and Habitat Conservation Activities

Ongoing maintenance of the proposed pumps, diversion structures and fish screens, and levees will be conducted as necessary. In addition, conservation activities will be performed intermittently on the Project Habitat Islands and may involve an exposure of sensitive uses to intermittent noise from vehicles and light maintenance equipment. However, these activities are anticipated to be relatively infrequent. Because of the intermittent nature of these activities and the relatively far distance of 2.5 miles between the nearest receptor and a proposed pump station, this impact is considered less than significant.

Mitigation
No mitigation is required.

Alternative 1

Alternative 1 would have the same effects as Alternative 2.

Alternative 3

Under Alternative 3, all four Project islands would be used as reservoirs (as opposed to two). Under this alternative, there would be reduced hunting activities but more construction and pump noise. The potential short- and long-term effects of Project noise would be essentially the same as under Alternative 2.

No-Project Alternative

Because the No-Project Alternative would not involve any construction, only operational impacts are discussed in this section. Operation of the No-Project Alternative includes increases in agricultural activity and recreational uses compared to existing conditions. Operation of the No-Project Alternative could result in noise effects from increased traffic and hunting.

Increase in Traffic Noise Levels

Table 4.10-9 from the Section 4.10, Traffic and Navigation, summarizes peak hour traffic volumes on roadways in the Project area that are generated by the No-Project Alternative. In addition, Tables 4.10-8 and 4-10-9 from Section 4.10, Traffic and Navigation, summarize future no project peak hour traffic volumes on roadways in the Project area, while Tables 4.10-10 and 4-10-11 summarize future with project peak hour traffic volumes on roadways in the Project area. Based on the data found in Tables 4.10-7 through 4.10-11, it is anticipated that traffic volumes under the No-Project Alternative would increase by 19% on Bacon Island Road at the Bacon Island Road Bridge and 27% on Jersey Island Road north of Cypress Road. This would equate to a noise increase of less than 1 dB on Bacon Island Road and on Jersey Island Road. As previously indicated, a change in sound level of 3 dBA is just noticeable, while a change of at least 5 dBA is required before any noticeable change in human response would be expected. Therefore, the increase in traffic noise levels attributable to the No-Project Alternative along these roadway segments would be barely perceptible.

Exposure of Sensitive Receptors to Noise from Recreational Activities

Operation of the No-Project Alternative is anticipated to result in increases in hunter use-days on the Project islands attributable to the proposed intensive for-fee hunting program. However, these increases are not anticipated to result in any increases in the exposure of noise-sensitive receptors to noise from hunting activities, as the Project would not locate these activities closer to any noise-sensitive land uses.

Chapter 5
Cumulative Impacts

Introduction

The 2000 RDEIR/EIS presented cumulative impacts within each resource section. This chapter consolidates the potential cumulative impacts of the Proposed Project (Alternative 2), organized by resource topic.

State CEQA Guidelines require that the cumulative impacts of a proposed project be addressed in an EIR when the cumulative impacts are expected to be significant and when the project's incremental effect is cumulatively considerable (Guidelines 15130[a]). If an environmental effect is not "cumulatively considerable", a Lead Agency need not consider that effect significant, but shall briefly describe its basis for concluding that the incremental effect is not cumulatively considerable. (Id.) Cumulative impacts are impacts on the environment that result from the incremental impacts of a proposed action when added to other past, present, and reasonably foreseeable future actions (Guidelines 15355[b]). Such impacts can result from individually minor but collectively significant actions taking place over time.

The cumulative impact analysis determines the combined effect of the Proposed Project and other closely related, reasonably foreseeable, projects. This section describes the methods used to evaluate cumulative effects, lists related projects and describes their relationship to the proposed Project, identifies cumulative impacts by resource area, and recommends mitigation for significant cumulative effects. Section 15130 of the State CEQA Guidelines states that the discussion of cumulative impacts need not provide as much detail as the discussion of effects attributable to the project alone. The level of detail should be guided by what is practical and reasonable.

According to the State CEQA Guidelines (Section 15130), an adequate discussion of significant cumulative impacts should contain the following elements:

- an analysis of related future projects or planned development that would affect resources in the project area similar to those affected by the proposed project;
- a summary of the expected environmental effects to be produced by those projects with specific reference to additional information stating where that information is available; and

- a reasonable analysis of the cumulative impacts of the relevant projects. An EIR must examine reasonable, feasible options for mitigating or avoiding the project's contribution to any significant cumulative effects.

To identify the related projects, the State CEQA Guidelines (15130[b]) recommend either the "list" or "projection" approach. This analysis uses the list approach, which entails listing past, present, and probable future projects producing related or cumulative impacts, including, if necessary, those projects outside the control of the lead agency. The Lead Agency has not identified any previously approved land use documents that contain a pertinent discussion of cumulative impacts.

Projects to Be Cumulatively Considered

Projects Previously Considered

This analysis incorporates all reasonably foreseeable, relevant projects and focuses on those water management actions or projects that, when combined with the Proposed Project, could contribute to cumulative effects. The 2001 FEIR and 2001 FEIS considered the following projects when analyzing potential cumulative impacts:

- State Water Board Bay-Delta Proceedings
- CALFED Bay-Delta Program
- CVP and SWP Endangered Species Consultations
- Coordinated Operations Agreement
- Banks Pumping Plant Fish Protection Agreement
- Central Valley Project Improvement Act
- DWR Delta Water Management Programs
  - North Delta Program
  - South Delta Program
  - West Delta Program
- DWR Delta Levee Maintenance Program
  - Subventions Program
  - Special Projects
- Delta Ecological Studies
- DWR Offstream Storage South of the Delta
  - Los Banos Grandes
  - Kern Water Bank

- SWP Coastal Branch Project, Phase II
- CCWD Los Vaqueros Project
- Montezuma Wetlands Project
- Delta Water Transfers
- Reoperation of Folsom Dam and Reservoir
- East Bay Municipal Utility District Activities
  - American River Diversions
  - Water Supply Management Program
- Activities of the Metropolitan Water District of Southern California
  - Arvin-Edison/Metropolitan Water District Storage and Exchange Program
  - Domenigoni Reservoir Project

Updated Project List

Because so much time has passed since the cumulative impact analysis was performed for the 2001 FEIR and 2001 FEIS, the above list of programs and projects relevant to the Project that could contribute to cumulative impacts is largely out-of-date. Scoping for this Place of Use EIR and other recent documents was used to update the list of projects considered in this revised cumulative impact analysis. The analysis considers projects that could affect the same resources and, where relevant, in the same time frame as the Proposed Project, resulting in a cumulative impact. The following list contains projects considered for this updated cumulative effects section; each project is then described and its relationship to the resource impacts caused by the Proposed Project is discussed.

- Alternative Intake Project
- Bay Area Water Quality and Water Supply Reliability Program
- Bay Delta Conservation Plan
- CALFED Ecosystem Restoration Program
- CALFED Levee System Integrity Program
- Cecchini Ranch
- City of Stockton Delta Water Supply Project
- Clifton Court Forebay–Jones Pumping Plant Intertie
- Delta Cross Channel Reoperation and Through-Delta Facility
- Delta-Mendota Canal–California Aqueduct Intertie
- Dutch Slough Tidal Marsh Restoration Project

- East Altamont Energy Center Power Plant Project
- Franks Tract Project
- Freeport Regional Water Project
- Ironhouse Sanitary District Wastewater Treatment Plant Expansion
- Level 2 Federal Refuge Water Supply Program
- Liberty Island Conservation Bank
- Los Vaqueros Reservoir Expansion
- Lower San Joaquin River Flood Improvements
- Monterey Plus (Monterey Amendment to the State Water Project Contracts)
- Mountain House Community
- National Marine Fisheries Service Biological Opinion Reasonable and Prudent Alternative for Central Valley Project/State Water Project OCAP
- North Bay Aqueduct Alternative Intake Project
- North Delta Flood Control and Ecosystem Restoration Project
- North-of-Delta Off-Stream Storage (Sites Reservoir)
- Old River and Rock Slough Water Quality Improvement Project
- Red Bluff Diversion Dam Plant Fish Passage Improvement Project
- River Islands at Lathrop Development
- Sacramento Valley Water Management Settlement Agreement (Phase 8)
- San Joaquin River Restoration Program
- San Luis Reservoir Low Point Improvement Project
- Shasta Dam and Reservoir Enlargement
- South Bay Aqueduct Enlargement
- South Bay Salt Ponds Restoration Project
- South Delta Improvements Program
- State Water Project—Oroville Facilities
- Suisun Marsh Management Plan
- SWP Harvey O. Banks Pumping Plant Operations
- Tracy Fish Test Facility
- Two-Gate Fish Protection Demonstration Project
- Upper San Joaquin River Basin Storage

- U.S. Fish and Wildlife Service Biological Opinion Reasonable and Prudent Alternative for Central Valley Project/State Water Project OCAP
- Projects in Contra Costa General Plan
- Projects in San Joaquin County General Plan
- Other Development Projects

Alternative Intake Project

CCWD's Alternative Intake Project (AIP) consists of a new 250 cfs screened intake at Victoria Canal and a pump station; levee improvements; and a conveyance pipeline to CCWD's existing conveyance facilities. CCWD will operate the intake and pipeline together with its existing facilities to better meet its delivered water quality goals and to better protect listed species. Operations with the AIP will be similar to existing operations: CCWD will deliver Delta water to its customers by direct diversion when salinity at its intakes is low enough, and will blend Delta water with releases from Los Vaqueros Reservoir when salinity at its intakes exceeds the delivered water quality goal. Los Vaqueros Reservoir will be filled from the existing Old River intake or the new Victoria Canal intake during periods of high flow in the Delta, when Delta salinity is low. The choice of which intake to use at any given time will be based in large part upon salinity, consistent with fish protection requirements in the biological opinions; salinity at the Victoria Canal intake site is at times lower than salinity at the existing intakes. The no-fill and no-diversion periods will continue as part of CCWD operations, as will monitoring and shifting of diversions among the four intakes to minimize impacts on listed species.

The AIP is a water quality project and will not increase CCWD's average annual diversions from the Delta. However, it will alter the timing and pattern of CCWD's diversions in two ways: winter and spring diversions will decrease while late summer and fall diversions will increase because Victoria Canal salinity tends to be lower in the late summer and fall than salinity at CCWD's existing intakes; and diversions at the unscreened Rock Slough Intake will decrease while diversions at screened intakes will increase. It is estimated that with the AIP, Rock Slough intake diversions will fall to about 10% of CCWD's total diversions, with the remaining diversions taking place at the other screened intakes.

The project was initiated in July 2004 with a two-year planning phase that included an environmental analysis to comply with federal and state requirements (NEPA and CEQA). CCWD and Reclamation released the Draft EIR/EIS in May 2006 and the Final EIR/EIS in October 2006. In November 2006, the CCWD Board of Directors approved the project and certified the EIR. Construction began in 2008 and is expected to be completed by September 2010. Impacts identified in the AIP EIR/EIS include air quality and loss of agricultural land. Additional information is provided at:

<http://www.ccwater-alternativeintake.com/index.htm>.

Bay Area Water Quality and Water Supply Reliability Program

The Bay Area Water Quality and Water Supply Reliability Program would encourage participating Bay Area partners, including Alameda County Water District, Zone 7 Water Agency, Bay Area Water Supply and Conservation Agency, CCWD, EBMUD, San Francisco Public Utilities Commission, and the Santa Clara Valley Water District (SCVWD), to develop and coordinate regional exchange projects to improve water quality and supply reliability. This project would include the cooperation of these agencies in operating their water supplies for the benefit of the entire Bay Area region as well as the potential construction of interconnects between existing water supplies. This program is in the preliminary planning stages.

Bay Delta Conservation Plan

The BDCP is a plan to provide for the recovery of Endangered, Threatened, and sensitive species and their habitats in the Delta in a way that also will protect and restore water supplies. The BDCP will identify and implement conservation strategies to improve the overall ecological health of the Delta; identify and implement ecologically friendly ways to move freshwater through and/or around the Delta; address toxic pollutants, invasive species, and impairments to water quality; and provide a framework and funding to implement the plan over the next 50 years. The BDCP is being prepared through a collaborative process among state, federal, and local water agencies (e.g., DWR, Reclamation, Westlands Water District); state and federal fish agencies (USFWS, DFG, NMFS); environmental organizations (e.g., The Nature Conservancy, Defenders of Wildlife); other federal agencies (EPA and Corps); and other interested parties.

The BDCP proposes to construct new intakes on the Sacramento River connected to one or more conveyance facilities that would extend south to existing SWP and CVP export systems. Alternatives currently being evaluated comprise the following conveyance options: through-Delta; east alignment (tunnel and canal); west alignment (tunnel and canal); all-tunnel; or dual conveyance (combines portions of east, west, or all-tunnel alignments with some elements of through-Delta alignment) (Delta Habitat Conservation and Conveyance Program 2009). The restoration options include various degrees of restoration in the Delta and Suisun Marsh. Overall, it could contribute to a more stable water supply, improved levee stability, and reduced impacts on fish. The BDCP public review draft is scheduled to be released for public comment in late 2010, and its accompanying EIS/EIR is expected to be complete in 2011.

At present, the all-tunnel alignment is the preferred option because of its smaller footprint. If constructed, the east, west, and all-tunnel alignments would each have a maximum capacity of 15,000 cfs. This project could contribute to cumulative impacts on fish, water supply, hydrodynamics, and loss of agricultural land. It could also contribute beneficially to habitat improvements for fish and estuarine species in the Delta.

CALFED Ecosystem Restoration Program

The goals of the CALFED Ecosystem Restoration Program (ERP) are to:

- recover 19 at-risk native species and contribute to the recovery of 25 additional species;
- rehabilitate natural processes related to hydrology, stream channels, sediment, floodplains and ecosystem water quality;
- maintain and enhance fish populations critical to commercial, sport, and recreational fisheries;
- protect and restore functional habitats, including aquatic, upland, and riparian, to allow species to thrive;
- reduce the negative impacts of invasive species and prevent additional introductions that compete with and destroy native species; and
- improve and maintain water and sediment quality to better support ecosystem health and allow species to flourish.

The ERP plan, which is now administered and funded by DFG, is divided into the Sacramento, San Joaquin, and Delta and Eastside Tributary regions. This plan includes the following kinds of actions:

- develop and implement habitat management and restoration actions, including restoration of river corridors and floodplains, reconstruction of channel-floodplain interactions, and restoration of Delta aquatic habitats;
- restore habitat that would specifically benefit one or more at-risk species;
- implement fish passage programs and conduct passage studies;
- continue major fish screen projects and conduct studies to improve knowledge of their effects;
- restore geomorphic processes in stream and riparian corridors;
- implement actions to improve understanding of at-risk species;
- develop understanding and technologies to reduce the impacts of irrigation drainage on the San Joaquin River and reduce transport of contaminant (selenium) loads carried by the San Joaquin to the Delta and the Bay; and
- implement actions to prevent, control, and reduce impacts from nonnative invasive species.

ERP actions contribute to cumulative benefits on fish and wildlife species, habitats, and ecological processes. Many of the Delta ERP actions will be included in the BDCP planning and design process.

CALFED Levee System Integrity Program

The Levee System Integrity Program is being implemented by the DWR, DFG and the U.S. Army Corps of Engineers. The goal of the CALFED Levee System Integrity Program is to uniformly improve Delta levees by modifying cross sections, raising levee height, widening levee crown, flattening levee slopes, or constructing stability berms. Estimates are that 520 miles of levees need improvement and maintenance to meet the PL 84-99 standard for Delta levees. The levees program continues to implement levee improvements throughout the Delta, including the south Delta area.

This project could contribute to cumulative impacts on fish, geology and soils, cultural resources, and water quality. It would be considered cumulatively beneficial for water supply because improving Delta levee stability is needed to ensure that Delta waterways are a reliable means for conveying water for in-Delta and export purposes.

Cecchini Ranch

Private Island Homes is planning to develop a planned master community on the 1,100-acre Cecchini Ranch property adjacent to Discovery Bay. This new community would include 4,000 to 6,000 residences; a new marina; commercial and light industrial uses; new parks, schools, and trails; and a Delta interpretive center (Contra Costa County Community Development Department 2007). The land where this development would be built was designated as important agricultural land in Contra Costa County's 2005 general plan. If constructed, this project could have cumulative impacts on water supply, water quality, fish, and loss of agricultural land.

City of Stockton Delta Water Supply Project

Currently under construction, this project proposes to divert water from the San Joaquin River for use as a supplemental water supply for the city of Stockton. The proposed intake location is on the southwestern tip of Empire Tract, adjacent to the Stockton DWSC. The maximum diversion rate for the initial phase of the project would be 46 cfs (33,600 af/yr), which would increase to 248 cfs (125,900 af/yr) under the final (2050) phase of development. This project is designed to fulfill the treated water supply needs of full buildout under the City of Stockton's 1990 general plan. A final program EIR, with the City of Stockton as lead agency, was completed and submitted to the State Clearinghouse in October 2005. (City of Stockton 2005)

As identified in the DEIR, the Delta Water Supply Project would have significant effects on visual resources and air quality, and would contribute to a loss of agricultural land and urban growth. This project would have less-than significant effects on land use, water quality, hazardous materials, groundwater, soils, wetlands, special-status species and sensitive habitats, noise, traffic, utilities, cultural resources, and fish. This project could contribute to cumulative impacts on water supply, water quality, special-status species and sensitive habits, fish, and loss of agricultural land.

Clifton Court Forebay–Jones Pumping Plant Intertie

This project would construct an intertie between the CVP and the CCF. It would require an increase in the capacity of the proposed CCF screened intake (see description of Banks Pumping Plant Operations, above). This project would provide increased operational flexibility by modifying intake operations to improve the water quality of exports, improve water supply reliability, and minimize impacts on fish entrainment. This project was included in the CALFED ROD and therefore is analyzed in this cumulative impact assessment. This project will likely be necessary as part of the BDCP isolated conveyance facility, if that facility is constructed. It could contribute to cumulative impacts on water supplies and fish.

Delta Cross Channel Reoperation and Through-Delta Facility

As part of the CALFED ROD, changes in the operation of the DCC and the potential for a through-Delta facility (TDF) are being evaluated. Studies are being conducted to determine how changing the operations of the DCC could benefit fish and water quality. This evaluation will help determine whether a screened through-Delta facility is needed to improve fisheries and avoid water quality disruptions. In conjunction with the DCC operations studies, feasibility studies are being conducted to determine the effectiveness of a TDF. The TDF would include a screened diversion on the Sacramento River of up to 4,000 cfs and conveyance of that water into the Delta. These projects will probably be replaced by the BDCP, if that project is constructed.

Both a DCC reoperation and a TDF would change the flow patterns and water quality in the Delta, affecting fisheries, ecosystems, and water supply reliability. Thus, these projects could have cumulative impacts on water supply, water quality, fish, and terrestrial biological resources.

Delta-Mendota Canal–California Aqueduct Intertie

This project would construct an intertie between the CVP’s Delta-Mendota Canal and the California Aqueduct just south of the Banks and Jones Pumping Plants. It would allow Reclamation to pump to the full permitted capacity of 4,600 cfs at Jones, resulting in a shift in timing of pumping and therefore filling San Luis Reservoir sooner and potentially increasing the amount of water delivered south of the Delta by an average of 35,000 af/yr. An IS/MND was adopted in 2004 by the San Luis & Delta Mendota Water Authority, and Reclamation prepared a DEIS in July 2009 and an FEIS in November 2009.

This project is likely to be built and operated as it has been the focus of recent attention to the drought situation for agricultural water users south of the Delta. It could contribute to cumulative impacts on water supplies and associated resources. It could modify the timing and magnitude of upstream reservoir releases in wet years to accommodate this increased conveyance capacity.

Dutch Slough Tidal Marsh Restoration Project

This project proposes to restore wetlands and upland habitat and provide public access to the 1,166-acre Dutch Slough, which is currently owned by DWR (California Department of Water Resources and California State Coastal Conservancy 2008). The project is located in the city of Oakley in eastern Contra Costa County. The DEIR for the Dutch Slough restoration project was issued by DWR on November 20, 2008. The FEIR was approved by DWR on March 17, 2010.

In the DEIR, Alternative 1 was selected as the environmentally superior alternative, with significant impacts on hydrology and geomorphology, water quality, geology and soils, terrestrial and wetland biological resources, aquatic biological resources, air quality, recreation, cultural resources, and hazards and hazardous materials. Less-than significant impacts were identified for noise, aesthetics, agricultural resources, transportation, and public services and utilities. Terrestrial and wetland biological resources could be cumulatively affected by the project. This project could also result in cumulative beneficial effects on habitat for aquatic species and on recreation.

East Altamont Energy Center Power Plant Project

Calpine Corporation plans to construct an energy center with the intent to market power from hydroelectric plants, such as Shasta and Folsom Dams, to other entities, such as merchant power plants. The center would be located on a 174-acre parcel of land in Alameda County. The actual footprint of the plant would be approximately 55 acres, with the remainder of the parcel available for agricultural leases. Water for cooling and other power plant processes would be provided by Byron Bethany Irrigation District. The plant is expected to have a 30- to 50-year operating life. Environmental documentation equivalent to an EIS/EIR (Revised Presiding Member’s Proposed Decision) was completed in January 2003, and approval from the Energy Commission was granted in August 2003. The project could contribute to cumulative loss of agricultural land.

Franks Tract Project

DWR and Reclamation propose to implement the Franks Tract Project to improve water quality and fisheries conditions in the Delta. DWR and Reclamation are evaluating installing operable gates to control the flow of water at key locations (Three Mile Slough and/or West False River) to reduce seawater intrusion, and to positively influence movement of fish species of concern to areas that provide favorable habitat conditions. By protecting fish resources, this project also would improve operational reliability of the SWP and the CVP because curtailments in water exports (pumping restrictions) are likely to be less frequent. The overall purpose of the Franks Tract Project is to modify hydrodynamic conditions to protect and improve water quality in the central and south Delta, protect and enhance conditions for fish species of concern in the western and central Delta, and achieve greater operational flexibility for pump operations in the south Delta. The project gates would be operated seasonally and during certain hours of the day, depending on fisheries and tidal conditions. Boat passage facilities would be included to allow for passing of watercraft when the gates are in operation.

DWR and Reclamation have conducted studies to evaluate the feasibility of modifying the hydrodynamic conditions near Franks Tract to improve Delta water quality and enhance the aquatic ecosystem. The results of these studies have indicated that modifying the hydrodynamic conditions near Franks Tract may substantially reduce salinity in the Delta and protect fishery resources, including the sharply declining populations of delta smelt.

Preparation of a joint EIS/EIR for the project is underway. However, the project schedule is subject to availability of State Bond funds.

This project could contribute to cumulative fish and tidal hydraulic impacts by changing flows in the North Delta to improve migratory conditions.

Freeport Regional Water Project

The Freeport Regional Water Project (FRWP) is a regional water supply project being developed on the Sacramento River near the town of Freeport by the Sacramento County Water Agency (SCWA) and the East Bay Municipal Utility District (EBMUD), in close coordination with the City of Sacramento and Reclamation. The project is designed to help meet future drinking water needs in the central Sacramento County area and supplement water conservation and recycling programs in the East Bay to provide adequate water supply during future drought periods.

FRWP will provide up to 100 mgd of water for EBMUD to use during drought years and 85 mgd for SCWA to use in all years. The project would divert water from the Sacramento River and deliver it to a Sacramento County Treatment Facility and the Folsom South Canal. From the Folsom South Canal, water will be delivered to the Mokelumne Aqueducts. This project includes construction of fish screens and a pumping plant at the intake on the Sacramento River, a water treatment facility in Sacramento County, and pipeline facilities to transport the water from Freeport to the Mokelumne Aqueducts. The FRWP is under construction and is expected to begin operations in 2010 (it was officially dedicated on April 8, 2010). As such, only operational impacts are considered in this cumulative impact assessment.

The FRWP EIR/EIS identified significant impacts on recreation, vegetation and wetlands, wildlife, noise, visual resources, and cultural resources. Less than significant impacts were identified for water quality, water supply, fish, land use, agricultural resources, and public health. These impacts would occur primarily at the FRWP facilities located at the intake, the pipelines, and on the Mokelumne River. Additional information can be found at:

<http://www.freeportproject.org/index.php>.

Ironhouse Sanitary District Wastewater Treatment Plant Expansion

The Ironhouse Sanitary District (ISD) provides sewage collection, treatment, and disposal service to the city of Oakley, the unincorporated Bethel Island, and unincorporated areas in eastern Contra Costa County. In 1991, ISD proposed to upgrade and expand its wastewater treatment and disposal facilities. In 1994, ISD prepared, circulated, and certified a FEIR (State Clearinghouse Number 92093042) that described the potential impacts on environmental resources for the proposed expansion. (Jones & Stokes 2006)

Since the 1994 FEIR was certified, ISD expanded its treatment capacity from 2.3 mgd to 2.7 mgd, and also developed 396 acres of agricultural land on Jersey Island for irrigation with reclaimed water (treated effluent). In 2006, ISD prepared the *Draft Supplemental Environmental Impact Report for Ironhouse Sanitary District Wastewater Treatment Plant Expansion* to evaluate and disclose potential impacts of their proposed wastewater treatment expansion that were not considered in their 1994 EIR. The Final Supplemental EIR was prepared in January 2007. In that document, ISD selected the alternative that includes a new 8.6 mgd treatment plant on ISD land adjacent to the existing plant (the first phase of the new plant will have a capacity of 4.3 mgd); 114 million gallons of existing storage capacity for treated effluent; a maximum of 510 acres of year-round irrigation lands for disposal of treated effluent; and a new discharge to the San Joaquin River, which will be located off the northern shore of Jersey Island (Contra Costa Local Agency Formation Commission 2007). Ground was broken for the new wastewater treatment plant on April 22, 2009, and construction is expected to be completed by October 2011 (Ironhouse Sanitary District 2010).

As identified in the DEIR, this project would result in less-than significant impacts on agricultural resources (loss of farmland), air quality, cultural resources, hydrology and water quality, fish, vegetation and wildlife, geology, land use, noise, recreation, public services and utilities, public health/hazards, traffic and circulation, and visual resources. It could contribute to cumulative impacts on fish, water quality, and loss of agricultural lands.

Level 2 Federal Refuge Water Supply Program

The 1992 CVIPA mandated that a secure, reliable source of water be established for wildlife refuges in the Sacramento and San Joaquin Valleys. Since 1992, an average of approximately 400,000 af/yr of Level 2 water has been delivered to these refuges to meet this requirement (U.S. Fish and Wildlife Service 2010). This water derives primarily from CVP water. This program could contribute to cumulative impacts on water supply, and beneficial cumulative impacts on wildlife habitat and fish.

Liberty Island Conservation Bank

Reclamation District 2093 (RD 2093) is acting as the lead agency for the Liberty Island Conservation Bank project located at the intersection of Liberty Cut and Liberty Slough on the northern tip of Liberty Island approximately five miles west of Courtland and 10 miles north of the City of Rio Vista in the southern Yolo Bypass which is part of the Sacramento Delta, located in Yolo County, California. The purpose of the Proposed Project is to restore habitat for Delta native fish species for use as mitigation for impacts to Delta native fish habitat in the region. The project is the creation of a conservation bank which would preserve, create, restore, and enhance habitat for all native Delta fish species including Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, California Central Valley Steelhead, delta smelt, and Central Valley fall- and late fall-run Chinook salmon.

The project consists of creating tidal channels, perennial marsh, and occasionally flooded uplands on the site. The project also includes the breaching of the northernmost east-west levee, and preservation and restoration of shaded riverine aquatic habitat along the levee shorelines of the tidal sloughs. When complete, the site will provide a mosaic of interior tidal channels (i.e., open water) to connect interior island marshes to adjacent tidal channels. Construction on the project is scheduled to be completed in 2009. Other restoration projects are also planned on Liberty Island

Resources for which effects may be cumulatively considerable include agricultural and land use resources, air quality, biological resources (fish and Swainson's hawk foraging habitat), and hydrology and water quality.

Los Vaqueros Reservoir Expansion

Reclamation, DWR, and CCWD are conducting a feasibility study examining alternatives to improve water quality and water supply reliability for Bay Area water users while enhancing the Delta environment through providing water for environmental uses, which will include expanding Los Vaqueros Reservoir as well as a variety of other alternatives. Current work has focused on planning-level evaluations of expanding Los Vaqueros Reservoir from 100,000 acre-feet up to 275,000 acre-feet in order to improve Bay Area water quality and water supply reliability, as well as provide water for environmental purposes. An expanded reservoir could require a new or expanded Delta intake. Locations being considered for the new Delta intake include Old River and adjacent channels. Water from an expanded reservoir could be delivered to Bay Area water users through a connection to the South Bay Aqueduct.

A draft planning report, including an evaluation of the environmental impacts of an expanded Los Vaqueros Reservoir on the Delta, was released in May 2003 (U.S. Bureau of Reclamation, Contra Costa Water District, and Western Area Power Administration 2010). Studies conducted for the draft planning report show that there would be no significant effect on water levels for current Delta water users, or on river velocities. An expanded Los Vaqueros could change the timing of diversions from the Delta. Passage of Measure N in March 2004 allowed further environmental and engineering studies to continue, with environmental review public scoping meetings held in 2006. The DEIR/EIS was released in February 2009.

The FEIS/EIR for this project was certified by CCWD on March 31, 2010, with Alternative 4 identified as the environmentally superior alternative under CEQA and as Reclamation's preferred alternative (Reclamation will identify their environmentally preferable alternative in the ROD). This alternative would increase storage capacity from 100 taf to 160 taf and does not include a new Delta intake and pump station. Construction is scheduled to begin in 2011. (U.S. Bureau of Reclamation, Contra Costa Water District, and Western Area Power Administration 2010).

The Los Vaqueros Reservoir Expansion could contribute to cumulative effects on water supplies and associated resources and could increase water supplies available for export in those years when Los Vaqueros Reservoir otherwise would have spilled. It also could modify the timing and magnitude of upstream reservoir releases in wet years and would reduce Delta outflow during diversions needed to fill the reservoir.

Lower San Joaquin Flood Improvements

The primary objective of the Lower San Joaquin Flood Improvements project is to "design and construct floodway improvements on the lower San Joaquin River and provide conveyance, flood control, and ecosystem benefits" (CALFED ROD). This potential project would construct setback levees in the South Delta Ecological Unit along the San Joaquin River between Mossdale and Stockton, and convert adjacent lands to overflow basins and nontidal wetlands or land designated for agricultural use. The levees are necessary for future urbanization and will be compatible with the Sacramento and San Joaquin River Basins comprehensive study.

If implemented, the potential project also may include the restoration of riparian and riverine aquatic habitat, increased riparian habitat, restrictions on dredging and sediment disposal, reduction of invasive plants, and protection and mitigation of effects on Threatened or Endangered species. Progress has been delayed indefinitely with no scheduled date for completion.

This potential project could contribute to ecosystem improvements in the lower San Joaquin River.

Monterey Plus (Monterey Amendment to the State Water Project Contracts)

In 1994, DWR and six water agencies (Kern County Agency, Tulare Lake Basin Water Storage District, Coachella Valley Water District, Metropolitan, Central Coast Water Authority, and Solano County Water Agency) established a set of principles, known as the *Monterey Agreement,* to settle long-term water allocation disputes and create a new management structure for the SWP. The Final EIR for the Monterey Agreement was completed in October 1995 and certified in November 1995. Subsequently, this EIR was challenged in a lawsuit, and on September 15, 2000, the California Third District Court of Appeals ruled the EIR failed to analyze certain impacts relating to water reallocation among contractors in the event of a permanent water shortage, and ordered a new EIR to be prepared. (California Department of Water Resources 2007)

As a result of the court's ruling, a new DEIR and FEIR, for a project now dubbed the *Monterey Amendment,* were prepared, and the FEIR was certified on February 10, 2010. According the DEIR, the primary elements of the Monterey Amendment comprise the following:

- Altered water allocation procedures
- Permanent Table A water transfers and retirements
- New water supply management practices (California Department of Water Resources 2007).

Significant impacts were identified in the draft Monterey Plus EIR for terrestrial biological resources; visual resources; air quality; geology, soils, and mineral resources; recreation; and cultural resources. Less-than significant impacts were identified for surface water hydrology, water quality, and water supply; groundwater; agricultural resources; geology, soils, and mineral resources; land use and planning; hazards and hazardous materials; noise; public services and utilities; traffic and transportation; and energy. The Monterey Plus project could contribute to cumulative impacts on water supply; water quality; and fish species, including special-status species.

Mountain House Community

Trimark Communities has started development of a new community in the western portion of San Joaquin County along the Alameda–San Joaquin County line north of Interstate 205. At full buildout, 16,105 residential units on 4,784 acres would be developed. Mountain House is located directly south of Old River and west of Patterson Pass Road and will include residential, commercial, and some industrial development. It has been designed to accommodate all the needs of the expected 43,522 residents, including housing, jobs, retail, commercial, open space, and public services, such as schools, emergency services, and roads. The EIR was completed in 1994. Construction began in 2003. This project would contribute to cumulative urbanization and associated impacts on water supply, water quality, and fish. It would also cumulatively contribute to loss of agricultural land.

National Marine Fisheries Service Biological Opinion Reasonable and Prudent Alternative for Central Valley Project/State Water Project OCAP

NMFS determined (June 2009) that for the OCAP, an RPA is necessary for the protection of salmon, steelhead, and green sturgeon. The RPA includes measures to improve habitat, reduce entrainment, and improve salvage, through both operational and physical changes in the system. Additionally, the RPA includes development of new monitoring and reporting groups to assist in water operations throughout the CVP and SWP systems and a requirement to study passage and other migratory conditions. The more substantial actions of the RPA include:

- providing fish passage at Shasta, Nimbus, and Folsom Dams;
- providing adequate rearing habitat on the lower Sacramento River and Yolo Bypass through alteration of operations, weirs, and restoration projects;
- establishing new San Joaquin River flows in April and May with reduced exports in April and May to protect San Joaquin River steelhead and Chinook salmon;
- reducing reverse OMR flows from January to June to protect Chinook salmon, steelhead, and green sturgeon;
- engineering projects to further reduce hydrologic effects and indirect loss of juveniles in the interior Delta; and
- technological modifications to improve temperature management in Folsom Reservoir.

Overall, the RPA is intended to avoid jeopardizing listed species or adversely modifying their critical habitat, but not necessarily to achieve recovery. Nonetheless, the RPA would result in benefits to salmon, steelhead, green sturgeon, and other fish and species that use the same habitats. Additional information is provided at:

<http://swr.nmfs.noaa.gov/ocap.htm>.

North Bay Aqueduct Alternative Intake Project

The North Bay Aqueduct Alternative Intake Project would construct a new intake for the North Bay Aqueduct to increase the flow in the aqueduct. It will involve the construction of pipeline corridors and connection points to the existing North Bay Aqueduct. This project would construct and operate an alternative intake on the Sacramento River and connect it to the existing North Bay Aqueduct system by a new pipe segment. Proposed project facilities would be located in generally rural areas in Solano and Yolo Counties, west of the Sacramento River and north of Barker Slough. The new intake would be operated in conjunction with the existing North Bay Aqueduct located at Barker Slough. The proposed alternative intake and pumping station would be designed to accommodate the projected peak flow needs of up to 240 cfs. (California Department of Water Resources 2009.)

The Notice of Preparation for the alternative intake project was issued by DWR (lead agency) on November 24, 2009. The public comment period ended on January 8, 2010. The project could contribute to cumulative impacts on water supplies and associated resources. It could modify the timing and magnitude of upstream reservoir releases in wet years to accommodate this increased conveyance capacity. It could also contribute to considerable cumulative impacts on water quality, fish, and loss of agricultural land.

North Delta Flood Control and Ecosystem Restoration Project

The purpose of the North Delta Flood Control and Ecosystem Restoration Project is to implement flood control improvements in the northeast Delta in a manner that benefits aquatic and terrestrial habitats, species, and ecological processes. The North Delta project area includes the North and South Fork Mokelumne Rivers and adjacent channels downstream of I-5 and upstream of the San Joaquin River. Components being considered for flood control include bridge replacement, setback levees, dredging, island bypass systems, and island detention systems. The project will involve ecosystem restoration and science actions in this area, and improving and enhancing recreation opportunities. Many of the elements of this project are currently being considered in the BDCP planning and design process.

In support of the environmental review process, an NOP/NOI was prepared and public scoping was held in 2003. An EIR was prepared in 2008, but the project is not currently funded for implementation. The EIR identified significant impacts on flood control, water quality, groundwater, geology and soils, air quality, noise, vegetation and wetlands, fish, wildlife, land use, public health, and cultural resources. Less-than significant impacts were identified on the following resources: geomorphology, water supply, transportation, population and housing, utilities, energy, and visual resources. If constructed, this project could contribute to cumulative impacts on geology and soils, loss of agricultural land, and cultural resources.

North-of-Delta Off-Stream Storage (Sites Reservoir)

Reclamation and DWR are studying several off-stream storage locations, including Sites Reservoir, located 70 miles northwest of Sacramento, as possible options for additional storage north of the Delta. With a potential maximum capacity of 1.8 maf, Sites Reservoir could increase the reliability of water supplies for a large portion of the Sacramento Valley and could improve fish migration by reducing water diversions on the Sacramento River.

Sites reservoir, as an off-stream project, would be filled primarily by pumped diversions from the Sacramento River. Water would be diverted into the reservoir during peak flow periods in winter months. To minimize potential impacts of existing diversions on Sacramento River fisheries, Sites would release water back into the valley conveyance systems (such as the Glenn Colusa Irrigation District Canal and Tehama Colusa Canal) in exchange for water that would otherwise have been diverted from the Sacramento River. This undiverted summer water could become available for other downstream uses in the Bay-Delta.

A new Sites Reservoir could contribute to cumulative effects on water supplies and associated resources. It could increase water supplies available for export in those years when water otherwise would have been unavailable for storage and export, and modify the timing and magnitude of upstream reservoir releases in wet years.

A Notice of Preparation/Notice of Intent (NOP/NOI) for this project was issued in November 2001, and public scoping for the environmental document took place in January 2002. The initial alternatives information report was issued in May 2006 and a plan formulation report was issued in May 2009. The EIS/EIR and feasibility study are scheduled for completion in 2010.

Old River and Rock Slough Water Quality Improvement Project

CCWD completed the Old River and Rock Slough Water Quality Improvement Project in 2006. This project was designed to minimize salinity and other constituents of concern in drinking water by relocating or reducing agricultural drainage in the south Delta. CCWD intake facilities are located on Rock Slough and Old River, which also receive agricultural drainage water discharged from adjacent agricultural lands. Agricultural drainage water can adversely affect water quality entering the CCWD system.

Drainage from Veale Tract, which used to discharge directly into Rock Slough, is now discharged outside of Rock Slough in an area where strong currents quickly dilute the drainage without re-directing impacts. The Old River project modified an agricultural drain discharge from Byron Tract by lengthening the outfall 150 feet further out into Old River. Previously, the outfall extended only to the immediate bank of the river where channel velocities are slow and dilution of the discharge was minimal. This project could have a cumulative impact on fish, including special-status species.

Red Bluff Diversion Dam Plant Fish Passage Improvement Project

The Fish Passage Improvement Project includes construction of a pumping plant near the existing Tehama-Colusa headworks with an initial installed capacity of 2,180 cfs, with capability of adding pumps that will allow expansion to 2,500 cfs. Tehama-Colusa Canal Authority (TCCA) certified the EIR on June 4, 2008, and Reclamation signed the ROD on July 16, 2008.The changed operations of the Red Bluff Diversion Dam (RBDD) will improve upstream fish passage. The new pumping plant will allow the RBDD gates to remain out (open) for approximately 10 months of the year. The pumping plant upstream from the dam will augment existing capabilities for diverting water into the Tehama-Colusa Canal during times when gravity diversion is not possible because the RBDD gates are out.

The new pumping plant would be capable of operating throughout the year, providing additional flexibility in dam gate operation and water diversions for the TCCA customers. In order to improve adult green sturgeon passage during their spawning migrations (generally March through July) the gates could remain open during the early part of the irrigation season and the new pumping plant could be used alone or in concert with other means to divert water to the Tehama-Colusa and Corning Canals.

Green sturgeon spawn upstream of the diversion dam, and the majority of adult upstream and downstream migrations occur prior to July and after August. After the new pumping plant has been constructed and is operational, Reclamation proposes to operate the RBDD with the gates in during the period from 4 days prior to the Memorial Day weekend to 3 days after the holiday weekend (to facilitate the Memorial Day boat races in Lake Red Bluff), and between July 1 and the end of the Labor Day weekend. This operation would provide improved sturgeon and salmon passage.

The project is expected to be operational by spring of 2012.

This project could contribute beneficially to a cumulative impact on fish. Additional information is provided at:

<http://www.usbr.gov/projects/Facility.jsp?fac_Name=Red+Bluff+Diversion+Dam&groupName=Overview>.

River Islands at Lathrop Development

The Cambay Group, Inc. is proposing to develop approximately 4,990 acres of agricultural land and open space known as the River Islands at Lathrop Project. The project applicant intends to build a mixed-use residential/commercial development on Stewart Tract and Paradise Cut. Stewart Tract is an inbound island bounded by Paradise Cut, the San Joaquin River, and Old River. Paradise Cut is a flood control bypass connecting the San Joaquin River and Old River in the Delta. This mixed-use development is expected to include a town center, employment center, dock facilities, residences, and golf courses. It is expected to generate 31,680 residents and 16,751 jobs at full buildout. The Draft Subsequent EIR was completed in October 2002, Buildout of the development is planned for 2025. It could contribute to cumulative impacts on visual resources and loss of agricultural land.

Sacramento Valley Water Management Settlement Agreement (Phase 8)

The State Water Board has held proceedings regarding the responsibility for meeting the flow-related water quality standards in the Delta established by the Delta WQCP (D-1641). The State Water Board hearings have focused on which users should provide this water, and Phase 8 focuses on the Sacramento Valley users. The Sacramento Valley Water Management Settlement Agreement (SVWMSA) is an alternative to the State Water Board's Phase 8 proceedings. The SVWMSA, entered into by DWR, Reclamation, Sacramento water users, and export water users, provides for a variety of local water management projects that will increase water supplies cumulatively. An environmental document is being prepared for the program.

San Joaquin River Restoration Program

The SJRRP is a comprehensive long-term effort to restore flows to the San Joaquin River from Friant Dam to the confluence of Merced River and restore a self-sustaining Chinook salmon fishery in the river while reducing or avoiding adverse water supply impacts from restoration flows. The Program is a direct result of a Stipulation of Settlement (Settlement) reached in September 2006 after more than 18 years of litigation of the lawsuit challenging the renewal of a long-term water service contract between the United States and CVP Friant Division contractors. The Settling Parties include U.S. Departments of the Interior and Commerce, the Natural Resources Defense Council (NRDC), and the Friant Water Users Authority (FWUA). The Settlement received Federal court approval in October 2006. The San Joaquin River Restoration Settlement Act (Act), included in the Omnibus Public Land Management Act of 2009, was signed by the President on March 30, 2009, and became Public Law 111-11. The Act authorizes and directs the Secretary of the Interior to fully implement the Settlement. The Settlement is based on two goals: to restore and maintain fish populations in “good condition” in the mainstem of the San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally reproducing and self-sustaining populations of salmon and other fish; and to reduce or avoid adverse water supply impacts on all of the Friant Division long-term contractors that may result from the Interim Flows and Restoration Flows provided for in the Settlement. The program is scheduled to have a draft Programmatic EIS/EIR by late 2009.

This program could contribute beneficially to cumulative fish impacts.

San Luis Reservoir Low Point Improvement Project

Reclamation, along with the San Luis & Delta-Mendota Water Authority and SCVWD, is preparing a Feasibility Study for the San Luis Reservoir Low Point Improvement Project (Project). The Project would use one or a combination of alternatives, including treatment options, bypasses, and other storage options, to reduce the risk of “low point” water levels. High temperatures and factors in San Luis Reservoir create conditions that foster algae growth. The water quality in areas of the algal blooms is not suitable for agricultural water users with drip irrigation systems in San Benito County or for municipal and industrial water users relying on existing water treatment facilities in Santa Clara County. Typically, low point conditions occur when water levels in San Luis Reservoir reach an elevation of 369 feet msl or approximately 300 taf when the water is approximately 35 feet above the top of the Lower Pacheco Intake. If water levels fall below 369 feet, the San Felipe Division’s use of CVP supplies could be limited by algae-related water quality effects. San Luis Reservoir is the only delivery route for the San Felipe Division’s CVP supplies authorized under their current CVP Water Service Contracts.

The alternatives being considered to avoid water quality problems SCVWD in and to increase the effective storage capacity of the reservoir include, but are not limited to:

- conjunctive use with administrative actions,
- lowering the San Felipe Division intake facilities, and
- expanding Pacheco Reservoir.

An NOP/NOI to prepare an EIS/EIR was published in August 2008, and the EIS/EIR is expected to be released in 2010. Implementation of this project would provide flexibility in operation of the San Luis Reservoir and improve reliability of water deliveries to CVP contractors.

This project could contribute to cumulative impacts on water supply and water quality.

Shasta Dam and Reservoir Enlargement

The CALFED ROD includes enlargement of Shasta Reservoir as an option to increase storage north of the Delta. Alternatives to expand Shasta Reservoir by raising the height of the dam by 6.5 to 18.5 feet would inundate a segment of McCloud River, protected under the California Wild and Scenic Rivers Act, as well as portions of the Pit River and Upper Sacramento River. The alternatives include modifications to the dam and reservoir re-operations. This project is in the planning stages, with an initial alternatives information report issued in 2004. A Plan Formulation Report was issued in 2008, and a DEIS is expected in winter 2010.

Shasta Enlargement could contribute to cumulative effects on water supplies and associated resources and could increase water supplies available for export in those years when Shasta Reservoir otherwise would have spilled. It also could modify the timing and magnitude of upstream reservoir releases in wet years.

South Bay Aqueduct Enlargement

The purpose of the South Bay Aqueduct (SBA) Enlargement Project is to increase the capacity of the SBA from 270 cfs to 430 cfs to meet Zone 7 Water Agency's future needs and provide operational flexibility to reduce SWP peak power consumption. The Project includes the addition of four 45-cfs pumps to the South Bay Pumping Plant, including expanding the plant structure, a new service bay, and a new switchyard; constructing a third (Stage 3) Brushy Creek Pipeline and surge tank parallel to the existing two barrels; constructing a 500-acre-foot reservoir (425 acre-feet of active storage) to be served by the Stage 3 Brushy Creek Pipeline; raising the height of the canal embankments, canal lining, and canal overcrossing structures and bridges along the Dyer, Livermore, and Alameda Canals and at the Patterson Reservoir; modifying check structures and siphons along the Dyer, Livermore, and Alameda Canals; and constructing new drainage overcrossing structures to eliminate drainage into the canals. Currently, construction is proceeding to enlarge the South Bay Pumping Plant to make room for the four new pump units being fabricated. Final completion is expected in fall 2010.

The SBA Enlargement Project could contribute to cumulative impacts on water supplies and associated resources. It could modify the timing and magnitude of upstream reservoir releases in wet years to accommodate this increased conveyance capacity.

South Bay Salt Ponds Restoration Project

The South Bay Salt Pond Restoration Project is the largest tidal wetland restoration project on the West Coast. When complete, the project will restore 15,100 acres of industrial salt ponds in the south San Francisco Bay to a mosaic of tidal wetlands and other habitats.

The project is being implemented by DFG and USFWS, in collaboration with the Coastal Conservancy. The goals are to restore and enhance a mix of wetland habitats, to provide wildlife-oriented public access and recreation, and to provide for flood management in the South Bay. An FEIS/EIR was released in December 2007. The project has begun to design and construct habitat, recreation and flood protection features at each of the pond complexes.

The Project could cumulatively increase tidal wetlands in the bay area and reduce habitats for species dependent on the salt marshes.

South Delta Improvements Program

The SDIP is a series of proposed actions that improve water quality and protect salmon in the southern part of the Sacramento-San Joaquin Delta while allowing the State Water Project to operate more effectively to meet California's existing and future water needs. The SDIP is divided into Stages 1 and 2. Stage 1 includes the construction and operation of permanent operable gates (to replace the temporary barriers), dredging in portions of the south Delta, and extension of some agricultural diversion structures by 2012. The operation of the gates is included in the OCAP analysis. The head of Old River gate would be operated between April 15 and May 15 and in the fall. The remaining three agricultural gates would be operated April 15 through the agricultural season. The gates would maintain south Delta water levels above 0.0 msl for channels upstream of the operable gates. Stage 2 addresses the proposed operational component to increase water deliveries south of the Delta by increasing the permitting diversion amount at CCF to 8,500 cfs. All of SDIP was evaluated in an EIS/EIR, finalized in 2006. DWR and Reclamation are preparing a supplemental document for Stage 1. Neither agency intends to pursue Stage 2 in the near future, nor is it likely to occur in the near future due to POD, but it is included in the cumulative analysis because it is foreseeable if Delta conditions improve and DWR or Reclamation decides to pursue it.

The SDIP has the potential to affect nearly all the same resources as are affected by the Project applicant, and could be implemented during the 50-year life of the Proposed Project. Specifically, the SDIP would result in impacts related to geology and soils, air quality, fish, vegetation and wetlands, wildlife, visual resources, and cultural resources. Other less than significant changes in tidal hydraulics, water quality, recreation, levee stability, agricultural resources, public health and traffic would also occur. These impacts would occur primarily in the south Delta. Stage 1 would improve water supply for in-Delta diverters, while Stage 2 would improve water supply for south-of-Delta users. Additional information is provided at:

<http://baydeltaoffice.water.ca.gov/sdb/sdip/index_sdip.cfm>.

State Water Project—Oroville Facilities

Lake Oroville and Oroville Dam are part of a complex which includes Hyatt Powerplant, Thermalito Diversion Dam and Powerplant, the Feather River Fish Hatchery, Thermalito Power Canal, Thermalito Forebay, Thermalito Pumping-Generating Plant, Thermalito Afterbay, and the Lake Oroville Visitors Center.

The SWP Oroville facility operations are regulated by FERC and the State Water Board. A new license from FERC is being sought by DWR. Until FERC issues the new license for the Oroville Project, DWR will not significantly change the operations of the facilities and when the FERC license is issued, it is assumed that downstream of Thermalito Afterbay Outlet, the future flows will remain the same. There is a great deal of uncertainty as to when the license will be issued and what conditions will be imposed by FERC and the State Water Board.

The process that DWR has to go through to get the new license is as follows.

DWR finalized the Final EIR in July 2008; the State Water Board will prepare the CWA Section 401 Certification for the project, which may take up to a year and the 401 Certification may have additional requirements for DWR operations of Oroville. Once the 401 Certification is issued, FERC can issue the new license; in the interim, however, the documents or process may be challenged in court. When the new FERC license is issued, additional flow or temperature requirements may be required. At this time, DWR assumes that the flow and temperature conditions required will be those in the FERC Settlement Agreement (SA); therefore, those are what DWR proposes for the near-term and future Oroville operations.

The proposed future operations in the SA include 100–200 cfs increase in flows in the low-flow channel of the Lower Feather River and reduced water temperatures at the Feather River Hatchery and in the low-flow channel. It is unlikely that either the proposed minor flow changes in the low-flow channel or the reduced water temperatures will affect conditions in the Sacramento River downstream of the confluence, but if they were detectable, they would be beneficial to anadromous fish in the Sacramento River.

The SA includes habitat restoration actions such as side-channel construction, structural habitat improvement such as boulders and large woody debris, spawning gravel augmentation, a fish counting weir, riparian vegetation and floodplain restoration, and facility modifications to improve coldwater temperatures in the low and high flow channels. These actions are designed to improve conditions for Chinook salmon and steelhead in the Feather River.

As such, this project could contribute beneficially to cumulative fish impacts. Additional information is provided at:

<http://www.water.ca.gov/orovillerelicensing/>.

Suisun Marsh Management Plan

Reclamation, USFWS, and DFG are NEPA and CEQA lead agencies in the development of a management plan to restore 5,000 to 7,000 acres of tidal wetlands and enhance existing seasonal wetlands in Suisun Marsh. The plan would be implemented over 30 years and is expected to contribute to the recovery of many terrestrial and aquatic species. The EIS/EIR for the plan is expected to be complete in 2010. It could contribute to cumulative recreation, fish, levee stability, and terrestrial species impacts.

SWP Harvey O. Banks Pumping Plant Operations

Banks Pumping Plant has a physical export pumping capacity of 10,300 cfs; however, current permit terms limit the diversion of water to CCF to 6,680 cfs. Implementation of the SDIP, as described above, would have increased allowable diversions at CCF from 6,680 cfs to 8,500 cfs. Although Banks Pumping at 10,300 cfs was included in the CALFED ROD, given the POD and other major challenges that are occurring with the currently permitted amount, it is unlikely that this capacity will ever be attained. Additional future changes in the CCF or the Skinner Fish facility or the Banks Pumping Plant are being considered by DWR within the overall BDCP planning and design process.

Tracy Fish Test Facility

The Tracy Fish Test Facility, to be constructed near Byron, California, will develop and implement new fish collection, holding, transport, and release technology to significantly improve fish protection at the major water diversions in the south Delta. DWR and Reclamation will use results of the Tracy Fish Test Facility to design the CCF Fish Facility, an element of the 10,300 cfs project described above, and improve fish protection at the Jones Pumping Plant facility as required by the CVPIA. The test facility, unlike conventional fish screening facilities, will require fish screening, holding, sorting, transport and stocking capabilities. The facility would be designed to screen about 500 cfs of water at an approach velocity of 0.2 feet per second and meet other appropriate fish agency criteria. The facility would have the structural and operational flexibility to optimize screening operations for multiple species in the south Delta. However, construction of the facility has been delayed by shortfalls in funding. The South Delta Fish Facilities Forum, a CALFED workgroup, is evaluating the cost effectiveness and cost sustainability of the fish facilities strategy. According to the federal budget for Reclamation for 2010 and 2011, this project has $0 allocated for fiscal years 2010 and 2011 (Office of Management and Budget 2010). If eventually constructed, the Tracy Fish Test Facility would not affect current CVP and SWP operations, nor would it contribute considerable cumulative effects.

Two-Gates Fish Protection Demonstration Project

The Two-Gate Project has been proposed by Delta exporters in coordination with Reclamation as a physical and operational measure to help reduce potential delta smelt entrainment and to reduce the water costs associated with such protection. This project would involve the installation and operation of two gate systems in the central Delta: one on the Old River between Holland Tract and Bacon Island, and one on Connection Slough near Middle River between Bacon Island and Mandeville Island. These gates would not interfere with Proposed Project operations.

The project would be implemented in two phases. Phase 1 (a 5-year pilot period) would involve the installation and operation of temporary gates constructed from barge modules with top-mounted butterfly gates. This barge-gate system and temporary sheetpile walls connecting them to the river channel levees would be set in place seasonally from mid-December through June, and then removed until the following December. If operation of these gates proves successful during the pilot phase, Phase 2 would involve the installation and operation of an inflatable bladder gate system or equivalent system.

Both the Phase 1 and Phase 2 gate installations would be operated under protocols developed to protect delta smelt; this would include real-time monitoring elements to determine when to operate the gates, and an evaluation process to assess operational success. In effect, the Old River and Connection Slough gates would provide hydraulic separation of the Franks Tract area from the effects of reverse flows of Old River and Middle River and would be operated in a manner to allow vessel passage.

A draft Environmental Assessment/Finding of No Significant Impact was released by Reclamation on October 19, 2009. Three public meetings were subsequently held by Reclamation to provide information about the project. A 30-day public review and comment period for this project ended on November 30, 2009.

This project could contribute to cumulative beneficial impacts on fish.

Upper San Joaquin River Basin Storage

The Upper San Joaquin River Basin Storage Investigation is a feasibility study by Reclamation and DWR. The purpose of the investigation is to determine the type and extent of federal, state and regional interests in a potential project in the upper San Joaquin River watershed to expand water storage capacity; improve water supply reliability and flexibility of the water management system for agricultural, urban, and environmental uses; and enhance San Joaquin River water temperature and flow conditions to support anadromous fish restoration efforts.

DWR, Reclamation, and their partners have developed a two-phase Plan of Study. Phase 1 will identify water resource opportunities and issues in the Upper San Joaquin River watershed. This phase will include an appraisal of opportunities to increase surface storage and conjunctive uses for groundwater. Phase 2 will be more detailed and will begin with public meetings to determine the scope of the study.

Progress and results of the Investigation are being documented in a series of interim reports that will culminate in a Feasibility Report and an EIS/EIR. The first of a series of reports analyzing alternatives was completed in 2003, with a second report, an initial alternatives information report, completed in spring 2005, and a plan formulation report completed in October 2008. A final feasibility report and environmental review are expected to be complete in 2011.

This project could contribute to cumulative impacts related to water supplies and associated resources including fish and terrestrial species.

U.S. Fish and Wildlife Service Biological Opinion Reasonable and Prudent Alternative for Central Valley Project /State Water Project OCAP

The USFWS determined (December 2008) that for the CVP-SWP Operations and Criteria Plan (OCAP), an RPA is necessary for the protection of delta smelt. The RPA includes measures to: (1) prevent/reduce entrainment of delta smelt at Jones and Banks Pumping Plants; (2) provide adequate habitat conditions that will allow the adult delta smelt to successfully migrate and spawn in the Bay-Delta; (3) provide adequate habitat conditions that will allow larvae and juvenile delta smelt to rear in the Bay-Delta; (4) provide suitable habitat conditions that will allow successful recruitment of juvenile delta smelt to adulthood; and (5) monitor delta smelt abundance and distribution through continued sampling programs through the IEP. The RPA comprises the following actions:

Action 1: To protect pre-spawning adults, exports would be limited starting as early as December 1 (depending on monitoring triggers) so that the average daily OMR flow is no more negative than -2,000 cfs for a total duration of 14 days.

Action 2: To further protect pre-spawning adults, the range of net daily OMR flows will be no more negative than -1,250 to -5,000 cfs (as recommended by smelt working group) beginning immediately after Action 1 as needed.

Action 3: To protect larvae and small juveniles, the net daily OMR flow will be no more negative than -1,250 to -5,000 cfs (as recommended by the smelt working group) for a period that depends on monitoring triggers (generally March through June 30).

Action 4: To protect fall habitat conditions, sufficient Delta outflow will be provided to maintain average X2 for September and October no greater (more eastward) than 74 km (Chipps Island) in the fall following wet years and 81 km (Collinsville) in the fall following above-normal years.

Action 5: The head of Old River barrier will not be installed if delta smelt entrainment is a concern. If installation of the head of Old River barrier is not allowed, the agricultural barriers would be installed as described in the Project Description.

Action 6: A program to create or restore a minimum of 8,000 acres of intertidal and associated subtidal habitat in the Delta and Suisun Marsh will be implemented within 10 years. A monitoring program will be developed to focus on the effectiveness of the restoration program.

These actions are intended to ensure that operations of the CVP and SWP do not lead to jeopardy of this species. Since delta smelt spend their entire life-cycle in the Delta, these actions are expected to significantly improve conditions for this population compared to previous operational scenarios. This RPA would contribute beneficially to a cumulative impact on delta smelt.

Additional information on this RPA and the associated BO is provided at:

<http://www.fws.gov/sacramento/es/delta_smelt.htm>.

Projects in Contra Costa General Plan

The *Contra Costa General Plan 2005–2020* (2005) states that East Contra Costa County (unincorporated Bethel Island, Discovery Bay, Brentwood, Oakley) is projected to add 29,600 homes, which would result in approximately 97,800 more people by 2020 (Contra Costa County 2005). Bethel Island; the land north, south, and east of Discovery Bay; and the land between Discovery Bay and Brentwood/Oakley are considered important agricultural areas. This development would contribute to cumulative urbanization and associated impacts on water supply, water quality, and fish. This development would also cumulatively contribute to loss of agricultural land.

Projects in San Joaquin County General Plan

The *San Joaquin County General Plan* is currently being updated; this update began in June 2008 and is scheduled for completion in June 2011. The most recent version of the complete general plan is from 1992, but information from this version was not used for cumulative analysis due to the likelihood of it being out of date.

However, a revised Housing Element for San Joaquin County was adopted by the county board of supervisors on January 12, 2010. According to this document, planned development in the vicinities of Stockton and Tracy would convert agricultural lands to residential uses. This development would contribute to cumulative urbanization and associated impacts on water supply, water quality, and fish. It would also cumulatively contribute to loss of agricultural land.

Other Development Projects

The Cities of Tracy, Stockton, Byron, and Brentwood, as well as the Town of Discovery Bay, each have proposed multiple development projects ranging in size and impacts. Developments include new residential and commercial areas and associated infrastructure; updating, expanding, or creating water treatment and delivery systems; and waste management facilities such as landfills and recycling centers. It also is likely that future conditions will include additional development beyond what is currently identified. These projects could contribute to cumulative impacts on water quality, loss of agricultural land, and visual resources, as well as construction-related impacts for air quality, noise, and traffic.

Summary of Impacts

Table 5-1 provides a summary and comparison of the impacts and mitigation measures from the 2001 FEIR and 2001 FEIS and this 2010 Place of Use EIR. Some of the cumulative impacts have not changed and do not require an updated discussion below. For these impacts, the cumulative impact discussion from the 2001 FEIR and 2001 FEIS is hereby incorporated by reference and summarized in the discussion sections below for each resource.

Table 5-1. Comparison between Delta Wetlands Project 2010 Place of Use EIR Cumulative Impacts and 2001 FEIR Cumulative Impacts

2001 Final EIR Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR Impacts and 2001 FEIR Impacts
Water Supply	
Impact A-4: Reduction in Delta Consumptive Use (B) **Mitigation:** No mitigation is required.	**Impact CUM-1:** Reduction in Delta Consumptive Use (B) **Mitigation:** No mitigation is required. No change.
	Impact CUM-2: Increased Water Supplies Available for Export (B) **Mitigation:** No mitigation is required. Please see the discussion of this new cumulative impact below.
Hydrodynamics	
Impact B-7: Cumulative Hydrodynamic Effects on Local Channel Velocities and Stages during Maximum DW Diversions (NCC) **Mitigation:** No mitigation is required.	**Impact CUM-3:** Cumulative Hydrodynamic Effects on Local Channel Velocities and Stages during Maximum Project Diversions (NCC) **Mitigation:** No mitigation is required. This cumulative impact has not changed. Please refer to Chapter 3B in the 2001 FEIS for a description of this impact.

2001 Final EIR Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR Impacts and 2001 FEIR Impacts
Impact B-8: Cumulative Hydrodynamic Effects on Local Channel Velocities and Stages during Maximum DW Discharges (NCC) **Mitigation:** No mitigation is required.	**Impact CUM-4:** Cumulative Hydrodynamic Effects on Local Channel Velocities and Stages during Maximum Project Discharges (NCC) **Mitigation:** No mitigation is required. This cumulative impact has not changed. Please refer to Chapter 3B in the 2001 FEIS for a description of this impact.
Impact B-9: Cumulative Hydrodynamic Effects on Net Channel Flows (NCC-M) **Mitigation Measure B-1:** Operate the DW Project to Prevent Unacceptable Hydrodynamic Effects in the Middle River and Old River Channels during Flows That Are Higher Than Historical Flows	**Impact CUM-5:** Cumulative Hydrodynamic Effects on Net Channel Flows (NCC-M) **Mitigation Measure CUM-MM-1:** Operate the Project to Prevent Unacceptable Hydrodynamic Effects in the Middle River and Old River Channels during Flows That Are Higher Than Historical Flows This cumulative impact has not changed. Please refer to Chapter 3B in the 2001 FEIS for a description of this impact and mitigation measure.
Water Quality	
Impact C-17: Salinity (EC) Increase at Chipps Island during Months with Applicable EC Objectives under Cumulative Conditions (NCC) **Mitigation Measure C-1:** Restrict DW Diversions to Limit EC Increases at Chipps Island	This is no longer considered a cumulative impact. Effects on salinity at Chipps Island are addressed in Section 4.1, Water Quality, under Impact WQ-1, and are not expected to be any different under cumulative conditions.
Impact C-18: Salinity (EC) Increase at Emmaton under Cumulative Conditions (NCC-M) **Mitigation Measure C-2:** Restrict DW Diversions to Limit EC Increases at Emmaton	This is no longer considered a cumulative impact. Effects on salinity at Emmaton are addressed in Section 4.1, Water Quality, under Impact WQ-2, and are not expected to be any different under cumulative conditions.
Impact C-19: Salinity (EC) Increase at Jersey Point under Cumulative Conditions (NCC-M) **Mitigation Measure C-3:** Restrict DW Diversions to Limit EC Increases at Jersey Point	This is no longer considered a cumulative impact. Effects on salinity at Jersey Point are addressed in Section 4.1, Water Quality, under Impact WQ-3, and are not expected to be any different under cumulative conditions.
Impact C-20: Salinity (Chloride) Increase in Delta Exports under Cumulative Conditions (NCC) **Mitigation Measure C-4:** Restrict DW Diversions or Discharges to Limit Chloride Concentrations in Delta Exports	This is no longer considered a cumulative impact. Effects on salinity in Delta exports are addressed in Section 4.1, Water Quality, under Impact WQ-4, and are not expected to be any different under cumulative conditions.
Impact C-21: Elevated DOC Concentrations in Delta Exports (CCWD Rock Slough, SWP Banks, CVP Tracy) under Cumulative Conditions (NCC-M) **Mitigation Measure C-5:** Restrict DW Discharges to Prevent DOC Increases of Greater Than 0.8 mg/l in Delta Exports	This is no longer considered a cumulative impact. Effects on DOC concentrations in Delta exports are addressed in Section 4.1, Water Quality, under Impact WQ-6, and are not expected to be any different under cumulative conditions.
Impact C-22: Elevated THM Concentrations in Treated Drinking Water from Delta Exports (CCWD Rock Slough, SWP Banks, CVP Tracy) under Cumulative Conditions (NCC-M) **Mitigation Measure C-6:** Restrict DW Discharges to Prevent Increases of More Than 16 µg/l in THM Concentrations or THM Concentrations of Greater than 72 µg/l in Treated Delta Export Water	This is no longer considered a cumulative impact. THM is no longer evaluated because THM concentration would depend on DOC concentrations and operations at each water treatment plant. Effects on THM concentrations in drinking water from the Delta are tracked in the WQMP and addressed in Section 4.1, Water Quality, under Impact WQ-6 for DOC, and are not expected to be any different under cumulative conditions.

2001 Final EIR Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR Impacts and 2001 FEIR Impacts
Impact C-23: Changes in Other Water Quality Variables in Delta Channel Receiving Waters under Cumulative Conditions (NCC-M) **Mitigation Measure C-7:** Restrict DW Discharges to Prevent Adverse Changes in Delta Channel Water Quality	This is no longer considered a cumulative impact. Effects on other water quality variables in Delta channel receiving waters are addressed in Section 4.1, Water Quality, under Impact WQ-8, and are not expected to be any different under cumulative conditions.
Impact C-24: Increase in Pollutant Loading in Delta Channels (CCU) **Mitigation Measure C-9:** Clearly Post Waste Discharge Requirements, Provide Waste Collection Facilities, and Educate Recreationists regarding Illegal Discharges of Waste **Mitigation Measure RJ-1:** Reduce the Number of Outward Boat Slips Located at the Proposed Recreation Facilities	**Impact CUM-6:** Increase in Pollutant Loading in Delta Channels Associated with Recreational Boating (CCU) **Mitigation Measure CUM-MM-2:** Clearly Post Waste Discharge Requirements, Provide Waste Collection Facilities, and Educate Recreationists regarding Illegal Discharges of Waste **Mitigation Measure REC-MM-1:** Reduce the Size or Number of Recreation Facilities No change.
	Impact CUM-7: Improved CVP and SWP Water Quality Resulting from Increased Use of Sacramento River Water (B) **Mitigation:** No mitigation is required. Please see the discussion of this new cumulative impact below.
Flood Control	
Impact D-12: Decrease in Cumulative Flood Hazard in the Delta (B) **Mitigation:** No mitigation is necessary.	**Impact CUM-8:** Decrease in Cumulative Flood Hazard in the Delta (B) **Mitigation:** No mitigation is necessary. This cumulative impact has not changed. However, an updated impact discussion is provided below.
Impact D-13: Decrease in the Need for Public Financing of Levee Maintenance and Repair on the DW Project islands (B) **Mitigation:** No mitigation is necessary.	**Impact CUM-9:** Decrease in the Need for Public Financing of Levee Maintenance and Repair on the Project islands (B) **Mitigation:** No mitigation is necessary. No change.
Utilities and Highways	
Impact E-27: Cumulative Decrease in the Risk of Structural Failure of Roadways and Utilities (B) **Mitigation:** No mitigation is required.	**Impact CUM-10:** Cumulative Decrease in the Risk of Structural Failure of Roadways and Utilities (B) **Mitigation:** No mitigation is required. No change.
Fishery Resources	
Impact F-17: Alteration of Habitat under Cumulative Conditions (NCC) **Mitigation:** No mitigation is required.	The cumulative fish impacts have been consolidated into Impact CUM-11. See discussion of this impact below.
Impact F-18: Potential Increase in Accidental Spills of Fuel and Other Materials under Cumulative Conditions (NCC) **Mitigation:** No mitigation is required.	The cumulative fish impacts have been consolidated into Impact CUM-11. See discussion of this impact below.

2001 Final EIR Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR Impacts and 2001 FEIR Impacts
Impact F-19: Potential Increase in the Mortality of Chinook Salmon Resulting from the Indirect Effects of DW Project Diversions and Discharges on Flows under Cumulative Conditions (NCC) **Mitigation:** No mitigation is required.	The cumulative fish impacts have been consolidated into Impact CUM-11. See discussion of this impact below.
Impact F-20: Reduction in Downstream Transport and Increase in Entrainment Loss of Striped Bass Eggs and Larvae, Delta Smelt Larvae, and Longfin Smelt Larvae under Cumulative Conditions (NCC) **Mitigation:** No mitigation is required.	The cumulative fish impacts have been consolidated into Impact CUM-11. See discussion of this impact below.
Impact F-21: Change in Area of Optimal Salinity Habitat under Cumulative Conditions (NCC) **Mitigation:** No mitigation is required.	The cumulative fish impacts have been consolidated into Impact CUM-11. See discussion of this impact below.
Impact F-22: Increase in Entrainment Loss of Juvenile Striped Bass and Delta Smelt under Cumulative Conditions (NCC) **Mitigation:** No mitigation is required.	The cumulative fish impacts have been consolidated into Impact CUM-11. See discussion of this impact below.
Impact F-23: Increase in Entrainment Loss of Juvenile American Shad and Other Species under Cumulative Conditions (NCC) **Mitigation:** No mitigation is required.	The cumulative fish impacts have been consolidated into Impact CUM-11. See discussion of this impact below.
	Impact CUM-11: Cumulative Adverse Impacts on Listed Fish Species (CCU) **Mitigation Measure FISH-MM-1:** Replacement of Habitat Lost during Construction of Project Facilities **Mitigation Measure FISH-MM-2:** Implement a Fishery Improvement Mitigation Fund **Mitigation Measure FISH-MM-3:** Establish a Shallow-Water Aquatic Habitat Conservation Easement The cumulative fish impacts have all been consolidated into this new impact. Please see the discussion of this consolidated cumulative impact below.
Vegetation and Wetlands	
Impact G-7: Increase in Wetland and Riparian Habitats in the Delta (B) **Mitigation:** No mitigation is required	**Impact CUM-12:** Increase in Wetland and Riparian Habitats in the Delta (B) **Mitigation:** No mitigation is required This cumulative impact has not changed. However, an updated impact discussion is provided below.
Wildlife	
Impact H-38: Cumulative Increase in Foraging Habitat for Wintering Waterfowl in the Delta (B) **Mitigation:** No mitigation is necessary.	**Impact CUM-13:** Cumulative Increase in Foraging Habitat for Wintering Waterfowl in the Delta (B) **Mitigation:** No mitigation is necessary. No change.
Impact H-39: Cumulative Loss of Herbaceous Habitats in the Delta (NCC) **Mitigation:** No mitigation is necessary.	**Impact CUM-14:** Cumulative Loss of Herbaceous Habitats in the Delta (NCC) **Mitigation:** No mitigation is necessary. This cumulative impact has not changed. However, an updated impact discussion is provided below.

2001 Final EIR Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR Impacts and 2001 FEIR Impacts
Impact H-40: Cumulative Temporary Loss of Riparian Habitat in the Delta (NCC) **Mitigation:** No mitigation is necessary.	**Impact CUM-15:** Cumulative Temporary Loss of Riparian Habitat in the Delta (NCC) **Mitigation:** No mitigation is necessary. This cumulative impact has not changed. However, an updated impact discussion is provided below.
Land Use and Agriculture	
Impact I-8: Cumulative Conversion of Agricultural Land (CCU) **Mitigation:** No mitigation is available.	**Impact CUM-16:** Cumulative Conversion of Agricultural Land (CCU) **Mitigation:** No reasonable mitigation is available. This cumulative impact has not changed. However, an updated impact discussion is provided below.
Recreation and Visual Resources	
Impact J-23: Increase in Recreation Opportunities in the Delta (B) **Mitigation:** No mitigation is required.	**Impact CUM-17:** Increase in Recreation Opportunities in the Delta (B) **Mitigation:** No mitigation is required. This cumulative impact has not changed. However, an updated impact discussion is provided below.
Impact J-24: Enhancement of Waterfowl Populations and Increased Hunter Success in the Delta (B) **Mitigation:** No mitigation is required.	**Impact CUM-18:** Enhancement of Waterfowl Populations and Increased Hunter Success in the Delta (B) **Mitigation:** No mitigation is required. This cumulative impact has not changed. However, an updated impact discussion is provided below.
	Impact CUM-19: Reduction in the Quality of Views of the Reservoir Islands (CCU) **Mitigation Measure REC-MM-1:** Reduce the Size or Number of Recreation Facilities **Mitigation Measure REC-MM-2:** Partially Screen Proposed Recreation Facilities and Pump and Siphon Stations from Important Viewing Areas **Mitigation Measure REC-MM-3:** Design Levee Improvements, Siphon and Pump Stations, and Recreation Facilities and Boat Docks to Be Consistent with the Surrounding Landscape Please see the discussion of this new cumulative impact below.
Traffic and Navigation	
Impact L-21: Increase in Traffic on Delta Roadways during Operation of Future Projects, Including the DW Project (NCC-M) **Mitigation Measure L-4:** Implement Caltrans' Route Concepts for SR 4 and SR 12 **Mitigation Measure RJ-1:** Reduce the Number of Outward Boat Slips Located at the Proposed Recreation Facilities	This is no longer considered a cumulative impact. Future condition scenarios with the Proposed Project, as analyzed in Section 4.10, Traffic and Navigation, capture the effects of both cumulative projects and those of the Proposed Project. For this reason, this impact is not explored further in this chapter. Please refer to Section 4.10, Impact T-2: Increase in Traffic on Delta Roadways during Project Operation, for discussion of this impact.

2001 Final EIR Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR Impacts and 2001 FEIR Impacts
Impact L-22: Reduction in Safety Conflicts on Delta Roadways during Operation of Future Projects, Including the DW Project (B) **Mitigation:** No mitigation is required.	This is no longer considered a cumulative impact. Future condition scenarios with the Proposed Project, as analyzed in Section 4.10, Traffic and Navigation, capture the effects of both cumulative projects and those of the Proposed Project. For this reason, this impact is not explored further in this chapter. Please refer to Section 4.10, Impact T-4: Potential for Traffic Safety Conflicts during Operation, for discussion of this impact.
Impact L-23: Cumulative Increase in Safety Problems on Delta Waterways (CCU) **Mitigation Measure L-5:** Develop and Enforce a Boater Safety Program for DW Private Boat Users **Mitigation Measure RJ-1:** Reduce the Number of Outward Boat Slips Located at the Proposed Recreation Facilities	This is no longer considered a cumulative impact. Future condition scenarios with the Proposed Project, as analyzed in Section 4.10, Traffic and Navigation, capture the effects of both cumulative projects and those of the Proposed Project. For this reason, this impact is not explored further in this chapter. Please refer to Section 4.10, Impact T-7: Increase in Boat Traffic and Congestion on Delta Waterways during Operation, for discussion of this impact.
Cultural Resources	
Impact M-13: Destruction of or Damage to Prehistoric Archaeological Sites in the Delta (NCC) **Mitigation:** No mitigation is required.	**Impact CUM-20:** Destruction of or Damage to Prehistoric Archaeological Sites in the Delta (NCC) **Mitigation:** No mitigation is required. No change.
Impact M-14: Destruction of or Damage to the NRHP-Eligible Historic Districts Representing Agricultural Labor Camp Systems in the Delta (CCU) **Mitigation Measure M-5:** Prepare an HPMP and a Data Recovery Plan for Archaeological Deposits on Bacon Island **Mitigation Measure M-6:** Prepare a Videotape of Public Broadcasting System Quality of the NRHP-Eligible Historic District on Bacon Island **Mitigation Measure M-7:** Prepare a Popular Publication on Bacon Island Resources for Use by Museums, Cultural Centers, and Schools **Mitigation Measure M-8:** Complete Historic American Building Survey/Historic American Engineering Record Forms, Including Photographic Documentation, That Preserve Information about the NRHP-Eligible District on Bacon Island	**Impact CUM-21:** Destruction of or Damage to Historic Districts Representing Agricultural Labor Camp Systems in the Delta (NCC-M) **Mitigation Measure CUL-MM-1:** Prepare and Implement a Historic Properties Treatment Plan This cumulative impact has changed and is no longer considered cumulatively considerable. An updated discussion is provided below.

2001 Final EIR Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR Impacts and 2001 FEIR Impacts
Impact M-15: Destruction of or Damage to Prehistoric Archaeological Sites in the Delta (Alternative 3) (CCU) **Mitigation Measure M-4:** Prepare an HPMP to Provide for the Long-Term Monitoring and Treatment of Archaeologically Sensitive Areas on Holland Tract **Mitigation Measure M-11:** Cap Archaeological Sites on Holland Tract **Mitigation Measure M-12:** Construct Fencing or Other Barriers to Prevent Site Access on Holland Tract **Mitigation Measure M-13:** Construct Levees or Beach Slopes around Archaeological Sites to Decrease Wave Action and Erosion on Holland Tract **Mitigation Measure M-14:** Prepare an HPMP to Provide for the Long-Term Monitoring of Known Archaeological Sites on Holland Tract **Mitigation Measure M-15:** Survey Unsurveyed Portions of Holland Tract and Determine Eligibility for NRHP Listing and Appropriate Treatment	**Impact CUM-20:** Destruction of or Damage to Prehistoric Archaeological Sites in the Delta (NCC) **Mitigation:** No mitigation is required. This cumulative impact has changed and is no longer considered cumulatively considerable. An updated discussion is provided below.
Impact M-16: Destruction of or Damage to the NRHP-Eligible Historic Districts Representing Agricultural Labor Camp Systems in the Delta (Alternative 3) (CCU) **Mitigation Measure M-5:** Prepare an HPMP and a Data Recovery Plan for Archaeological Deposits on Bacon Island **Mitigation Measure M-6:** Prepare a Videotape of Public Broadcasting System Quality of the NRHP-Eligible Historic District on Bacon Island **Mitigation Measure M-7:** Prepare a Popular Publication on Bacon Island Resources for Use by Museums, Cultural Centers, and Schools **Mitigation Measure M-8:** Complete Historic American Building Survey/Historic American Engineering Record Forms, Including Photographic Documentation, That Preserve Information about the NRHP-Eligible District on Bacon Island	**Impact CUM-21:** Destruction of or Damage to Historic Districts Representing Agricultural Labor Camp Systems in the Delta (NCC-M) **Mitigation Measure CUL-MM-1:** Prepare and Implement a Historic Properties Treatment Plan This cumulative impact has changed and is no longer considered cumulatively considerable. An updated discussion is provided below.
Mosquitoes and Public Health	
Impact N-6: Increase in Abatement Levels during Partial-Storage, Shallow-Storage, or Shallow-Water Wetland Periods on the Reservoir Islands under Cumulative Conditions (NCC-M) **Mitigation Measure N-1:** Coordinate Project Activities with SJCMAD and CCMAD	**Impact CUM-22:** Increase in Abatement Levels during Partial-Storage, Shallow-Storage, or Shallow-Water Wetland Periods on the Reservoir Islands under Cumulative Conditions (NCC-M) **Mitigation Measure PH-MM-1:** Develop an Integrated Pest Management Program and Coordinate Project Activities with SJCMVCD and CCCMVCD This cumulative impact has not changed. The mitigation measure has been updated and is described in Section 4.12, Mosquitoes and Public Health.

2001 Final EIR Impacts and Mitigation Measures	Differences between 2010 Place of Use EIR Impacts and 2001 FEIR Impacts
Impact N-7: Cumulative Increase in Mosquito Abatement Needs Resulting from Implementation of Future Projects, Including the DW Project (CCU) **Mitigation:** No mitigation is available.	**Impact CUM-23:** Cumulative Increase in Mosquito Abatement Needs Resulting from Implementation of Future Projects, Including the Project (CCU) **Mitigation Measure PH-MM-1:** Develop an Integrated Pest Management Program and Coordinate Project Activities with SJCMVCD and CCCMVCD This cumulative impact has not changed. However, an updated impact discussion is provided below.
Air Quality	
Impact O-17: Increase in Cumulative Production of Ozone Precursors and CO in the Delta (CCU) **Mitigation Measure RJ-1:** Reduce the Number of Outward Boat Slips Located at the Proposed Recreation Facilities **Mitigation Measure O-4:** Coordinate with Local Air Districts to Reduce or Offset Emissions	**Impact CUM-24:** Increase in Cumulative Production of Ozone Precursors and CO in the Delta (CCU) **Mitigation Measure REC-MM-1:** Reduce the Size or Number Recreation Facilities **Mitigation Measure Air-MM-4:** Coordinate with the SJVAPCD and BAAQMD to Reduce or Offset Emissions This cumulative impact has not changed. However, an updated impact discussion is provided below.
Climate Change	
The effects of and to global Climate Change were not discussed in the 2001 FEIR or 2001 FEIS.	The Project is not anticipated to contribute to any cumulative impacts related to climate change because implementation of the Project would result in a net reduction in annual greenhouse gas emissions.
Noise	
The effects of noise attributable to the Project were not discussed in the 2001 FEIR or 2001 FEIS.	The Project is not anticipated to contribute to any cumulative impacts related to noise because of the lack of sensitive receptors in and near the Project area.
Note: CCU = Cumulatively Considerable and Unavoidable; NCC = Not Cumulatively Considerable; NCC-M = Not Cumulatively Considerable with Mitigation; B = Beneficial.	

Cumulative Impacts by Resource

Based on the updated list of projects described above, conditions included as part of the baseline, and the Project, the description of the potential cumulative impacts and the Project's contribution to these impacts is revised for each resource evaluated in this Place of Use EIR if the analysis needed to be updated or changed. For cumulative impacts that did not change from those described in the 2001 FEIR and 2001 FEIS, the cumulative impacts are summarized here. The resources are presented in the same order as in Chapter 4.

Water Supply

The physical environmental impacts from changes in water supply conditions are similar to potential changes in runoff and river flow. The change in flow is not itself considered an impact unless this change exceeds the normal range of flows for the river or stream channel. An increased water supply diversion would change the downstream flow, and an increased flow could allow increased diversions, but these changes are not considered impacts unless the normal range of the water supply diversions was exceeded. Nevertheless, two cumulative water supply impacts are identified.

Impact CUM-1: Reduction in Delta Consumptive Use under Cumulative Conditions

This cumulative impact has not changed since the 2001 FEIR and 2001 FEIS. Under cumulative conditions, implementation of Alternative 2 would decrease Delta consumptive use from consumptive use estimated for the No-Project Alternative.

This cumulative impact is considered beneficial.

Mitigation

No mitigation is required.

Impact CUM-2: Increased Water Supplies Available for Export

Combining the Project facilities and operations with existing Delta operations and cumulative future storage and conveyance projects, including Shasta Reservoir Enlargement, North-of-Delta Off-Stream Storage, Los Vaqueros Reservoir Expansion, Upper San Joaquin River Basin Storage, an isolated conveyance facility (under BDCP), and possible increases in Banks Pumping Plant permitted capacity (to 10,300 cfs) could result in increased water supplies available for export. It is assumed that these cumulative water supply projects could have positive effects on Delta water supply conditions by improving the amount and timing of flow to the Delta, providing flexibility in timing of storage and release of water for exports, and increasing the amount and timing of water used to protect sensitive aquatic species in upstream tributaries, in the rivers and Delta channels, or with Delta outflow.

Implementation of the Project would not contribute to any cumulative impacts on water supply conditions, but is instead intended to improve reliability by increasing operational flexibility and storage in the system. Combined with the other projects listed above, it is expected that the overall water supply reliability would improve. The Project would result in a small increase in overall water deliveries from the Delta, resulting in potential new areas of use south of the Delta. (See Chapter 6, "Growth-Inducing Impacts.")

In addition to the various projects listed above, the USFWS and NMFS BOs for OCAP include several additional CVP and SWP pumping restrictions (implemented as OMR reverse flow limits) to protect delta smelt and other fish from entrainment. These new restrictions in the months of January–June are likely to reduce the allowable total pumping by CVP and SWP and increase the need for full capacity pumping in the months of July–December. This will make the Project more valuable for maintaining the maximum possible south-of-Delta water supply reliability with the existing south Delta intakes. The cumulative effects of these restrictions may be significant for water supply, but the Project's contribution could at least partially offset this cumulative loss of water supply. The Project's contribution to cumulative water supply impacts therefore is considered both considerable and beneficial.

This cumulative impact is considered beneficial.

Mitigation
No mitigation is required.

Delta Hydrodynamics

The effects of Project operations on the Delta channel hydrodynamics was not further evaluated in this Place of Use EIR, as the Project siphons and discharge pumps on Webb Tract and Bacon Island (reservoir Islands) are generally the same as previously described and evaluated for the 2001 FEIR and 2001 FEIS. This Place of Use EIR describes the Project operations, including the possible impacts of the Project diversion and discharge on Delta channel flows, in Chapter 3, "Project Operations."

The cumulative impacts and mitigation measures for this resource (Delta hydrodynamics) have not changed since publication of the 2001 FEIR and 2001 FEIS. The channel hydrodynamics are generally controlled by the combination of channel geometry, tidal flows, river inflows and export pumping. Therefore, the cumulative impacts of all other projects and regulatory programs that may change or modify channel geometry, river inflows, tidal restoration, unplanned flooded islands, or export pumping could have a cumulative impact on Delta tidal hydrodynamics. However, the contribution of the Project operations on these cumulative impacts would be not cumulative considerable with mitigation.

Impact CUM-3: Cumulative Hydrodynamic Effects on Local Channel Velocities and Stages during Maximum Project Diversions

This cumulative impact has not changed since the 2001 FEIR and 2001 FEIS. Because the basic tidal hydraulics that control local channel velocities and stages are not expected to change substantially under cumulative future conditions, possible hydrodynamic impacts of Alternative 2 during maximum Project diversions under cumulative future conditions are expected to be similar to those described in the 2001 FEIR and 2001 FEIS Hydrodynamics analysis.

This cumulative impact is not cumulatively considerable.

Mitigation
No mitigation is required.

Impact CUM-4: Cumulative Hydrodynamic Effects on Local Channel Velocities and Stages during Maximum Project Discharges

This cumulative impact has not changed since the 2001 FEIR and 2001 FEIS. Because the basic tidal hydraulics that control local channel velocities and stages are not expected to change substantially under cumulative future conditions, possible hydrodynamic impacts of Alternative 2 during maximum Project discharges under cumulative future conditions are expected to be similar to those described in the 2001 FEIR and 2001 FEIS Hydrodynamics analysis.

This cumulative impact is not cumulatively considerable.

Mitigation
No mitigation is required.

Impact CUM-5: Cumulative Hydrodynamic Effects on Net Channel Flows

This cumulative impact has not changed since the 2001 FEIR and 2001 FEIS. Under future conditions, the full physical capacity (10,300 cfs) at Banks Pumping Plant was assumed in the DeltaSOS simulations. Use of full capacity at the Banks Pumping Plant may require implementation of DWR's South Delta Improvements Project to provide sufficient channel conveyance and Clifton Court diversion capacity, to protect agricultural diversion siphons and pumps at low tidal stages, and to maintain water quality that is sufficient for south Delta irrigation uses. This may allow flows in the Old River and Middle River channels during periods of maximum Delta exports that are higher than historical flows. Project discharges would contribute to these channel flows during periods with available water for diversion and during periods with available export pumping capacity for Project discharges.

Pumping at full Banks Pumping Plant capacity would increase, by about 3,620 cfs (6,680 cfs to 10,300 cfs), the total export capacity of the Banks Pumping Plant pumps. Because the Old River and Middle River channels each carry about half of the export flow (not supplied by diversion from the San Joaquin River at the head of Old River), the increased assumed pumping rate under cumulative conditions would be expected to increase the maximum net flow in the Old and Middle River channels by about 1,800 cfs each. However, because tidal flows in these channels are substantial under No-Project Alternative conditions, these channels (with modifications included in the DWR South Delta Improvements Project) are expected to provide sufficient flow conveyance for maximum export pumping without any hydrodynamic impacts from channel scouring or other hydraulic effects (i.e., navigation or recreation effects).

Nevertheless, because the possible hydrodynamic effects of Project operations on south Delta channels under cumulative future conditions is uncertain at this time, this cumulative hydrodynamic impact is cumulatively considerable. Implementation of Mitigation Measure CUM-MM-1 will reduce this impact to a not-cumulatively-considerable level.

Mitigation Measure CUM-MM-1: Operate the Project to Prevent Unacceptable Hydrodynamic Effects in the Middle River and Old River Channels during Flows That Are Higher Than Historical Flows
This mitigation measure has not changed since the 2001 FEIR and 2001 FEIS. USGS and DWR tidal flow measurements (i.e., velocities and stages) in south Delta channels, as well as tidal hydrodynamic model simulations, should be used to determine the effects of Project operations, and Project operations should be

controlled to prevent unacceptable hydrodynamic conditions in south Delta channels. Measures that may be used to prevent unacceptable hydrodynamic effects include establishing minimum tidal stages and maximum channel velocities. Project operations would be reduced or eliminated during these extreme tidal conditions.

Water Quality

The 2001 FEIR identified several cumulative water quality impacts that were the same as the Project-level impacts. Cumulative water quality impacts are bound by the requirements and existing controls mandated by various regulatory measures, such as the D-1641objectives and the RWQCB basin plans, TMDL implementation programs, and NPDES discharge permits.

Future activities affecting water quality in the Delta will include continued agricultural and municipal diversions, discharges from treated municipal wastewater and agricultural drainage, and maintenance of existing channels and levees. New facilities (e.g., channel gates and barriers) may be constructed, and existing channels may be modified for navigation or for increased water conveyance (e.g., BDCP and DWR/Reclamation SDIP). Some existing agricultural lands may be converted to urban development or to wetlands and other wildlife habitat uses, changing the water diversion and discharge patterns for these lands. Increasing populations in the watershed may result in higher concentrations of water quality variables associated with wastewater and increased surface runoff.

The nature of the water quality impacts described in Section 4.1, Water Quality, would not be expected to change as a result of cumulative effects. The magnitude of the impacts also are not expected to change substantially. These less-than-significant water quality impacts are not likely to become significant impacts because the same basic water quality control programs will govern any future changes in the Delta.

One exception, however, is Impact CUM-6: Increase in Pollutant Loading in Delta Channels Associated with Recreational Boating. This impact is considered to be less than significant as Impact WQ-11, but is considered significant under cumulative conditions. It is presented in this cumulative chapter as Impact CUM-6, which has not changed from the 2001 FEIR and 2001 FEIS, where it was presented as Impact C-24.One new cumulative impact, Impact CUM-7, has been added and is described below. This is a benefit associated with a potential isolated conveyance facility or through-Delta conveyance improvements.

Many future actions and projects could affect the Delta, but it is difficult to envision a single future for the Delta with any certainty for use in a cumulative assessment. Instead, cumulative impacts are discussed for several potential future conditions.

Impact CUM-6: Increase in Pollutant Loading in Delta Channels Associated with Recreational Boating

This cumulative impact has not changed since the 2001 FEIR and 2001 FEIS. Pollutant loading associated with recreational boat use in the Delta, including pollutant loading effects caused by the Project, could result in periodic pollution problems in Delta waters.

This cumulative impact is cumulatively considerable and unavoidable.

Mitigation Measure CUM-MM-2: Clearly Post Waste Discharge Requirements, Provide Waste Collection Facilities, and Educate Recreationists regarding Illegal Discharges of Waste

This mitigation measure has not changed since the 2001 FEIR and 2001 FEIS. Prior to operation of the Project recreation facilities, the Project applicant shall:

- Post notices at all Project recreation facilities describing proper methods of disposing of waste. Waste discharge requirements shall be posted and enforced in accordance with local and state laws and ordinances.
- Provide waste collection receptacles on and around the boat docks for the boaters using the Project recreation facilities.
- Provide educational materials to inform recreationists about the deleterious effects of illegal waste discharges and the location of waste disposal facilities throughout the Delta.

Mitigation Measure REC-MM-1: Reduce the Size or Number of Recreation Facilities

This mitigation measure is described in Section 4.9, Recreation and Visual resources.

Increased Delta Exports

Increased Delta exports could result from increased pumping capacity at SWP Banks (as with the SDIP) or relaxation of export restrictions. Increases in Delta exports could result in a decreased availability of water for Project diversions, which generally would tend to reduce any water quality impacts associated with the Project operations. However, an increase in Delta pumping capacity could increase the ability to export water from Delta wetlands, but the WQMP would ensure that there would be no significant water quality effects at the urban intakes.

Decreased Delta Exports

Decreases in Delta exports could occur if new export restrictions are established. Decreases in Delta exports could result in increased availability of water for Project diversions (because they would be screened), which might increase the water quality impacts associated with Project operations. However, the WQMP would ensure that there would be no significant water quality effects at the urban intakes.

Changes in Future Delta Water Quality

Delta water quality could be affected by new actions such as habitat restoration (potential for increased DOC), improved wastewater treatment, increased generation of wastewater associated with growing population size, and changes in volume and quality of agricultural return flows. Degraded baseline water quality could restrict Project operations in order to avoid not meeting water quality objectives, whereas improved baseline Delta water quality could result in fewer restrictions on Project operations. These variations in future baseline conditions and Project operations are not expected to cause any significant cumulative impacts.

Improvements in Water Treatment Procedures

Many EPA MCL objectives, as well as water treatment regulations, are likely to be revised in the future. Many water treatment plants have responded to recent regulatory changes by using coagulation to remove DOC and using chloramines or ozone instead of chlorination for disinfection. Health concerns about the effects of DOC and bromide on DBP concentrations should diminish over time, as drinking water treatment techniques improve. As concerns about DOC decrease, potential WQMP restrictions on Project operations may relax.

Future Delta Conveyance Facilities

Impact CUM-7: Improved Central Valley Project and State Water Project Water Quality Resulting from Increased Use of Sacramento River Water

If an isolated conveyance facility or improved through-Delta conveyance facilities are constructed, possible effects on the Project operations would depend on the Delta operating procedures. With an isolated conveyance facility and increased pumping capacity, there could be less water available for Project diversions, but there likely would be more unused capacity to export the Project water. With an isolated conveyance facility in place, Project water could be used to meet requirements such as Delta outflow and thereby allow increased exports of clean Sacramento River water in the isolated conveyance facility. Urban intakes that remain in the Delta could receive a higher percentage of water from Project discharges, but potential water quality impacts at these urban intakes still would be controlled by the WQMP. No significant water quality impacts are likely, and this future impact is considered beneficial.

This cumulative impact is considered beneficial.

Mitigation
No mitigation is required.

Flood Control and Levee Stability

Impact CUM-8: Decrease in Cumulative Flood Hazard in the Delta

Implementation of the Project and other proposed projects will cause a decrease in cumulative flood hazard within the Delta. Other projects that have the potential to alter flood hydrology or alter levee stability are proposing to do so with the intent of reducing flood hazards. The proposed levee geometry on the four Project island levees would improve their general stability and improve their potential to provide necessary flood control. Implementation of any of these alternatives would increase the levee mass, decrease the internal levee seepage potential, provide improved erosion protection, and maintain levee top widths and heights in accordance with PL84-99, which exceeds the existing condition.

Through increased stability of the Project islands, the Delta levee system would benefit from an overall improvement and reduced risk of potential levee failure on Project islands affecting adjacent island levee stability (e.g., levee failure of a Project island directing flow at an adjacent island levee). Under certain operational schemes, the Project islands could provide flood pressure relief on the Delta levee system by storing floodwaters and contribute to flood stage reduction if storage exists during times of Delta flooding.

This cumulative impact is considered beneficial.

Mitigation
No mitigation is required.

Impact CUM-9: Decrease in the Need for Public Financing of Levee Maintenance and Repair on the Project islands

This cumulative impact has not changed since the 2001 FEIR and 2001 FEIS. Implementation of Alternative 2 would likely reduce the need for public financing of levee maintenance and repair on the Project islands. Savings at the state and federal level would result from Project implementation because the risk of levee failure would be reduced, so the cost of reclamation would be much lower than in the case of existing levees.

This cumulative impact is considered beneficial.

Mitigation
No mitigation is necessary.

Utilities and Highways

Cumulative impacts related to utilities and highways have not changed, and Impact CUM-10 (presented as Impact E-27 in the 2001 FEIR and 2001 FEIS) still applies.

Impact CUM-10: Cumulative Decrease in the Risk of Structural Failure of Roadways and Utilities

Implementation of planned levee improvements throughout the Delta, combined with levee improvements on the Project islands, would decrease the cumulative risk of levee failure on Delta islands. Furthermore, increased levee stability in the vicinity of the Project islands would reduce the cumulative risk of structural failure of roadways and utilities in the area.

This cumulative impact is considered beneficial.

Mitigation

No mitigation is required.

The levee improvements and management of the four islands associated with the Project have the potential to disrupt existing utilities, but measures included in the Project and as mitigation would ensure that there are no disruptions to service. Other projects, such as levee and road improvements and restoration, also could disrupt these services. However, pipelines, electrical lines, and other utilities generally have right-of-way or senior rights, and Project proponents will coordinate with the owners/operators of these utilities to ensure there is minimal disruption of service. Additionally, the levee improvements proposed as part of the Project would increase road and utility stability and result in a beneficial effect.

Fishery Resources

Cumulative Project effects on fish are tied to past and present environmental conditions, such as operations of the DCC and export pumping by the SWP and CVP facilities in the south Delta. The impact analyses detailed in Section 4.5, Fishery Resources, included some relevant impacts of other activities such as south Delta diversions by the SWP and CVP export facilities. Impact analyses and significance declarations described in Impacts FISH-1through FISH-11 also apply under cumulative conditions, as do the proposed mitigation measures.

Overview of Cumulative Conditions

A number of activities in the Delta that cumulatively may affect fishery resources are summarized below relating to water diversions, contaminants, urbanization, climate change, nonnative species, and beneficial actions.

Water Diversions

Herren and Kawasaki (2001) enumerated 2,209 water diversions within the Delta, of which 17 were screened. As of May 2009, the total number of diversions listed in the California Fish Passage Assessment Database is 2,265, of which 20 are screened (CalFish 2009). For 1,881 of these, the maximum diversion capacity is not known. Not all diversions are functional. The 384 diversions for which capacity is known total almost 27,000 cfs: about 16,000 cfs of this are screened (with the SWP and CVP export facilities making up 15,200 cfs, albeit with screening consisting of relatively low-efficiency louvers). This included 365 unscreened intakes and 19 screened intakes. Of the unscreened intakes 82% were less than 50-cfs maximum capacity, and of the screened intakes 74% were less than 50-cfs maximum capacity. Aside from large diversions such as the SWP and CVP export facilities (see above), little study has been done of the numerous diversions in the Delta. Moyle and Israel (2005) conducted an extensive literature review and found only six studies related to the Delta and Suisun Marsh from which any quantitative information could be obtained. From the available information, it was not possible to ascertain whether the smaller diversions would have measurable effects at the population level, beyond the loss of individuals. Installation of fish screens in many cases may be indicative of a "precautionary approach that a diversion should be assumed to harm fish populations unless it can be proven otherwise" (Moyle and Israel 2005, 26).

Contaminants

Fish inhabiting the Delta potentially are affected by a variety of contaminants. California's 2006 list of water quality–impaired water bodies, submitted to the USEPA as required under Section 303(d) of the CWA, names 13 pollutants for which TMDLs have been required (Table 5-2). Recent investigations related to the POD have shown that moderate to high levels of ammonia (in Sacramento River water samples) may result in high mortality of larval delta smelt during bioassays (Baxter et al. 2008). However, studies using biomarkers (e.g., histological abnormalities) to indicate the effects of contaminants have provided little evidence for negative effects on delta smelt, longfin smelt, and threadfin shad but more evidence for striped bass, yellowfin goby, and inland silverside (Baxter et al. 2008, 15–16).

Table 5-2. Contaminants in the Delta That Have Been Identified as Requiring TMDLs (California Environmental Protection Agency, State Water Resources Control Board 2007)

Chlorpyrifos	Group A pesticides
DDT	Mercury
Diazinon	Organic enrichment/low dissolved oxygen
Dioxin	Pathogens
Electrical conductivity	PCBs (polychlorinated biphenyls)
Exotic species	Unknown toxicity
Furan compounds	

Urbanization

The human population living in the counties bordering the Delta is projected to double in number from 2000 to 2050, with some counties possibly tripling in size (State of California, Department of Finance 2007; Table 5-3). Accompanying these increases will be increased demand for water, among other resources. Increased urbanization tends to be accompanied by a number of cumulative impacts on aquatic resources, including increased impervious surface levels (leading to greater runoff and stream flashiness) and contaminants. Bilby and Mollot (2008) demonstrated a significant decline (75%) in incidences of coho salmon spawning associated with increasing urbanization (50% more urban or industrial use) from 1986 to 2001 in several tributary streams of Puget Sound, Washington. Similar effects could occur in California for Chinook salmon or steelhead. Larger human populations may place a greater pressure on waters for recreation, with associated effects such as disturbance of streambeds and erosion of banks by recreational vessel wakes.

Table 5-3. Projections of Population Growth in the Six Counties Bordering the Sacramento–San Joaquin River Delta (State of California, Department of Finance 2007)

							2000–2050	
County	2000	2010	2020	2030	2040	2050	% Increase	Factor Increase
Alameda	1,453,078	1,550,133	1,663,481	1,791,721	1,923,505	2,047,658	41%	1.4
Contra Costa	956,497	1,075,931	1,237,544	1,422,840	1,609,257	1,812,242	89%	1.9
Sacramento	1,233,575	1,451,866	1,622,306	1,803,872	1,989,221	2,176,508	76%	1.8
San Joaquin	569,083	741,417	965,094	1,205,198	1,477,473	1,783,973	213%	3.1
Solano	396,995	441,061	503,248	590,166	697,206	815,524	105%	2.1
Yolo	170,190	206,100	245,052	275,360	301,934	327,982	93%	1.9
Total	4,779,418	5,466,508	6,236,725	7,089,157	7,998,596	8,963,887	88%	1.9

Climate Change

Climate change is predicted to bring profound changes to California's natural environment. Hayhoe et al. (2004) describe the results of four climate change models: compared to 1960–1991, by 2070–2099 statewide average annual temperatures will be 2.3–5.8ºC higher, average annual precipitation will be reduced by >100 mm, sea level will have risen 19.2–40.9 cm, snowpack will have declined by 29–89%, and change in annual inflow to reservoirs will decline by >20%. (One model predicted slight increases in precipitation, snowpack, and reservoir inflow). Changes in vegetation also are predicted, e.g., substantial decreases in the extent of alpine/subalpine forest, evergreen conifer forest, mixed evergreen woodland, and shrubland and increases in mixed evergeen forest and grassland (Hayhoe et al. 2004). Climate change is likely to cumulatively affect native fishes by increasing water temperatures (hence reducing DO), reducing streamflows, and increasing the likelihood of drought-related fires. A rise in sea level will lead to increasing rates of erosion, sedimentation, flooding, and inundation of low-lying coastal ecosystems. With reductions in snowmelt runoff, peak flows may come earlier as rainfall contributes more, which could affect species such as Central Valley spring-run Chinook salmon that have evolved their life history based on predictable runoff patterns (Williams 2006). Increasing temperatures may increase metabolic needs of fish predators and increase predation (Lindley et al. 2007). Moyle et al. (2008) qualitatively assessed the potential for climate-related impacts on California's native salmonids (Table 5-4). Their analysis indicated that the majority of species (18 of 29, 62%) were vulnerable in all or most of the watersheds inhabited; no species was invulnerable to climate change. Of the species that migrate through the Delta and may be cumulatively affected by the Project Alternative, late fall–run, winter-run, and spring-run Chinook salmon were assessed to be "vulnerable in all watersheds inhabited," steelhead were "vulnerable in most watersheds inhabited," and fall-run Chinook salmon were "vulnerable in portions of watersheds inhabited" (Table 4.5-23).

Table 5-4. Qualitative Assessment of California Salmonids' Vulnerability to Climate Change Based on Analysis by Moyle et al. (2008)

Vulnerability	Taxon
Vulnerable in all watersheds inhabited	Klamath Mountains Province Summer Steelhead[SSC]; Northern California Coastal Summer Steelhead[T,SSC]; Central California Coast Steelhead[T]; South–Central California Coast Steelhead[T,SSC]; Southern Steelhead[E,SSC]; Upper Klamath–Trinity Rivers Spring-Run Chinook Salmon[SSC]; **Central Valley Late Fall–Run Chinook Salmon[SC,SSC]; Sacramento Winter-Run Chinook Salmon[E,E]; Central Valley Spring-Run Chinook Salmon[T,T]**; Southern Oregon–Northern California Coastal Coho Salmon[T,T]; Central California Coast Coho Salmon[E,E]; McCloud River Redband Trout[SSC]; Eagle Lake Rainbow Trout[SSC]; Lahontan Cutthroat Trout[T]
Vulnerable in most watersheds inhabited (possible refuges present)	**Central Valley Steelhead[T];** Upper Klamath–Trinity Rivers Fall-Run Chinook Salmon; California Coast Chinook Salmon[T]; Goose Lake Redband Trout[SC]; Coastal Cutthroat Trout[SSC]
Vulnerable in portions of watershed inhabited (e.g., headwaters, lowermost reaches of coastal streams)	Northern California Coastal Winter Steelhead[T]; **Central Valley Fall-Run Chinook Salmon[SC];** California Golden Trout[SC,SSC]; Little Kern Golden Trout[T]; Kern River Rainbow Trout[SC,SSC]; Paiute Cutthroat Trout[T]; Mountain Whitefish
Low vulnerability because of location, cold water sources, and/or active management	Klamath Mountains Province Winter Steelhead; Resident Coastal Rainbow Trout; Southern Oregon–Northern California Coastal Chinook Salmon
Not vulnerable to significant population loss because of climate change	None

Note: Species in **bold** migrate through the Delta and could be affected by Project operations.

[E] Endangered (Federal), **[T]**Threatened (Federal), [E]Endangered (State), [T]Threatened (State), **[SC]**Species of Concern (Federal), [SSC]Species of Special Concern (State).

Nonnative Species

Nonnative species have been introduced intentionally and incidentally into the Delta and neighboring areas for more than 100 years. Striped bass stocking and rearing activities are of particular importance. Striped bass originally were stocked into this area in 1879, with artificial propagation attempted from 1907 to 1910 (Dill and Cordone 1997). DFG, in association with private aquaculturists, released 11 million fingerlings and yearlings from 1981 to 1991 in an attempt to offset declining abundance (Figure 5-1). Following termination of the hatchery-rearing program because of concerns regarding predation by striped bass on listed species, striped bass juveniles were salvaged from the SWP diversion in the south Delta, reared for 1 or 2 years in net pens, and then released into the San Francisco Bay estuary (Moyle 2002). From 1993 to 2001, an average of more than 230,000 striped bass salvaged and reared by this program were released annually into the San Francisco Bay/Delta system (Figure 4.5-8). It was hoped that the decline in striped bass adult abundance from 2.2 million adults in the 1960s–1970s to less than 1 million adults in the 1990s could be offset by this program, with the goal of stabilizing the population at about 3 million adults (Lindley and Mohr 2003). Lindley and Mohr (2003) estimated that the predatory effects of a population of 3 million adult striped bass would increase the probability of quasi-extinction (i.e., three consecutive spawning runs of fewer than 200 adults) of winter-run Chinook salmon to 55%, compared to probabilities of 28% with 512,000 striped bass adults or 30% with 700,000 adults.

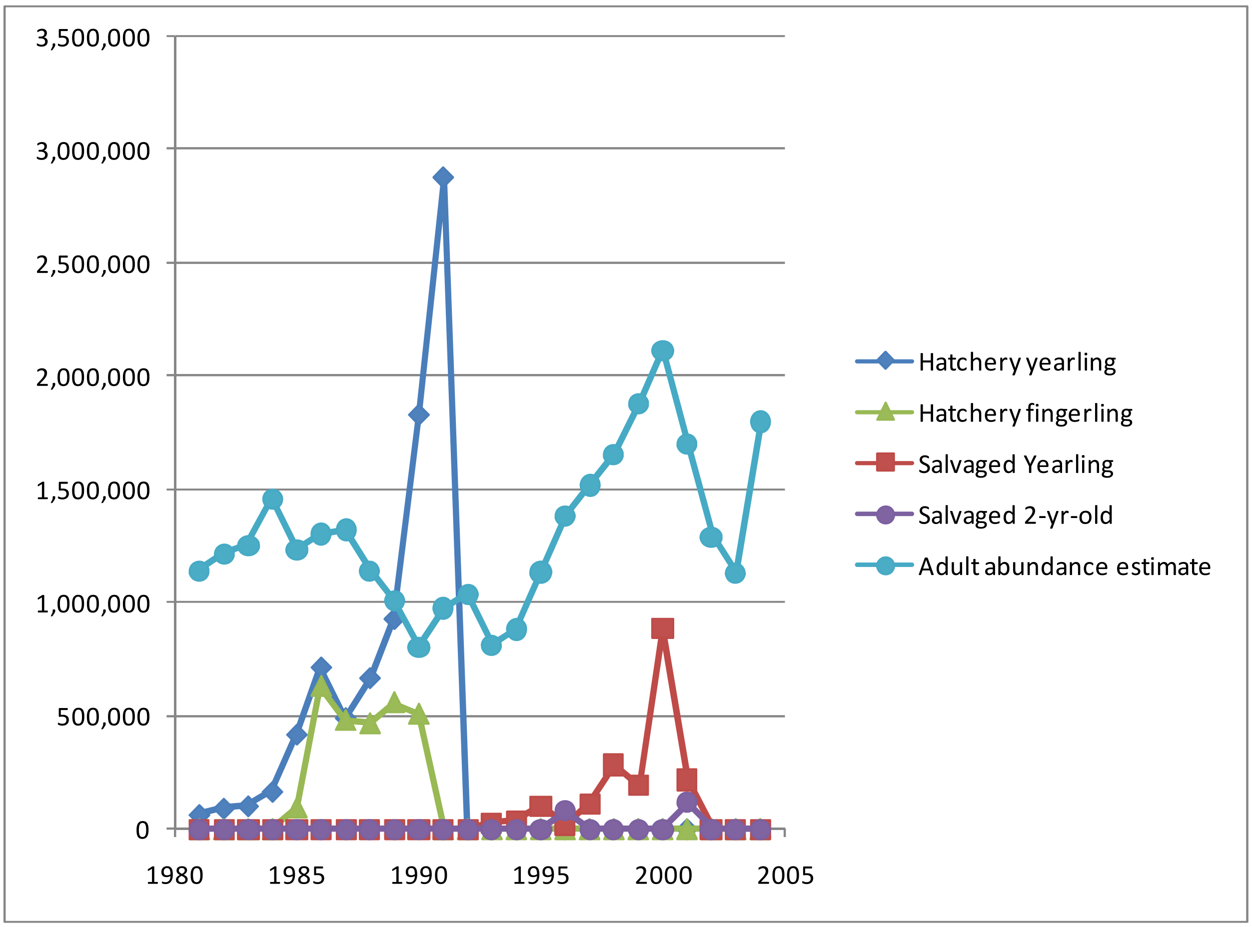

Figure 5-1. Releases of Hatchery-Reared and Salvaged Striped Bass into the Greater San Francisco Bay Watershed, with Estimates of Adult Abundance, 1981–2004 (Gingras 2008)

Note: Adult abundance estimates for 1995, 1997, 1999, and 2001 were interpolated from adjacent years.

Discharge of ballast water from foreign ships entering San Francisco Bay and the Delta probably has introduced several species. The introduced clam *Corbula amurensis* appears to have greatly depleted stocks of plankton upon which fish and other species depend (Kimmerer 2002a). Yellowfin goby (*Acanthogobius flavimanus*) and shimofuri goby (*Tridentiger bifasciatus*) are well established in several coastal regions and may compete with native fauna, prey upon them, or be preyed upon by them (Moyle 2002; Workman and Merz 2007). A number of fish species have been introduced to enhance recreational fishing, either as targets for harvest (e.g., striped bass, brown trout, largemouth bass [*Micropterus salmoides*]) or else as bait (e.g., inland silverside, *Menidia beryllina*) (Moyle 2002). Inland silversides may prey upon eggs and larvae of delta smelt and compete with juveniles (Bennett 2005). Illegal introductions of fish and other animals, e.g., from the aquarium trade or for recreational fishing, is another pathway that may cumulatively affect native species.

Beneficial Actions

Measures outlined in the RPA of the USFWS (2008a) and NMFS (2009) OCAP BO are expected to improve conditions for fishery resources in the Delta (see Environmental Setting, above, and Appendix C). Many actions outside the Delta will benefit species such as salmonids that inhabit the Delta for portions of their life cycles. Examples of these actions include changes in operation of the Feather River Hatchery and Oroville Dam in relation to FERC relicensing, restoration of the San Joaquin River above its confluence with the Merced River for eventual reintroduction of Chinook salmon, and habitat restoration and removal of barriers to fish passage in Battle Creek.

If implemented as currently proposed, the BDCP is expected to provide the most benefit to fishery resources in the Delta because of its numerous actions intended to balance the needs of aquatic organisms and humans.

The Overview of the BDCP Draft Conservation Strategy (http://baydeltaconservationplan.com/NewsLtrBackgroundDoc/Overview_of_Conservation_Strategy_1-12-2009.pdf, p. 6) mentions that “the main challenge facing the BDCP is the restoration of key ecosystem functions in the highly altered environment of the Delta.” The Conservation Strategy will include

> a comprehensive integrated package of conservation measures that incorporate physical improvements (e.g., habitat restoration, fish passage improvements), improved ecosystem processes (e.g., improvements in flow patterns, improved food web, enhanced habitat quality and availability), and direct enhancement of production and survival of covered species (mark-select fisheries, conservation hatcheries, and reductions of toxicants and non-native predators) (BDCP Conservation Strategy Overview, p.7).

The primary components of the Conservation Strategy include:

> (1) the construction of new north Delta diversion facilities and an isolated conveyance facility in conjunction with operation of existing facilities; (2) detailed criteria that will govern the operations of the conveyance system across a range of hydrological conditions; (3) restoration of tidal marsh,

floodplain, and riparian, and upland transition habitat; and (4) actions to address and control contaminants, non-native invasive species, and predation; and to address other potentially important non-conveyance and non-habitat-related stressors on covered species (collectively called "other stressors") (BDCP Conservation Strategy Overview, p.7).

Impacts

Impact CUM-11: Cumulative Impacts on Listed Fish Species

The Project's effects in conjunction with ongoing cumulative conditions related to water diversions, contaminants, urbanization, climate change, and nonnative species are likely to reduce significantly the abundance of sensitive Delta fish species, namely salmonids, delta and longfin smelt, and green sturgeon. While the Project's incremental contribution is very small, environmental conditions are substantially degraded and the additional increment could contribute further to these species' decline. Therefore, this impact is considered significant. However, there are also beneficial elements of the Project that could offset some of these impacts, including screening intakes and providing periodic water supply releases for environmental benefits. Furthermore, recent BO conditions require measures to improve Delta habitat conditions for sensitive Delta fish species, and BDCP efforts also are focused on measures to benefit these species. As noted above, impact analyses and significance declarations described in Impacts FISH-1 through FISH-11 in Section 4.5, Fishery Resources, also are applicable under cumulative conditions, as are the proposed mitigation measures.

Implementation of Mitigation Measures FISH-MM-1 through FISH-MM-3 and the environmental commitments described in Chapter 2 will help reduce Impact CUM-11, but not necessarily to a less-than-significant level.

This cumulative impact is considered cumulatively considerable and unavoidable.

Mitigation Measure FISH-MM-1: Replacement of Habitat Lost during Construction of Project Facilities

This mitigation measure is described in Section 4.5.

Mitigation Measure FISH-MM-2: Implement a Fishery Improvement Mitigation Fund

This mitigation measure is described in Section 4.5.

Mitigation Measure FISH-MM-3: Establish a Shallow-Water Aquatic Habitat Conservation Easement

This mitigation measure is described in Section 4.5.

Vegetation and Wetlands

The Project would result in changes in vegetation and wetland types at the reservoir and Habitat Islands, but would mitigate impacts to ensure no net losses of any vegetation or wetland type. Many other projects throughout the Delta have resulted or could result in loss of wetlands (In-Delta Storage Project, Banks Pumping Plant Expansion to 10,300 cfs, Mountain House Development Project, River Islands Development Project, and a power facility development project), and many proposed and future projects (Suisun Management Plan, BDCP) include substantial protection and restoration of tidal and other wetlands. Additionally, loss of wetlands typically is mitigated through regulatory programs (e.g., USACE 404 permit) to ensure there is no net loss of wetland types.

It is expected that over the long term there will be a net increase in wetlands as a result of various restoration efforts.

Impact CUM-12: Increase in Wetland and Riparian Habitats in the Delta

Implementation of the Project in conjunction with implementation of the other Delta projects with restoration, mitigation, or creation components described above is expected to result in an increase in the acreage of permanent and seasonal wetlands and riparian habitat in the Delta.

This cumulative impact is considered beneficial.

Mitigation
No mitigation is required.

Wildlife

The Delta region, Suisun Marsh, and San Francisco Bay continue to be productive and important habitats for hundreds of bird and mammal species. Many restoration efforts that are designed to expand and enhance marsh habitat are being advanced by USFWS, DFG, and other agencies. Conversely, there continue to be wetland and upland habitat losses attributable to water and development projects throughout the region.

Many of the water storage projects listed above would result in impacts on vegetation and wildlife resources. For example, Sites Reservoir would inundate hundreds of acres of habitats, including annual grasslands, some of which support vernal pools, riparian woodlands, chaparral, and oak woodland. Similarly, expansion of Los Vaqueros Reservoir would inundate annual grassland, riparian woodlands, chaparral, and oak woodland. However, most of the projects listed above are not located near the Project and habitats are not contiguous. Therefore the Project would not contribute to cumulative impacts on habitats and related resources except with those projects that are within 60 miles.

Iimplementation of the Proposed Project in combination with other local and regional projects would contribute to the cumulative loss of identified sensitive resources, including foraging habitat for wintering waterfowl and herbaceous and riparian habitats for sensitive wildlife species from construction and operation activities. Although these combined impacts could be cumulatively considerable, implementing the final HMP would reduce the Proposed Project's contribution to these cumulative impacts to a level below the cumulatively considerable threshold.

Impact CUM-13: Cumulative Increase in Foraging Habitat for Wintering Waterfowl in the Delta

This cumulative impact has not changed since the 2001 FEIR and 2001 FEIS. Foraging habitat for wintering waterfowl would increase in the Delta as mitigation projects that convert existing land uses to habitat uses (including the Project) are implemented.

This cumulative impact is considered beneficial.

Mitigation

No mitigation is necessary.

Impact CUM-14: Cumulative Loss of Herbaceous Habitats in the Delta

Delta levee rehabilitation, water management, and flood control projects could reduce amounts of herbaceous habitat in the Delta region. This cumulative effect may be offset by habitat restoration and subsidence control projects that are implemented separately from or jointly with those projects. The Proposed Project would contribute to the loss of herbaceous habitats by flooding the Reservoir Islands but would compensate for this loss by creating habitats on the Habitat Islands and by implementing the final HMP. Habitat creation and implementation of the HMP would reduce the Proposed Project's contribution to the cumulative loss of herbaceous habitats in the Delta region to a level below the cumulatively considerable threshold.

This cumulative impact is not cumulatively considerable.

Mitigation

No mitigation is required.

Impact CUM-15: Cumulative Temporary Loss of Riparian Habitat in the Delta

Delta levee rehabilitation, water management, and flood control projects could reduce amounts of riparian habitat in the Delta region. Losses of riparian vegetation associated with these levee improvement projects are commonly temporary, and any long-term losses usually are offset by habitat restoration and subsidence control projects. Although the Proposed Project would remove riparian habitat, there would be a net increase in the amount of riparian habitat when the final HMP is implemented and habitats on the Habitat Islands are created. Habitat restoration and implementation of the HMP would reduce the Proposed Project's contribution to the cumulative temporary loss of riparian habitats in the Delta region to a level below the cumulatively considerable threshold.

This cumulative impact is not cumulatively considerable.

Mitigation
No mitigation is required.

Land Use and Agriculture

Implementation of the Project would not contribute to cumulative impacts on land use, including changes in Williamson Act contracts, a substantial reduction in regional housing supply, and incompatibilities with adjacent land uses. Implementation of the Project would, however, contribute to the regional conversion of agricultural land as described below. The Project, in conjunction with other projects that convert agricultural land to other uses, would not be consistent with general plan or DPC's principles that promote the retention and production of agricultural land as described in Section 4.8, Land Use and Agriculture.

The above list of related projects evaluated for cumulative impacts includes a number of projects that would convert agricultural lands to nonagricultural uses. Agricultural land conversions could occur through the urban development of Delta islands, levee improvement and flood control projects, or subsidence-reduction programs. The actual amount of agricultural land that may be converted by other projects is not known. Because these totals are not known, this assessment used countywide historical data on agricultural land conversion as a method to put the estimated Project conversion in context with conversion trends in Contra Costa and San Joaquin Counties.

The Project would result in the conversion of an estimated 14,949 acres of farmland (8,290 acres in San Joaquin County and 6,659 acres in Contra Costa County). In 2006, Contra Costa and San Joaquin Counties had a combined total of approximately 437,547 acres of prime farmland; 97,365 acres of farmland of statewide importance; and 66,820 acres of unique farmland (Table 4.8-6). The acreage of prime farmland affected by the Project (13,148 acres) represents approximately 3% of the total prime farmland in both counties. Between 1996 and 2006, the combined average annual loss of prime farmland for both counties was approximately 3,666 acres per year (California Department of Conservation 2006a and 2006b).

Impact CUM-16: Cumulative Conversion of Agricultural Land

The cumulative conversion of prime and other agricultural lands by the Project and related projects is considered a significant and unavoidable impact. This impact would be partially offset because the Proposed Project and other projects have the potential to increase water supply and reliability for agricultural uses, which could help maintain lands in agricultural production. Additionally, as part of the environmental commitments described in Chapter 2, agricultural conservation easements would be placed on the Habitat Islands; the inclusion of this environmental commitment would help protect agricultural resources in the region.

However, the cumulative conversion of agricultural land would be cumulatively considerable and unavoidable.

Mitigation
No reasonable mitigation is available to reduce this impact to a less-than-significant level. It is extremely unlikely that a similar amount of land in the region with similar qualities and productivity could be brought into production to mitigate the effects resulting from the cumulative loss of agricultural land. Counties in the Project region generally are losing farmland faster than new land is being brought into production. For example, between 2004 and 2006, approximately 6,618 acres of important farmland in San Joaquin County were converted to urban and other uses, while only 2,668 acres of grazing lands and other nonagricultural lands were converted to agricultural land (California Department of Conservation 2006a and 2006b).

Recreation and Visual Resources

The proposed levee improvements would result in a significant and unavoidable degradation of local views. This is addressed under Impact CUM-19 below.

Impact CUM-17: Increase in Recreation Opportunities in the Delta

This cumulative impact has not changed since the 2001 FEIR and 2001 FEIS. Implementation of Alternative 2 concurrent with other agricultural conversion projects and the DWR water management programs may result in an increase in recreation opportunities throughout the Delta. Although the North Delta Flood Control and Ecosystem Restoration Project is not currently funded for implementation, the 2008 EIR includes objectives to enhance Delta recreation, and calls for channel and levee improvements that may improve access for boaters and anglers. The South Bay Salt Ponds Project also aims to enhance recreation access and opportunities near the Delta region. In addition, the North Delta project, the CALFED Ecosystem Restoration Program, and the Franks Tract Project all have ecosystem restoration components that could improve fishery conditions and support increased fishing in the Delta.

Implementation of agricultural conversion projects by state and federal agencies would be expected to include provisions for public access and new opportunities for recreation in the Delta. Implementation of Alternative 2 would provide waterfowl habitat of varying quality and new recreation facilities for use by hunters, anglers, boaters, and other recreationists.

This cumulative impact is considered beneficial.

Mitigation
No mitigation is required.

Impact CUM-18: Enhancement of Waterfowl Populations and Increased Hunter Success in the Delta

This cumulative impact has not changed since the 2001 FEIR and 2001 FEIS. Implementation of Alternative 2 concurrent with other proposed agricultural conversion projects throughout the Delta would be expected to reduce available waste grain for waterfowl foraging habitat. However, projects that result in the conversion of agricultural land used by waterfowl for foraging would be required to compensate for the loss of wintering waterfowl foraging habitat. The overall effect of proposed projects in the Delta, including the Project, would be beneficial for waterfowl foraging habitat. This analysis assumes that adverse impacts of agricultural conversion projects would be mitigated or otherwise offset through implementation of other beneficial projects. Because Delta projects are expected to enhance or maintain habitat values overall, waterfowl would be expected to continue to use the Delta. Hunter success, therefore, may increase throughout the Delta.

This cumulative impact is considered beneficial.

Mitigation
No mitigation is required.

Impact CUM-19: Reduction in the Quality of Views of the Reservoir Islands

Visual impacts would be significant and unavoidable for views in and outside the Reservoir Islands because of levee and infrastructure improvements. Other development in the Delta could similarly degrade the overall visual quality of the Delta for viewer groups. Implementation of Mitigation Measures REC-MM-1, REC-MM-2, and REC-MM-3 would reduce the severity of Impact REC-8, but not to a less-than-significant level. The cumulative impact on visual resources resulting from the Proposed Project and other development projects in the Delta is therefore considered significant and unavoidable.

This cumulative impact is cumulatively considerable and unavoidable.

Mitigation Measure REC-MM-1: Reduce the Size or Number of Recreation Facilities
This mitigation measure is described in Section 4.9.

Mitigation Measure REC-MM-2: Partially Screen Proposed Recreation Facilities and Pump and Siphon Stations from Important Viewing Areas
This mitigation measure is described in Section 4.9.

Mitigation Measure REC-MM-3: Design Levee Improvements, Siphon and Pump Stations, and Recreation Facilities and Boat Docks to Be Consistent with the Surrounding Landscape
This mitigation measure is described in Section 4.9.

Traffic and Navigation

The analysis presented in Section 4.10, Traffic and Navigation, accounted for other projects that would occur independently of the Project. For instance, the traffic growth projections and roadway operation analysis account for regional and local population and employment growth, anticipated future development projects, and planned roadway improvement projects.

Because of this, future condition scenarios (2030) without the Proposed Project capture the effect of cumulative projects. Future condition scenarios (2030) with the Proposed Project capture the effects of both cumulative projects and those of the Proposed Project.

Cultural Resources

Impact CUM-20: Destruction of or Damage to Prehistoric Archaeological Sites in the Delta

This cumulative impact has not changed since the 2001 FEIR and 2001 FEIS. Fourteen prehistoric sites have been found near the Project site. Many of these have been adversely affected by agricultural activities, leveling, and sand extraction occurring in the Delta. The effects of the Project would not contribute to the overall loss of prehistoric resources in the Delta because the single prehistoric archaeological site within the APE for the Project is not eligible for listing in the NRHP.

This cumulative impact is not cumulatively considerable.

Mitigation

No mitigation is required.

Impact CUM-21: Destruction of or Damage to Historic Districts Representing Agricultural Labor Camp Systems in the Delta

During the last 25 years, the majority of agricultural labor camps in the Delta has been demolished or modified or have deteriorated without being documented or otherwise preserved. The resources on Bacon Island represent one of the last intact agricultural labor camp systems in the Delta. The destruction of the Bacon Island Rural Historic District would add to the loss of this historic resource type in the Delta. However, available environmental impact documents and cultural resource studies for the cumulative projects do not indicate that these projects, when combined with the Project effect, result in a cumulatively significant impact.

This cumulative impact is cumulatively considerable. Implementing Mitigation Measure CUL-MM-1 reduces this impact to a not-cumulatively-considerable level.

Mitigation Measure CUL-MM-1: Prepare and Implement a Historic Properties Treatment Plan

No mitigation is required beyond Mitigation Measure CUL-MM-1, described in Section 4.11, for the Project impact.

Mosquitoes and Public Health

Impact CUM-22: Increase in Abatement Levels during Partial-Storage, Shallow-Storage, or Shallow-Water Wetland Periods on the Reservoir Islands under Cumulative Conditions

This cumulative impact has not changed. The mitigation measure has been updated and is described in Section 4.12, Mosquitoes and Public Health.

This cumulative impact is cumulatively considerable. Mitigation Measure PH-MM-1 reduces this impact to a not-cumulatively-considerable level.

Mitigation Measure PH-MM-1: Develop an Integrated Pest Management Program and Coordinate Project Activities with SJCMVCD and CCCMVCD

This mitigation measure is described in Section 4.12, Mosquitoes and Public Health.

Impact CUM-23: Cumulative Increase in Mosquito Abatement Needs Resulting from Implementation of Future Projects, Including the Project

The Project would affect mosquito breeding habitat by reducing it from May through August and increasing it during September and October. Other projects, including the North Delta Flood Control and Ecosystem Restoration Project, Liberty Island Restoration, the CVP-SWP OCAP, and the CALFED ERP, also have the potential to create increased mosquito breeding habitat. Development around the periphery of the Delta increases the risk to people of mosquito-borne diseases. These combined increases require mosquito abatement districts such as SJCMVCD and CCMVCD to increase control efforts, increasing costs for abatement. Mitigation should be implemented for each project during the project evaluation and approval process to minimize the cumulative effects on mosquito abatement. Implementation of Mitigation Measure PH-MM-1 would reduce the Project's contribution to cumulative increases in mosquito abatement needs. However, because there is no guarantee that mitigation measures would be implemented for other future projects, this impact is considered significant and unavoidable.

This cumulative impact is considered cumulatively considerable and unavoidable.

Mitigation Measure PH-MM-1: Develop an Integrated Pest Management Program and Coordinate Project Activities with SJCMVCD and CCCMVCD

This mitigation measure is described in Section 4.12, Mosquitoes and Public Health.

Air Quality

Impact CUM-24: Increase in Cumulative Production of Ozone Precursors and Carbon Monoxide in the Delta
This cumulative air quality impact identified in the 2001 FEIR and 2001 FEIS has not changed. Project construction would contribute to minor increases in PM2.5, PM10, and CO. PM10, NO_X, and CO would be mitigated as part of the project. Construction- and operation-related increases in ROG would be significant and unavoidable. NO_X emissions could be reduced substantially by using electrically powered pumps. Other construction activities, along with ongoing agricultural activities, have the potential to contribute to cumulative air quality impacts. Implementing Mitigation Measures RJ-1 and O-4 would reduce this impact, but not to a less-than-significant level. The cumulative impact of ROG emissions therefore would be significant and unavoidable.

This cumulative impact is considered cumulatively considerable and unavoidable.

Mitigation Measure REC-MM-1: Reduce the Size or Number of Recreation Facilities
This mitigation measure is described in Section 4.9, Recreation and Visual Resources.

Mitigation Measure AIR-MM-4: Coordinate with the SJVAPCD and BAAQMD to Reduce or Offset Emissions
This mitigation measure is described in Section 4.13, Air Quality.

Climate Change

Implementation of the Project would increase GHG emissions associated with sources such as recreation and water pumping. However, the increase in emissions from these sources would be outweighed by reductions in peat oxidation–related GHG emissions resulting from inundation of Bacon Island and Webb Tract. Consequently, because the Project would reduce GHG emissions, it would not contribute to cumulative impacts related to climate change and would result in a long-term beneficial effect.

Noise

Construction noise associated with the Proposed Project would be temporary and highly localized, and noise attributable to the operation of the proposed pump stations is not anticipated to be audible at the nearest noise-sensitive land uses. Because of the lack of sensitive receptors described in Section 4.15, Noise, it is not anticipated that the Project would make a cumulatively considerable contribution to any significant cumulative noise impacts in the Project area.

Chapter 6
Growth-Inducing Impacts

Introduction

The 2001 FEIR concluded that the Project may induce growth in areas south of the Delta, resulting in secondary environmental impacts. This could occur in one of two ways:

- the Project could add water directly for export to municipal water supplies or agricultural production that may support growth; or
- Project water could be used to meet water quality or environmental requirements as a substitute for other water that could be used to support growth.

Although these conclusions remain unchanged, the growth-inducing impact discussion has been updated in this chapter to incorporate the identification of specific places of use for Project water into the Project description.

Summary of Changes, New Circumstances, and New Information

Substantial Changes in the Project

As detailed in the Project Description (Chapter 2), two major changes to the Project have been made since publication of the 2001 FEIR. The major changes are (1) the designation of specific places of use for the Project water and the incorporation of estimated water demands (i.e., quantities of water use) during years with less than full deliveries from the SWP, and (2) the addition of groundwater banks for storage of Project water to allow all Project water to be delivered to the designated places of use in years with actual unmet water demands. In the 2001 FEIR, the proposed Project was identified as having the potential to remove an obstacle for growth; however, because no specific end users of Project water were identified, the lead agency was unable to disclose where growth-inducing impacts of the Project could occur. Because of the referenced changes in the Project description, this EIR discloses where the potential growth could occur.

The Project applicant now plans to provide water to Semitropic, Golden State, and Valley District. An additional likely place of use is Metropolitan and its member agencies' service areas, including Western Municipal. These places of use have demonstrated need and capacity for additional sources of water to improve the reliability of their existing water supplies to meet current demand, and have infrastructure in place for conveyance and transfer of the Project water. The Project water will be used to improve water supply reliability for their current water uses, which include irrigation, domestic, and municipal and industrial beneficial uses. The Affected Environment section below describes these agencies' service areas, where growth could occur.

New Circumstances

Since the 2001 FEIR was completed, additional limitations have been placed on CVP and SWP operations based on ESA compliance with the coordinated operations of the SWP and CVP (see Section 4.5, Fishery Resources). These restrictions have limited water deliveries south of the Delta in recent years. Metropolitan also has entitlements to water from the Colorado River that have been reduced in recent years because of regulatory and climatic factors. Changes in SWP, CVP, and Colorado River water delivery operations related to these new circumstances do not affect the growth analysis in this chapter.

New Information

The water supply planning documents for the designated places of use were consulted for this analysis to determine the anticipated levels of growth and likely uses of Project water at each place of use. These planning documents are listed in Chapter 9, "References," and the levels of growth and likely uses of Project water are described below in the Affected Environment section.

Existing Conditions

Affected Environment

Places of Use

The Project applicant has identified the likely places of use as the service areas of Semitropic, Golden State, Metropolitan, and Valley District. Figures 1-2 through 1-6 in Chapter 1 show the areas served by these water suppliers that may use Project water. As described in Chapter 2, "Project Description," Semitropic provides irrigation water to 140,000 acres of agricultural land in Kern County. Golden State serves 75 communities throughout California; however, the regions of Golden State that would be served by Project water are limited to the 33 water systems and 53 communities shown in Table 6-1. Metropolitan provides municipal, industrial, and agricultural water supplies to a large area of southern

California encompassing 5,200 square miles, which includes 152 cities and 89 unincorporated communities (see Table 6-2). Valley District provides wholesale water to retail water agencies serving the communities of Bloomington, Colton, East Highlands, Fontana, Grand Terrace, Highland, Loma Linda, Mentone, Redlands, Rialto, Yucaipa, San Bernardino, and portions of Riverside County.

Table 6-3 shows a detailed summary of the purpose of water use, geography served, and planned growth within each place of use.

Table 6-1. Golden State Water Company Systems and Communities That May Use Project Water

Systems				
Region 1	**Region 2**		**Region 3**	
Edna	Artesia		Apple Valley North	Morongo
Los Osos	Bell/Bell Gardens		Apple Valley South	Placentia
Lake Marie	Culver City		Barstow	San Dimas
Nipomo	Florence Graham		Calipatria	South Arcadia
Ojai	Hollydale		Claremont	South San Gabriel
Orcutt	Norwalk		Cowan Heights	West Orange County
Simi Valley	Southwest		Desert View	Wrightwood
Sisquoc	Willowbrook		Lucerne	Yorba Linda
Tanglewood				
Communities				
Region 1	**Region 2**		**Region 3**	
Bay Point	Artesia	Hawaii Gardens	Apple Valley	Lucerne Valley
Clearlake	Athens	Hawthorne	Arcadia	Morongo Valley
Cordova	Bell	Hollydale	Barstow	Pomona
Los Osos	Bell Gardens	Inglewood	Calipatria	Rosemead
Santa Maria	Carson	Lakewood	Claremont	Rossmoor
Orcutt	Cerritos	Lawndale	Covina	San Dimas
Ojai	Compton	Liberty Acres	Cypress	San Gabriel
Simi Valley	Cudahay	Lennox	Duarte	Seal Beach
	Culver City	Norwalk	La Verne	Stanton
	El Camino Village	South Gate	Los Alamitos	Temple City
	Florence	Torrance		
	Gardena	Willowbrook		
	Graham			

Table 6-2. Metropolitan Water District of Southern California Member Agencies

Municipal Water Districts (11)		Member Cities (14)			County Water Authorities (1)
Calleguas	Orange County	Anaheim	Glendale	San Marino	San Diego
Central Basin	Three Valleys	Beverly Hills	Long Beach	Santa Ana	
Foothill	Upper San Gabriel Valley	Burbank	Los Angeles	Santa Monica	
Inland Empire	West Basin	Compton	Pasadena	Torrance	
Eastern	Western	Fullerton	San Fernando		
Las Virgenes					

Cities within Member Agencies

Calleguas MWD
Camarillo
Camarillo Heights*
Fairview*
Las Posas Valley*
Moorpark
Oak Park*
Oxnard
Port Hueneme (annexed)*
Santa Rosa Valley*
Simi Valley
Thousand Oaks

Central Basin MWD
Artesia
Bell
Bellflower
Cerritos
Commerce
Cudahy
Downey
East Compton*
East La Mirada*
East Los Angeles*
Florence*
Graham*
Hawaiian Gardens
Huntington Gardens*
La Habra Heights
Lakewood
Los Nietos*
La Mirada
Lynwood
Maywood
Montebello
Norwalk
Paramount
Pico Rivera
Santa Fe Springs
Signal Hill
South Gate
South Whittier*
Vernon
Walnut Park*
West Compton*
West Whittier*
Whittier
Willowbrook*

Foothill MWD
Altadena*
La Canada
La Crescenta*
Mintridge
Montrose*

Inland Empire
Chino
Chino Hills
Fontana
Montclair
Ontario
Rancho Cucamonga
Upland

Eastern MWD
East Hemet*
Good Hope*
Hemet
Homeland*
Lakeview-Nuevo*
Mead Valley*
Moreno Valley
Murrieta Hot Springs*
Perris
Quail Valley*
Romoland*
San Jacinto
Sun City*
Sunnymead*
Temecula
Valle Vista*
Winchester*

Las Virgenes MWD
Agoura Hills
Calabasas
Chatsworth Lake Manor*
Hidden Hills
Malibu Lake*
Monte Nido*
Westlake Village

MWD of Orange County
Aliso Viejo
Brea
Buena Park
Capistrano Beach*
Corona del Mar
Costa Mesa
Cypress
Dana Point
El Toro*
Fountain Valley
Garden Grove
Huntington Beach
Irvine
Lake Forest
Laguna Beach
Laguna Hills
Laguna Niguel
Laguna Woods
La Habra
La Palma
Los Alamitos
Mission Viejo
Newport Beach
Orange
Placentia
Rossmoor*
San Clemente
San Juan Capistrano
Seal Beach
South Laguna*
Stanton
Tustin
Tustin Foothills*
Villa Park

MWD of Orange Co (cont'd)
Westminster
Yorba Linda

Three Valleys MWD
Charter Oak*
Claremont
Covina Knolls*
Diamond Bar
Glendora
Industry
La Verne
Pomona
Rowland Heights*
San Dimas
South San Jose Hills*
Walnut

Upper San Gabriel Valley MWD
Arcadia
Avocado Heights*
Azusa
Baldwin Park
Bradbury
Citrus*
Covina
Duarte
El Monte
Hacienda Heights*
Irwindale
La Puente
Mayflower Village*
Monrovia
Rosemead
San Gabriel*
South El Monte
South Pasadena
South San Gabriel
Temple City
Valinda*
West Covina
West Puente Village*

West Basin MWD
Alondra Park*
Angeles Mesa*
Carson
Culver City
Del Aire*
El Nido–Clifton*
El Segundo
Gardena
Hawthorne
Inglewood
Ladera Heights*
Lawndale
Lennox*
Lomita
Malibu
Manhattan Beach
Marina del Rey*
Palos Verdes Estates
Point Dume*
Rancho Palos Verdes

West Basin MWD (cont'd)
Redondo Beach
Rolling Hills
Rolling Hills Estates
Ross Sexton*
Topanga Canyon*
Victor*
View Park*
West Athens*
West Carson*
West Hollywood
Westmost*
Windsor Hills*
National Military Home*
Wiseburn*

Western MWD of Riverside County
Bedford Heights*
Corona
Eagle Valley*
El Sobrante*
Green River*
Lake Elsinore
March Air Force Base*
Murrieta
Norco
Riverside
Temescal
Woodcrest*

San Diego CWA
Alpine*
Bonita*
Camp Pendleton*
Carlsbad
Casa De Oro*
Castle Park*
Chula Vista
Del Mar
El Cajon
Encinitas
Escondido
Fallbrook*
Lakeside*
La Mesa
Lemon Grove
Mount Helix*
National City
Oceanside
Otay*
Poway
Rainbow*
Ramona*
Rancho Santa Fe*
San Diego
San Marcos
Santee
Solana Beach
Spring Valley*
Valley Center*
Vista

* Unincorporated areas.

Table 6-3. Project Places of Use

Entity	Estimated Annual Water Demand (taf)	Estimated Maximum Annual Delivery from Project (taf)[1]	Purpose of Use[2]	Geography Served	Relevant Planning Document	Anticipated Growth based on Planning Document
Semitropic Water Storage District	420	45	Increase water supply reliability for agricultural irrigation.	140,000 acres of agricultural land in Kern County	Poso Creek Integrated Regional Water Management Plan, published in 2007	2006 population in the Poso Creek planning area was 120,000. Population growth is anticipated to continue at approximately 5% per year. Agriculture is expected to decline accordingly.
Golden State Water Company[3]	240[4]	20	Increase reliability of existing municipal and industrial deliveries.	53 communities in southern California (see Table 6-1)	19 Urban Water Management Plans, published in 2005	Population growth is expected to increase by approximately 18% by 2030. Among the service areas that have urban water management plans, the population in 2005 was 1,035,000 and is anticipated to be 1,230,000 by 2030; 80 new agricultural service connections are anticipated by 2030.
Metropolitan Water District of Southern California	4,100[5]	215	Increase reliability of existing agricultural, industrial, and municipal water supplies.	5,200 square miles of residential, municipal, industrial, and agricultural land in southern California, including 152 cities and 89 unincorporated communities (see Table 6-2).	Metropolitan Water District of Southern California Regional Urban Water Management Plan, 2005	Population growth in Metropolitan's service area is expected to average just over 150,000 people per year, increasing from an estimated 18.2 million in 2005 to 22 million in 2030. Water demand is anticipated to increase to 4,914,000 acre-feet by 2030.
San Bernardino Valley Municipal Water District	103[6]	15	Increase reliability of water deliveries to retail water agencies and of supplies used to recharge local groundwater basins.	325 square miles of the San Bernardino Valley, which include 12 communities and portions of Riverside County.	Upper Santa Ana River Watershed Integrated Regional Water Management Plan, 2007	Population growth in the Valley District service area is expected to increase from an estimated 641,000 in 2005 to 784,500 in 2025—a 22.4% increase.

Entity	Estimated Annual Water Demand (taf)	Estimated Maximum Annual Delivery from Project (taf)[1]	Purpose of Use[2]	Geography Served	Relevant Planning Document	Anticipated Growth based on Planning Document

[1] Denotes estimates of the maximum annual deliveries of Project water to each place of use, and not average deliveries. The sum of the estimated maximum annual deliveries exceeds anticipated Project yield. Maximum annual deliveries are used to conservatively assess the growth-inducing impacts of the Project.

[2] No new facilities would be needed to convey to or store water at the places of use as a result of the Project beyond those already built or those already analyzed and approved.

[3] Numbers provided for the Golden State Water Company include only information for those delivery areas with urban water management plans.

[4] Anticipated total water demand by 2030.

[5] Interpolated demand for 2005, as presented in the MWD Regional Urban Water Management Plan, 2005.

[6] SWP Table A quantity.

CEQA Requirements for Analysis of Growth-Inducing and Indirect Impacts

Regulatory conditions regarding growth-inducing and indirect impacts have not changed since publication of the 2001 FEIR. CEQA requires that an EIR discuss the potential for the proposed Project to remove an obstacle to growth and present the possible secondary effects that could result from growth indirectly induced by a project. Public Resources Code section 21100 requires that an EIR analyze the growth-inducing impacts of a project (Pub. Resources Code, § 21100, subd. [b][5]). According to the State CEQA Guidelines (Section 15126.2(d)), an EIR must discuss how a project could directly or indirectly lead to economic, population, or housing growth. A project can be considered growth-inducing if it removes obstacles to growth, increases the demands on community service facilities, or encourages other activities that cause significant environmental effects.

Sections 15144 and 15145 of the State CEQA Guidelines state that an agency must use its best efforts to predict impacts but is not required to predict the unforeseeable. If the agency finds, after a thorough investigation, that an impact is too speculative to evaluate, it should note this conclusion and proceed. Section 15146 states that the specificity of an EIR should correspond to the specificity of the underlying activity being evaluated.

Impact Analysis

The lead agencies prepared the 2001 FEIR based on the assumption that there was unmet demand for water in the SWP/CVP service area and that such demand would exist in the future. For purposes of impact assessment, the 2001 FEIR assumed that water stored on Project Reservoir Islands would be exported using the SWP and CVP facilities. However, the 2001 FEIR considered the specific areas of delivery and end use of Project water to be unforeseeable and too speculative for site-specific analysis.

The impact analysis took a general approach to determining potential growth-inducing impacts of the project based on two assumptions: first, that all project water would be delivered as exports to the SWP/CVP service area (as opposed to in-Delta or outflow uses); and second, that such water would constitute a new source of water that could remove an obstacle to growth.

Now that places of use for Project water have been identified, specific locations where growth may occur have been disclosed (see Tables 6-1 through 6-3), as have the types of growth that are anticipated in those areas (see Table 6-3). Relevant planning agencies in these areas have developed “growth management plans” that address the specific amount and location of growth, as well as possible environmental impacts associated with this growth. The impact analysis in this EIR focuses on determining how the Project could contribute to growth in the places of use, and on identification and disclosure of the types of indirect impacts that could result from this growth.

No-Project Alternative

A no-project alternative was not analyzed for growth-inducing impacts in the 2001 FEIR. Under the No-Project Alternative, no water would be supplied to any users outside of the Project islands; therefore, there would be no growth-inducing or related indirect environmental impacts.

Alternatives 1, 2, and 3

Alternatives 1, 2, and 3 involve storage of water on Project islands and delivery of that water south through the CVP or SWP conveyance facilities to urban and agricultural users in the identified places of use during years when there is unmet demand and to the Semitropic Groundwater Bank and Antelope Valley Water Bank for banking during years when there is not unmet demand. A goal of the Project is to improve the reliability of water delivery to the places of use, meeting demand created by reductions in CVP, SWP, and Colorado River water supply. Although there are many obstacles related to growth in these areas that go beyond the jurisdiction of the lead and responsible agencies, an improvement in water supply reliability could remove a major obstacle to growth in the places of use.

Improved water supply reliability in the places of use could allow planned development to go forward that otherwise may have been hindered by a lack of reliable water supplies. As shown in Table 6-3, relevant planning documents anticipate growth in all of the places of use, and the improved water supply reliability provided by the Project could accommodate a portion of this growth. Types of growth anticipated at the places of use include population growth and housing development, commercial and industrial development, and expansion of areas under agricultural cultivation.

The indirect impacts that could result from urban growth and increased crop cultivation in the identified places of use would vary depending on site-specific conditions. Although it is not possible to quantify specifics related to how and where the proposed Project would result in growth and what environmental impacts would occur from that growth, housing growth and commercial and industrial development in general could result in the following types of environmental impacts:

- loss of vegetation and wildlife habitat and related effects on plant communities and wildlife, including Threatened and Endangered species;
- decreased air quality caused by automobile emissions and industrial pollutants;
- reduced water quality caused by increased urban runoff and industrial discharges;

- destruction of cultural and historical resources located at development sites;
- conversion of prime and productive agricultural lands to nonagricultural uses, and related losses of agricultural employment;
- increased demand for government services, including educational services and police and fire protection services; and
- increased need for public infrastructure, including wastewater treatment facilities, parks, and roadways.

Additionally, if new water sources are used to bring existing fallow or natural lands into production, irrigating and cultivating more farmland could result in similar types of impacts, including:

- the loss of natural vegetation and wildlife habitat and related effects on plant communities and wildlife, including Threatened and Endangered species;
- decreased air quality resulting from generation of dust and applications of pesticides; and
- reduced water quality caused by agricultural runoff to streams and rivers, and related impacts on fish species and habitat.

The environmental documentation prepared by local, state, and federal agencies that approve and provide permits for this growth (e.g., residential, commercial, and industrial projects) would identify the site- and issue-specific environmental impacts. Public involvement and agency consultation would occur during the environmental documentation process for site-specific projects.

As part of the environmental process required by CEQA and NEPA, the significant impacts of this growth would be identified and mitigation of impacts would be adopted and implemented if available and feasible. The responsibility for implementing and monitoring mitigation measures would lie with the specific local, state, or federal agencies with discretionary authority over the projects. Some projects may result in impacts that cannot be mitigated or reduced to less-than-significant levels; in such cases, growth inducement associated with this growth could result in residual significant impacts.

Conclusions

In summary, the additional water supply provided by the Project may remove an obstacle to a portion of the planned growth in the identified places of use, which may result in secondary environmental impacts. More farmland could be brought into production as a result of Project implementation. As stated previously, the environmental documentation prepared by local, state, and federal agencies that approve and provide permits for residential, commercial, and industrial projects in the places of use would identify site- and resource-specific impacts of this growth. Mitigation measures implemented by agencies with jurisdiction over urban development projects would address many of the secondary impacts of this growth.

Although it is speculative to quantify the site- and resource-specific impacts of growth in the places of use identified, it is reasonable to conclude that feasible mitigation may not be available to reduce these impacts to a less-than-significant level. Although the Project could remove an obstacle to growth and therefore contribute to impacts related to this growth, neither the lead or responsible agencies nor the Project proponent has the jurisdiction or capabilities to provide the framework for mitigation of the undetermined specific impacts of this growth.

Chapter 7
Compliance with Applicable Laws, Policies, Plans, and Regulatory Framework

Introduction

Construction and operation of the Project would be subject to a variety of regulatory standards that are in place to safeguard the environment. This chapter provides preliminary information on the major requirements for potential permitting and environmental review and consultation for implementation of the Project alternatives. Table 7-1 lists the permit requirements and environmental review and consultation requirements that may be required for the Project. Certain local, state, and federal regulations require either the lead agency or project proponent to obtain applicable permits before project implementation; other regulations require agency consultation but may not require issuance of any authorization or entitlements before project implementation. Specific resource chapters contain a more detailed discussion of the regulatory setting and the applicability of these laws to the Project.

Table 7-1. Permits, Approvals, and Other Environmental Review and Consultation Requirements That May Be Required for the Project

Agency and Requirements	Agency Authority	Project Activities That Are Subject to Requirements and Initiate Review and Consultation Requirements
Federal		
U.S. Army Corps of Engineers		
Department of the Army permit pursuant to Section 404 of the Clean Water Act	The Corps issues permits for discharge of dredged or fill materials into waters of the United States, including wetlands; permits are issued following public interest review and analyses according to EPA's Section 404(b)(1) guidelines.	Construction activities; location of siphon, pump, and recreation facilities; and other activities requiring the discharge of dredged or fill material into waters of the United States, including wetlands. An Individual Permit was previously issued for the Project; authorization will be renewed under a new permit.
Department of the Army permit pursuant to Section 10 of the Rivers and Harbors Act of 1899	The Corps issues permits for activities in or affecting navigable waters of the United States.	Construction of intake structures, fish screens, discharge pumps, boat docks, or other facilities affecting navigable Delta waters. Section 10 authorization was previously issued for the Project and will be renewed in conjunction with Section 404.
U.S. Fish and Wildlife Service		
Consultation pursuant to Section 7 of the federal Endangered Species Act	Federal agencies must consult with USFWS when their actions may affect species listed under the ESA.	Corps approval of the Project because the Corps has determined that the Project may affect species listed under the ESA. The Corps will coordinate with USFWS to deter mine the extent to which reconsultation may be required.
Fish and Wildlife Coordination Act	Federal agencies must consult with USFWS when undertaking projects that control or modify surface water.	Corps approval of the Project; consultation will be achieved through the Corps' NEPA process in approving the project under a new Section 404 and Section 10 authorization.
National Marine Fisheries Service		
Consultation pursuant to Section 7 of the federal Endangered Species Act	Federal agencies must consult with NMFS when their actions may affect anadromous or marine species list under the ESA.	Corps approval of the Project because the Corps has determined that the Project may affect species listed under the ESA. The Corps will coordinate with NMFS to determine the extent to which reconsultation may be required.

Agency and Requirements	Agency Authority	Project Activities That Are Subject to Requirements and Initiate Review and Consultation Requirements
U.S. Environmental Protection Agency		
Clean Water Act and National Environmental Policy Act	EPA has oversight responsibility to ensure that federal and state agencies comply with the provisions of the Clean Water Act and NEPA	Need for a Department of the Army permit under Sections 404 and 401 of the Clean Water Act. The 2001 FEIS was prepared and certified under NEPA; NEPA review will be conducted as part of renewing authorization under the Clean Water Act.
Federal Clean Air Act	Federal agencies must consult with EPA and local air quality districts to ensure compliance with CAA.	Emission of air pollutants during Project construction and operation.
Farmland Protection Policy Act and Memoranda on Farmland Preservation	Federal agencies also must ensure that their programs are compatible with state, local, and private programs to protect farmland. NRCS is the federal agency responsible for ensuring that these laws and policies are followed.	The Project would result in loss of farmland.
Federal Aviation Administration		
Completion requirement of Form 7480-1 for change in use approval	FAA requires that all persons notify FAA prior to change in the status or use of a civil or joint-use airport.	Operation activities of the airport on Bouldin Island, including agricultural and private commercial activities.
State		
California Department of Fish and Game		
Section 1600 *et seq*. of the California Fish and Game Code - Streambed Alteration Agreement	DFG enters into agreements with project applicants proposing changes in conditions of rivers, streams, lakes, or other regulated areas.	Construction of intake structures, fish screens, discharge pumps, boat docks, or other facilities within regulated areas.
Consultation pursuant to the California Endangered Species Act	State lead agencies must consult with DFG when their actions may affect species listed under CESA.	State Water Board approval of the Project because State Water Board has determined that the Project may affect species only listed under CESA (Swainson's hawk and greater sandhill crane). Consultation was previously completed for the Project. The lead agency will coordinate with DFG to determine the extent to which reconsultation may be required.

Agency and Requirements	Agency Authority	Project Activities That Are Subject to Requirements and Initiate Review and Consultation Requirements
California Fish and Game Code Section 3503 and 3503.5—Protection of Bird Nests and Raptors	Project applicants must not take, possess, or needlessly destroy the nest or eggs of any bird, or take, possess, or destroy any raptors, including their nests or eggs.	Project construction and operation will take place in proximity to nesting birds. Take of bird nests and raptors will be avoided.
California Fish and Game Code—Fully Protected Species	Non-federal agencies and private parties must avoid take of any fully protected species.	Greater sandhill crane, white-tailed kite, and California black rail occur in the Project vicinity. Take of these species will be avoided.
Fish and Wildlife Coordination Act	Federal agencies must consult with state fish and game agencies when undertaking projects that control or modify surface water.	Corps approval of the Project; consultation will be covered through Corps' NEPA process in renewing authorization for the Project.
California Department of Water Resources, Division of Safety of Dams		
Approval of plans and specifications	DSOD reviews and grants approval of plans and specifications for construction of reservoirs where the barrier will exceed 6 feet in height to ensure that no threat to life or property could occur because of seepage, earth movement, or other types of reservoir-induced dam failures.	Designing and constructing water impoundment facilities (on Bouldin Island for Alternative 3).
Notice of completion and statement of actual cost; certificate of approval to impound water	DSOD evaluates the safety of newly constructed reservoirs and grants approval to initiate storage operations.	Storage of water in a reservoir (on Bouldin Island for Alternative 3).
California State Water Resources Control Board		
Porter-Cologne Water Quality Control Act of 1969	Created State Water Board and RWQCBs.	
Permit to appropriate and store water	State Water Board issues permits to allow the appropriation of unappropriated water from surface sources and grants approval to divert water to storage or for direct diversion and to change purpose of use.	Diversion of Delta water, storage of appropriated water, and later discharge of water for sale as export or outflow.
Statement of riparian water diversion and use	State Water Board requires submittal of a statement for applicants wishing to divert water under a riparian claim.	Diversion of Delta water for circulation on the islands to provide wetlands and wildlife habitat benefits.

Agency and Requirements	Agency Authority	Project Activities That Are Subject to Requirements and Initiate Review and Consultation Requirements
Water quality certification pursuant to Section 401 of the Clean Water Act	State Water Board certifies that an applicant for a Department of the Army permit pursuant to Section 404 of the Clean Water Act complies with the state's water quality standards.	Same as for Department of Army permit pursuant to Section 404 of the Clean Water Act, certification will be renewed.
California Department of Conservation		
California Surface Mining and Reclamation Act of 1975	State Mining and Geology Board monitors mining of minerals, gravel, and borrow material, and requires mitigation to reduce adverse impacts on public health, property, and the environment.	Because the Project would require borrow material for project construction, the Project applicant must comply with SMARA.
California Important Farmland Inventory System and Farmland Mapping and Monitoring Program	California Department of Conservation, Office of Land Conservation	System monitors farmland usage; Project would remove farmland from production.
California Land Conservation Act of 1965 (Williamson Act)	Counties may encourage the preservation of lands in agricultural use through voluntary restrictive contracts that offer property tax reductions.	Much of the Project lands are presently under Williamson Act contracts.
Regional Water Quality Control Board		
Issuance of or waiver from discharge requirements	RWQCB may set waste discharge requirements for any proposed activity that would discharge waste into surface waters, projects that affect groundwater quality, and projects from which waste would be discharge in a diffused manner; waivers are also granted based on project sponsor's water quality control plans. (RWQCB waste discharge requirements constitute NPDES permits where such permits are required.)	Any earthmoving activities, such as grading, excavating, and other construction; discharge of water from dewatering activities into storm drains and creeks; and discharge of wastewater from conveyance cleaning.
California Toxics Rule and State Implementation Policy	RWQCB is responsible for monitoring discharges to Waters of the State.	Project agricultural operations create the potential for pollution from herbicides and pesticides, some of which may be in use or may be present on the Project islands.
Basin Plan for the Sacramento and San Joaquin River Basins	The Basin Plan describes the officially designated beneficial uses for specific surface water and groundwater resources and the enforceable water quality objectives necessary to protect those beneficial uses.	The Project islands are located within the Central Valley RWQCB jurisdiction and is subject to the Basin Plan.

Agency and Requirements	Agency Authority	Project Activities That Are Subject to Requirements and Initiate Review and Consultation Requirements
State Lands Commission		
Land use lease	The SLC grants a lease to use state-owned lands, including tidelands and submerged lands.	Use of state-owned land for construction or siting of project facilities, such as boat docks, in tidelands and submerged lands.
Dredging permit	The SLC issues a permit to parties proposing to dredge or deposit material on state-owned lands as elements of various projects.	Construction of diversion and discharge facilities, if state-owned lands are dredged or altered.
California Department of Transportation		
Encroachment permit	Caltrans issues encroachment permits for projects affecting areas within the rights-of-way (ROWs) of state-owned roadways.	Activities that may affect SR 12.
California Department of Transportation, Division of Aeronautics		
State airport permit	Caltrans issues special use airport permits for airports not open to the general public, access to which is controlled by the owner in support of commercial activities, public service operations, and/or personal use.	Operation activities of the airport on Bouldin Island that include agricultural and private commercial activities.
Office of Historic Preservation and Advisory Council on Historic Preservation		
Archaeological survey review (Archaeological Resource Protection Act, National Historic Preservation Act); PA for project effects on archaeological resources on the project site	The SHPO reviews and comments on any archaeological surveys; if resources are identified, the SHPO must be consulted to determine the eligibility for nomination to the National Register of Historic Places. The Advisory Council on Historic Preservation must concur with the PA.	Archaeological survey conducted and determination of eligibility and effect prepared; PA circulated and signed by the Project applicant. State Water Boards, the Corps, the SHPO, and the Advisory Council on Historic Preservation; need for reconsultation will be coordinated in conjunction with Corps permit.
California Register of Historic Resources	California's Office of Historic Preservation maintains the CRHP.	Project islands contain cultural resources that may be impacted by the Project construction and operations.
Native American Heritage Commission		
Consultation with certain Native Americans in compliance with California Public Resources Code Section 5097.98 and California Health and Safety Code Section 7050.5	The commission identifies persons who may be likely descendants of Native Americans whose remains may be found and requires that consultation with identified persons be initiated.	Plans for physical alteration of a known cultural resource site that has a likely potential for containing remains of Native Americans.

Agency and Requirements	Agency Authority	Project Activities That Are Subject to Requirements and Initiate Review and Consultation Requirements
California Air Resources Board		
California Climate Solutions Act	Creates enforceable statewide cap on GHG emissions that will be phased in starting in 2012.	Project operations and construction will create air pollution emissions.
Regional and Local Agencies and Utilities		
Bay Area Air Quality Management District		
Authority to construct/permit to operate	BAAQMD issues permits based on emission estimates and subsequent tests performed at the construction facility.	Installation and subsequent operation of internal combustion equipment that generates any pollutant in excess of 150 pounds per day or is greater than 250 hp in size.
San Joaquin Valley Air Pollution Control District		
Authority to construct/permit to operate	SJVAPCD issues permits based on the size of stationary or portable internal combustion engines proposed for use.	Use, during construction and operation of the project, of stationary or portable internal combustion engines over 50 hp, if fueled by diesel or natural gas.
Contra Costa and San Joaquin Counties		
Building permit	County planning department issues permits for all permanent structures.	Construction of pump stations and recreation facilities.
Road encroachment permit and design approval	County public works department issues permits and approves designs for construction within the ROWs of any county-maintained roads.	Construction of conveyance facilities within the ROWs of county-maintained roads.
Grading permit	County planning department and public works department issues permits for grading activities associated with construction activities.	Grading of project site.
Conformance with general plan	County planning department reviews local agency projects for conformity with the general plan.	Project effects on land use.
San Joaquin County		
Minor Use permit	County issues permits for the opening of a new airport or modification of an existing airport.	Operational activities of the airport on Bouldin Island that include agricultural, recreational, and private commercial activities.

Agency and Requirements	Agency Authority	Project Activities That Are Subject to Requirements and Initiate Review and Consultation Requirements
Reclamation Districts		
Access easement and permission to cross levees	Individual Reclamation Districts grant easements and regulate access to levees under district jurisdiction.	Construction of conveyance and related facilities on Reclamation District lands.

Regulatory Framework

Federal Requirements

National Environmental Policy Act

NEPA (found at 42 USC § 4321 *et seq*.) is the nation's broadest environmental law, applying to all federal agencies and most of the activities they manage, regulate, or fund that have the potential to affect the human environment. It requires federal agencies to disclose and consider the environmental implications of their proposed actions. NEPA establishes environmental policies for the nation, provides an interdisciplinary framework for federal agencies to prevent environmental damage, and contains action-forcing procedures to ensure that federal agency decision makers take environmental factors into account.

NEPA requires the preparation of an appropriate document to ensure that federal agencies accomplish the law's purposes. The President's Council on Environmental Quality (CEQ) has adopted regulations and other guidance that provide detailed procedures that federal agencies must follow to implement NEPA. In addition, each federal agency has adopted specific regulations to comply with NEPA and the CEQ regulations.

Based on application to the Corps for permit authorization under the Clean Water Act and Rivers and Harbors Act, an EIS was prepared for the Project and record of decision issued in 2002. This document is focused on CEQA compliance for the Project; however, the information and analysis may support any necessary additional NEPA compliance for a renewed application for CWA and Rivers and Harbors Act permit from the Corps or similar federal action.

Federal Endangered Species Act

Section 7 of the ESA requires federal agencies, in consultation with USFWS and/or NMFS, to ensure that their actions do not jeopardize the continued existence of Endangered or Threatened species, or result in the destruction or adverse modification of the critical habitat of these species. The required steps in the Section 7 consultation process are as follows.

- Agencies must request information from USFWS and/or NMFS on the existence in a project area of special-status species or species proposed for listing.
- Agencies must initiate formal consultation with USFWS and/or NMFS if the proposed action may adversely affect special-status species.

ESA compliance also requires compliance with the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act), which establishes a management system for national marine and estuarine fishery resources. It also requires compliance with the Migratory Bird Treaty Act (MBTA), which regulates the taking of migratory birds. Because of overlapping requirements, compliance with the MBTA would be addressed through compliance with the ESA, CESA, and NEPA/CEQA. The Project incorporates mitigation measures required as part of these processes that would help ensure that construction and operational activities do not result in the take of migratory birds.

The Project has undergone prior consultation for ESA under Section 7, resulting in issuance of Biological Opinions from USFWS and NMFS to support issuance of a Clean Water Act permit from the Corps in 2001. The Corps will coordinate with USFWS and NMFS to determine the extent to which reconsultation may be required.

Clean Water Act Section 404, 404(b)(1) Guidelines, and Section 401

Section 404

Section 404 of the CWA requires that a permit be obtained from the Corps for the discharge of dredged or fill material into "waters of the United States, including wetlands."

Waters of the United States include wetlands and lakes, rivers, streams, and their tributaries. *Waters of the United States* are defined for regulatory purposes, at 33 CFR § 328.3 as:

> (1) All waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of tide; (2) All interstate waters, including interstate wetlands; (3) All other waters such as intrastate lakes, rivers, streams, mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation or destruction of which could affect interstate or foreign commerce; (4) All impoundments of waters otherwise defined as waters of the United States under the definition; (5) Tributaries of waters identified in paragraphs 1–4 in this section; (6) The territorial seas; and (7) Wetlands adjacent to waters identified in paragraphs 1–6 in this section.

CWA Section 404(b) requires that the Corps process permits in compliance with guidelines developed by EPA. These guidelines (404[b][1] Guidelines) require that there be an analysis of alternatives available to meet the project purpose and need, including those that avoid and minimize discharges of dredged or fill materials in waters. Once this first test has been satisfied, the project that is permitted must be the least environmentally damaging practical alternative before the Corps may issue a permit for the proposed activity.

(Note: Section 404 does not apply to authorities under the Rivers and Harbors Act of 1899, except that some of the same waters may be regulated under both

statutes; the Corps typically combines the permit requirements of Section 10 and Section 404 into one permitting process.)

A prior CWA permit for the Project was authorized by the Corps. Coordination has been initiated with the Corps to renew Section 404 authorization as the prior permit has expired.

Section 401

Under the CWA Section 401, applicants for a federal license or permit to conduct activities that may result in the discharge of a pollutant into waters of the United States must obtain certification from the state in which the discharge would originate. Therefore, all projects that have a federal component and may affect state water quality (including projects that require federal agency approval [such as issuance of a Section 404 permit]) must also comply with CWA Section 401. Water quality certification requires evaluation of potential impacts in light of water quality standards and CWA Section 404 criteria governing discharge of dredged and fill materials into waters of the United States.

In California, the authority to grant water quality certification has been delegated to the State Water Board. Although applications for water quality certification under CWA Section 401 are typically processed by the RWQCB with local jurisdiction, the prior permit issued under Section 404 received 401 certification directly from the State Water Board.

As part of the process to renew the prior Section 404 authorization by the Corps for the Project, a Section 401 certification will be similarly renewed.

River and Harbors Act of 1899

The River and Harbors Act of 1899 addresses activities that involve the construction of dams, bridges, dikes, and other structures across any navigable water, or that place obstructions to navigation outside established federal lines and excavate from or deposit material in such waters. Such activities require permits from the Corps. *Navigable waters* are defined in Section 329.4 of the act as:

> Those waters that are subject to the ebb and flow of the tide and/or are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce. A determination of navigability, once made, applies laterally over the entire surface of the water body, and is not extinguished by later actions or events which impede or destroy navigable capacity.

Section 10

Section 10 (33 USC § 403) prohibits the unauthorized obstruction or alteration of any navigable water of the United States. This section provides that the construction of any structure in or over any navigable water of the United States, or the accomplishment of any other work affecting the course, location, condition, or physical capacity of such waters, is unlawful unless the work has been authorized by the Chief of Engineers.

Compliance with the Rivers and Harbors Act of 1899 would be conducted as part of the CWA Section 404 permit renewal from the Corps.

Farmland Protection Policy Act and Memoranda on Farmland Preservation

Two policies require federal agencies to include assessments of the potential effects of a proposed project on prime and unique farmland. These policies are the FPPA and the Memoranda on Farmland Preservation, dated August 30, 1976, and August 11, 1980, respectively, from the CEQ. Under requirements set forth in these policies, federal agencies must determine these effects before taking any action that could result in converting designated prime or unique farmland for non-agricultural purposes. If implementing a project would adversely affect farmland preservation, the agencies must consider alternative actions to lessen those effects. Federal agencies also must ensure that their programs, to the extent practicable, are compatible with state, local, and private programs to protect farmland. NRCS is the federal agency responsible for ensuring that these laws and policies are followed.

The Project would result in loss of farmland. This issue is addressed in Section 4.8, Land Use and Agriculture, of this EIR.

National Historic Preservation Act

Section 106 of the NHPA requires federal agencies to evaluate the effects of their undertakings on historic properties, which are those properties listed or eligible for listing on the NRHP. Implementing regulations at 36 CFR Part 800 require that federal agencies, in consultation with SHPO, identify historic properties within the APE of the proposed project and make an assessment of adverse effects if any are identified. If the project is determined to have an adverse effect on historic properties, the federal agency is required to consult further with SHPO and the Advisory Council on Historic Preservation to develop methods to resolve the adverse effects. The Section 106 process has four basic steps.

1. Initiation of the Section 106 process (define the APE and scope of identification efforts).
2. Evaluation of historic properties.

3. Determination of adverse effects to historic properties.
4. Resolution of adverse effects to historic properties.

The Corps will coordinate with SHPO as part of the CWA Section 404permit renewal process to determine the extent to which reconsultation may be required.

American Indian Religious Freedom Act

The American Indian Religious Freedom Act of 1978 is also applicable to federal undertakings. This act established "the policy of the United States to protect and preserve for American Indians their inherent right of freedom to believe, express, and exercise the traditional religions, including but not limited to access to sites, use and possession of sacred objects, and the freedom to worship through ceremonial and traditional rites" (Public Law 95-431).

It is not anticipated that actions related to the Project will conflict with the American Indian Religious Freedom Act.

Executive Order 11990 (Protection of Wetlands)

Executive Order 11990 (May 24, 1977) requires federal agencies to prepare wetland assessments for proposed actions located in or affecting wetlands. Agencies must avoid undertaking new construction in wetlands unless no practicable alternative is available and the proposed action includes all practicable measures to minimize harm to wetlands. Wetland resources will be address as part of the CWA Section 404 permit renewal.

Executive Order 12898 (Environmental Justice)

Executive Order 12898 (February 11, 1994) requires federal agencies to identify and address adverse human health or environmental effects of federal programs, policies, and activities that could be disproportionately high on minority and low-income populations. Federal agencies must ensure that federal programs or activities do not directly or indirectly result in discrimination on the basis of race, color, or national origin. Federal agencies must provide opportunities for input into the NEPA process by affected communities and must evaluate the potentially significant and adverse environmental effects of proposed actions on minority and low-income communities during environmental document preparation. Even if a proposed federal project would not result in significant adverse impacts on minority and low-income populations, the environmental document must describe how Executive Order 12898 was addressed during the NEPA process.

Executive Order 12898 is addressed in Chapter 3K of the 2001 FEIR, "Economic Conditions and Effects."

Executive Order 13007 (Indian Sacred Sites) and April 29, 1994, Executive Memorandum

Executive Order 13007 (May 24, 1996) requires federal agencies with land management responsibilities to accommodate access to and ceremonial use of Indian sacred sites by Indian religious practitioners and avoid adversely affecting the physical integrity of such sacred sites. Where appropriate, agencies are to maintain the confidentiality of sacred sites. Among other things, federal agencies must provide reasonable notice of proposed actions or land management policies that may restrict future access to or ceremonial use of, or adversely affect the physical integrity of, sacred sites. The agencies must comply with the April 29, 1994, Executive Memorandum, *Government-to-Government Relations with Native American Tribal Governments*.

Sacred sites will be addressed through the CWA Section 404 renewal process.

Federal Clean Air Act

The federal CAA was enacted to protect and enhance the nation's air quality in order to promote public health and welfare and the productive capacity of the nation's population. The CAA requires an evaluation of any federal action to determine its potential impact on air quality in the project region. California has a corresponding law, which also must be considered during the EIR process.

For specific projects, federal agencies must coordinate with the appropriate air quality management district as well as with EPA. This coordination would determine whether the project conforms to the CAA and the State Implementation Plan (SIP).

Section 176 of the CAA prohibits federal agencies from engaging in or supporting in any way an action or activity that does not conform to an applicable SIP. Actions and activities must conform to a SIP's purpose of eliminating or reducing the severity and number of violations of the national ambient air quality standards and in attaining those standards expeditiously. EPA promulgated conformity regulations (codified in 40 CFR § 93.150 *et seq.*).

The potential air quality impacts of the Project resulting from construction (such as equipment emissions and fugitive dust) are discussed in Section 4.13, Air Quality, of this EIR, which analyzes and documents compliance with the CAA.

Federal Water Project Recreation Act

The federal Water Project Recreation Act requires federal agencies with authority to approve water projects to include recreation development as a condition of approving permits. Recreation development must be considered along with any navigation, flood control, reclamation, hydroelectric, or multipurpose water resource project. The act states that,

> consideration should be given to opportunities for outdoor recreation and fish and wildlife enhancement whenever any such project can reasonably serve either or both purposes consistently.

The Project proposes new water-based recreation facilities and features. Recreation effects are discussed in Section 4.9, Recreation and Visual Resources.

Sustainable Fisheries Act

In response to growing concern about the status of United States fisheries, Congress passed the Sustainable Fisheries Act of 1996 (PL 104-297) to amend the Magnuson-Stevens Fishery Conservation and Management Act (PL 94-265), the primary law governing marine fisheries management in the federal waters of the United State. Under the Sustainable Fisheries Act, consultation is required by NMFS on any activity that might adversely affect EFH. EFH includes those habitats that fish rely on throughout their life cycles. It encompasses habitats necessary to allow sufficient production of commercially valuable aquatic species to support a long-term sustainable fishery and contribute to a healthy ecosystem.

The extent to which additional compliance is required will be addressed through the ESA process as part of the CWA Section 404 renewal process.

State Requirements

California Environmental Quality Act

CEQA (Public Resources Code § 21000 *et seq*.) requires state and local agencies to identify the significant adverse environmental impacts of their actions and to avoid or mitigate those impacts, if feasible. The environmental review required imposes both procedural and substantive requirements. At a minimum, an initial review of the project and its potential environmental effects must be conducted. CEQA's primary objectives are to:

- disclose to decision makers and the public the significant environmental effects of proposed activities,
- identify ways to avoid or reduce environmental damage,
- prevent environmental damage by requiring implementation of feasible alternatives or mitigation measures,
- disclose to the public reasons for agency approval of projects with significant environmental effects,
- foster interagency coordination in the review of projects, and

- enhance public participation in the planning process.

CEQA applies to all discretionary activities proposed to be carried out or approved by California public agencies, including state, regional, county, and local agencies, unless an exemption applies. The act requires that public agencies comply with both procedural and substantive requirements. Procedural requirements include the preparation of the appropriate public notices (including notices of preparation), scoping documents, alternatives, environmental documents (including mitigation measures, mitigation monitoring plans, responses to comments, findings, and statements of overriding considerations), completion of agency consultation and State Clearinghouse review, and provisions for legal enforcement and citizen access to the courts.

CEQA's substantive provisions require agencies to disclose environmental impacts in an appropriate document. When avoiding or minimizing environmental damage is not feasible, CEQA requires agencies to prepare a written statement of overriding considerations when they decide to approve a project that will cause one or more significant effects on the environment that cannot be mitigated. CEQA establishes a series of action-forcing procedures to ensure that agencies accomplish the purposes of the law. In addition, under the direction of CEQA, the California Resources Agency has adopted regulations, known as the State CEQA Guidelines (CCR 14 §15000 *et seq*.), which provide detailed procedures that agencies must follow to implement the law.

This document is the instrument for CEQA compliance for the Project.

California Endangered Species Act

CESA is similar to ESA but pertains only to state-listed Endangered and Threatened species. CESA requires state agencies to consult with DFG when preparing documents under CEQA to ensure that the actions of the state lead agency do not jeopardize the continued existence of listed species. CESA directs agencies to consult with DFG on projects or actions that could affect listed species, directs DFG to determine whether there would be jeopardy to listed species, and allows DFG to identify "reasonable and prudent alternatives" to the project consistent with conserving the species. Agencies can approve a project that affects a listed species if the agency determines that there are "overriding considerations;" however, the agencies are prohibited from approving projects that would cause the extinction of a listed species.

Mitigating impacts on state-listed species involves avoidance, minimization, and compensation (listed in order of preference). Unavoidable impacts on state-listed species are typically addressed in a detailed mitigation plan prepared in accordance with DFG guidelines. DFG exercises authority over mitigation projects involving state-listed species, including those resulting from CEQA mitigation requirements.

CESA prohibits the "take" of plant and wildlife species state-listed as Endangered or Threatened. DFG may authorize take if through either an incidental take permit or as part of a natural communities conservation plan, or if take authorization has been obtained under the ESA and DFG determines that the authorization is consistent with the Fish & Game Code requirements.

Take of state-listed species or substantial degradation of habitat will be addressed through consultation with DFG, consistent with prior Project authorization.

Section 1600 *et seq*. of the California Fish and Game Code

DFG regulates work that will substantially affect resources associated with rivers, streams, and lakes in California, pursuant to Fish and Game Code Sections 1600 to 1607. Any action from a public project that substantially diverts or obstructs the natural flow or changes the bed, channel, or bank of any river, stream, or lake, or uses material from a streambed must be previously authorized by DFG in a lake or streambed alteration agreement under Section 1602 of the Fish and Game Code. This requirement may in some cases apply to any work undertaken within the 100-year floodplain of a body of water or its tributaries, including intermittent streams and desert washes. As a general rule, however, it applies to any work done within the annual high-water mark of a wash, stream, or lake that contains or once contained fish and wildlife, or that supports or once supported riparian vegetation.

A Streambed Alteration Agreement will be obtained from DFG to authorize the Project.

Porter-Cologne Water Quality Control Act of 1969

In 1967, the Porter-Cologne Act established the State Water Board and nine RWQCBs as the primary state agencies with regulatory authority over California water quality and appropriative surface water rights allocations. Under this act (and the CWA), the state is required to adopt a water quality control policy and WDRs to be implemented by the State Water Board and nine RWQCBs. The State Water Board also establishes Basin Plans and statewide plans. The RWQCBs carry out State Water Board policies and procedures throughout the state.

Basin Plans designate beneficial uses for specific surface water and groundwater resources and establish water quality objectives to protect those uses. The Project has the potential to affect water quality in surface water or groundwater within the Project area that is governed by the Central Valley RWQCB. Effects are analyzed in Section 4.2, Water Quality.

Central Valley Flood Protection Board Encroachment Permit

The Central Valley Flood Protection Board Encroachment Permit (CVFPB) (formerly The Reclamation Board) requires an encroachment permit for any non-federal activity along or near federal flood damage reduction project levees and floodways or in CVFPB-designated floodways to ensure that proposed local actions or projects do not impair the integrity of existing flood damage reduction systems to withstand flood conditions. The Project will not require a CVFPB Encroachment Permit, as the Project levees are not federal flood damage reduction project levees.

California Surface Mining and Reclamation Act

The California Surface Mining and Reclamation Act of 1975 (PRC Section 2710 *et seq*.) (SMARA) addresses surface mining. Activities subject to SMARA include, but are not limited to, mining of minerals, gravel, and borrow material. SMARA applies to an individual or entity that would disturb more than 1 acre or remove more than 1,000 cubic yards of material through surface mining activities, including the excavation of borrow pits for soil material. SMARA is implemented through ordinances for permitting developed by local government "lead agencies" that provide the regulatory framework under which local mining and reclamation activities are conducted. The State Mining and Geology Board reviews the local ordinances to ensure that they meet the procedures established by SMARA.

The SMARA statute requires mitigation to reduce adverse impacts on public health, property, and the environment. Because the Project would require borrow material for project construction, the Project applicant must comply with SMARA.

California Land Conservation Act (Williamson Act)

The California Land Conservation Act (California Government Code, beginning at Section 51200), also known as the Williamson Act, was adopted in 1965. The Williamson Act allows for the preservation of agricultural and open space lands through property tax incentives and voluntary restrictive use contracts. This Project allows property owners to have their property assessed on the basis of its agricultural production rather than at the current market value. The contract may be cancelled if the land is being converted to an incompatible use.

Generally, the anticipated Project land use changes are compatible with existing Williamson Act contracts covering Project lands. Williamson Act issues are addressed in Section 4.8, Land Use and Agriculture.

California Fish and Game Code Section 3503 and 3503.5—Protection of Bird Nests and Raptors

Section 3503 of the California Fish and Game Code states that it is unlawful to take, possess, or needlessly destroy the nest or eggs of any bird. Section 3503.5 specifically states that it is unlawful to take, possess, or destroy any raptors (i.e., species in the orders *Falconiformes* and *Strigiformes*), including their nests or eggs. Typical violations of these codes include destruction of active nests resulting from removal of vegetation in which the nests are located. Violation of Section 3503.5 could also include failure of active raptor nests resulting from disturbance of nesting pairs by nearby project construction. This statute does not provide for the issuance of any type of incidental take permit. Per the environmental commitment discussed in Section 4.07, Wildlife, take of bird nests and raptors will be avoided.

California Fish and Game Code—Fully Protected Species

Protection of fully protected species is described in Sections 3511, 4700, 5050, and 5515 of the California Fish and Game Code. These statutes prohibit take or possession of fully protected species and do not provide for authorization of incidental take of fully protected species. DFG has informed non-federal agencies and private parties that their actions must avoid take of any fully protected species. Fully protected species that have the potential to occur on the project site are greater sandhill crane, white-tailed kite, and California black rail. Per the environmental commitment discussed in Section 4.07, Wildlife, take of fully protected species will be avoided.

Basin Plan

Pursuant to the Porter-Cologne Act, the Central Valley RWQCB prepares and updates the Basin Plan for the Sacramento and San Joaquin River Basins every 3 years; the most recent update was completed in September 2009 (Central Valley Regional Water Quality Control Board 2009). The Basin Plan describes the officially designated beneficial uses for specific surface water and groundwater resources and the enforceable water quality objectives necessary to protect those beneficial uses. The Project Islands are located within the Central Valley RWQCB jurisdiction and is subject to the Basin Plan.

The Basin Plan includes numerical and narrative water quality objectives for physical and chemical water quality constituents. Numerical objectives are set for temperature, DO, turbidity, and pH; TDS, electrical conductivity, bacterial content, and various specific ions; trace metals; and synthetic organic compounds. Narrative objectives are set for parameters such as suspended solids, biostimulatory substances (e.g., nitrogen and phosphorus), oil and grease, color, taste, odor, and aquatic toxicity. Narrative objectives are often precursors to numeric objectives. The primary method used by the Central Valley RWQCB to ensure conformance with the Basin Plan's water quality objectives and implementation policies and procedures is to issue WDRs for projects that may discharge wastes to land or water. WDRs specify terms and conditions that must be followed during the implementation and operation of a project.

Section 4.2, Water Quality, addresses Basin Plan elements and compliance.

California Toxics Rule and State Implementation Policy

The California Toxics Rule (CTR) was promulgated in 2000 in response to requirements of the EPA National Toxics Rule (NTR). The NTR and CTR criteria are regulatory criteria adopted for inland surface waters, enclosed bays, and estuaries in California that are subject to regulation pursuant to Section 303(c) of the CWA. The NTR and CTR include criteria for the protection of aquatic life and human health. Human health criteria (water and organisms) apply to all waters with a Municipal and Domestic Supply beneficial use designation as indicated in the RWQCBs' basin plans. The Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California, also known as the State Implementation Plan, was adopted by the State Water Board in 2000 to establish provisions for translating CTR criteria, NTR criteria, and basin plan water quality objectives for toxic pollutants into the following:

- NPDES permit effluent limits,
- Compliance determinations,
- monitoring for dioxin (2,3,7,8-TCDD) equivalents,
- chronic toxicity control provisions,
- initiating site-specific objective development, and
- granting exceptions.

The numeric toxics criteria of the CTR and the State Implementation Plan are relevant to the assessment of potential pollution from herbicides and pesticides, some of which may be in use or may be present on the Project islands. Section 4.2, Water Quality, further addresses water quality issues.

California Register of Historic Resources

The CRHR includes resources that are listed in or formally determined eligible for listing in the NRHP (see Section 2.18, Cultural Resources) as well as some California State Landmarks and Points of Historical Interest (PRC Section 5024.1, 14, CCR Section 4850). Properties of local significance that have been designated under a local preservation ordinance (local landmarks or landmark districts) or that have been identified in a local historical resources inventory may be eligible for listing in the CRHR and are presumed to be significant resources for purposes of CEQA unless a preponderance of evidence indicates otherwise

(State CEQA Guidelines Section 15064.5[a][2]). The eligibility criteria for listing in the CRHR are similar to those for NRHP listing but focus on the importance of the resources to California history and heritage. A cultural resource may be eligible for listing in the CRHR if it:

1. is associated with events that have made a significant contribution to the broad patterns of California's history and cultural heritage;
2. is associated with the lives of person important in our past;
3. embodies the distinctive characteristics of a type, period, region, or method of construction, or represents the work of an important individual, or possesses high artistic values; or
4. has yielded, or may be likely to yield, information important in prehistory or history.

Historic resources are addressed in Section 4.11, Cultural Resources.

Native American Heritage Commission

NAHC identifies and catalogs places of special religious or social significance to Native Americans and known graves and cemeteries of Native Americans on private lands, and performs other duties regarding the preservation and accessibility of sacred sites and burials and the disposition of Native American human remains and burial items.

Native American resources are discussed in Section 4.11, Cultural Resources.

California Climate Solutions Act

In September 2006, Governor Arnold Schwarzenegger signed AB 32, the California Climate Solutions Act of 2006. AB 32 requires that statewide GHG emissions be reduced to 1990 levels by 2020. This reduction will be accomplished through an enforceable statewide cap on GHG emissions that will be phased in starting in 2012. To effectively implement the cap, AB 32 directs the California Air Resources Board (CARB) to develop and implement regulations to reduce statewide GHG emissions from stationary sources. AB 32 specifies that regulations adopted in response to AB 1493 should be used to address GHG emissions from vehicles. However, AB 32 also includes language stating that if the AB 1493 regulations cannot be implemented, then CARB should develop new regulations to control vehicle GHG emissions under the authorization of AB 32.

AB 32 requires that CARB adopt a quantified cap on GHG emissions representing 1990 emissions levels and disclose how it arrives at the cap; institute a schedule to meet the emissions cap; and develop tracking, reporting, and enforcement mechanisms to ensure that the state achieves the reductions in GHG emissions necessary to meet the cap. AB 32 also includes guidance to institute emissions reductions in an economically efficient manner and conditions to ensure that businesses and consumers are not unfairly affected by the reductions.

Contributions of GHG emissions related to the Project are discussed in Section 4.14, Climate Change.

California Regulations for Environmental Justice

Most state governments have plans and policies intended to protect and expand the local and regional economies affecting the communities within their jurisdictions. State plans and policies also frequently address other social and economic impact topics, including fiscal conditions and related public services that affect local residents' quality of life.

Within California, SB 115 (Chapter 690, Statutes of 1999) was signed into law in 1999. The legislation established OPR as the coordinating agency for state environmental justice programs (California Government Code, Section 65040.12[a]) and defined environmental justice in statute as "the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies" (Government Code Section 65040.12(e). SB 115 further required the CalEPA to develop a model environmental justice mission statement for boards, departments, and offices within the agency by January 1, 2001 (Public Resources Code, Sections 72000–72001).

In 2000, SB 89 (Chapter 728, Statutes of 2000) was signed, which complemented SB 115 by requiring the creation of an environmental justice working group and an advisory group to assist CalEPA in developing an intra-agency environmental justice strategy (PRC Sections 72002–72003). SB 828 (Chapter 765, Statutes of 2001) added and modified due dates for the development of CalEPA's intra-agency environmental justice strategy and required each board, department, and office within CalEPA to identify and address, no later than January 1,2004, any gaps in its existing programs, policies, and activities that may impede environmental justice (PRC, Sections 71114–71115).

Cal/EP A adopted its environmental justice policy in 2004 (California PRC, Sections 71110–71113). This policy (or strategy) provides guidance to its resource boards, departments, and offices. It is intended to help achieve the state's goal of "achieving fair treatment of people of all races, cultures and incomes with respect to the development, adoption, implementation and enforcement of environmental laws and policies."

AB 1553 (Chapter 762, Statutes of 2001) required OPR to incorporate environmental justice considerations in the General Plan Guidelines. AB 1553 specified that the guidelines should propose methods for local governments to address the following:

- planning for the equitable distribution of new public facilities and services that increase and enhance community quality of life,

- providing for the location of industrial facilities and uses that pose a significant hazard to human health and safety in a manner that seeks to avoid over-concentrating these uses in proximity to schools or residential dwellings,
- providing for the location of new schools and residential dwellings in a manner that avoids proximity to industrial facilities and uses that pose a significant hazard to human health and safety, and
- promoting more livable communities by expanding opportunities for transit-oriented development.

Although environmental justice is not a mandatory topic in the general plan, OPR is required to provide guidance to cities and counties for integrating environmental justice into their general plans. The 2003 edition of the *General Plan Guidelines* included the contents required by AB 1553 (see pages 8, 12, 20–27, 40, 114, 142, 144, and 260 of the revised *General Plan Guidelines*).

The Project does not present conflicts with environmental justice objectives, as described in Chapter 3K of the 2001 FEIS, “Economic Conditions and Effects.”

Water Use Efficiency

The California Constitution prohibits the waste or unreasonable use of water. Further, Water Code Section 275 directs DWR and the State Water Board to “take all appropriate proceedings or actions before executive, legislative, or judicial agencies to prevent waste or unreasonable use of water.” Several legislative acts have been adopted to develop efficient use of water in the state:

- Urban Water Management Planning Act of 1985,
- Water Conservation in Landscaping Act of 1992,
- Agricultural Water Management Planning Act,
- Agricultural Water Suppliers Efficient Management Practices Act of 1990,
- Water Recycling Act of 1991, and
- Agricultural Water Conservation and Management Act of 1992.

The Project proposes to make more efficient use of existing water resources through capture of Delta flow during times of surplus, as described in Section 4.1, Water Supply.

Public Trust Doctrine

When planning and allocating water resources, the State of California is required to consider the public trust and preserve for the public interest the uses protected by the trust. The public trust doctrine embodies the principle that certain resources, including water, belong to all and, thus, are held in trust by the state for future generations.

In common law, the public trust doctrine protects navigation, commerce, and fisheries uses in navigable waterways. However, the courts have expanded the doctrine's application to include protecting tideland, wildlife, recreation, and other public trust resources in their natural state for recreational, ecological, and habitat purposes as they affect birds and marine life in navigable waters. *The National Audubon Society v. Superior Court of Alpine County* (1983) 33 Cal 3d 419 decision extended the public trust doctrine's limitations on private rights to appropriative water rights, and also ruled that longstanding water rights could be subject to reconsideration and could possibly be curtailed. The doctrine, however, generally requires the court and the State Water Board to perform a balancing test to weigh the potential value to society of a proposed or existing diversion against its impact on trust resources.

The 1986 Rancanelli decision applied the public trust doctrine to decisions by the State Water Board and held that this doctrine must be applied by the State Water Board in balancing all the competing interests in the uses of Bay-Delta waters (*United States v. State Water Resources Control Board* [1986] 182 Cal. App. 3d 82).

The Project is consistent with the public trust doctrine, as its primary objective is to improve water supply reliability through capture of Delta flow during times of surplus, and secondarily provides for enhanced fish and wildlife habitat. These objectives are discussed in Section 4.1, Water Supply; Section 4.5, Fishery Resources; and Section 4.7, Wildlife.

Relocation Assistance and Property Acquisition

The State of California's Government Code Section 7260, *et seq.* brings the California Relocation Act into conformity with the federal Uniform Act. In the acquisition of real property by a public agency, both the federal and state acts seek to (1) ensure consistent and fair treatment of owners of real property, (2) encourage and expedite acquisition by agreement to avoid litigation and relieve congestion in the courts, and (3) promote confidence in public land acquisition.

The Relocation Assistance and Real Property Acquisition Guidelines were established by 25 CCR 1.6. The guidelines were developed to assist public entities with developing regulations and procedures implementing Title 42, Chapter 61 of the USC, the Uniform Act, for federal and federally assisted programs. The guidelines are designed to ensure that uniform, fair, and equitable treatment is given to people displaced from their homes, businesses, or farms as a result of the actions of a public entity. Under the act, persons required to relocate temporarily are not considered displaced, but must be treated fairly. Such persons have a right to temporary housing that is decent, safe, and sanitary, and must be reimbursed for all reasonable out-of-pocket expenses. In accordance with these guidelines, people may not suffer disproportionate injury as a result of action taken for the benefit of the public as a whole. Additionally, public entities must ensure consistent and fair treatment of owners of such property, and encourage and expedite acquisitions by agreement with owners of displaced property to avoid litigation.

The Project proposes no acquisition of property or resulting relocations.

State and Regional Plan Consistency

Clean Water Act, Section 303(d)

Under CWA Section 303(d), the RWQCB and the State Water Board list water bodies as impaired when not in compliance with designated water quality objectives and standards. A TMDL program must be prepared for waters identified by the state as impaired. A TMDL is a quantitative assessment of a problem that affects water quality. The problem can include the presence of a pollutant, such as a heavy metal or a pesticide, or a change in the physical property of the water, such as DO or temperature. A TMDL specifies the allowable load of pollutants from individual sources to ensure compliance with water quality standards. Once the allowable load and existing source loads have been determined, reductions in allowable loads are allocated to individual pollutant sources.

The Project effects on water quality are addressed in Section 4.2, Water Quality.

Water Rights

California employs a dual system of surface water rights that recognizes both appropriative and riparian rights. An appropriative water right consists of the right to divert a specified quantity of water for a reasonable, beneficial use. Under the riparian doctrine, the owner of land contiguous to a watercourse has the right to the reasonable, beneficial use of the natural flow of water on his or her land. A riparian user may not seasonally store water or use water outside the watershed.

The State Water Board administers the state's statutory water right permit and license system, which applies to appropriations of water from surface streams and subterranean streams flowing through known and definite channels. (Wat. Code, § 1200.) Since 1914, the permit and license system provides the exclusive means of acquiring a new appropriative water right. (*Id*, § 1225.) To obtain a new appropriative water right, a person must file a water right application with the State Water Board to appropriate water for a reasonable and beneficial purpose. (Wat. Code, §§ 100, 1252.)

As discussed in Chapter 1, the Project applicant originally filed water right applications 29062, 29066, 30268, and 30270 with the State Water Board in 1987 for water rights to store water seasonally on all four of its Project islands and to sell that water to potential users in the CVP and SWP service areas. In 1993, the Project applicant revised the 1987 applications to accommodate the reduction from four to two storage islands and also filed new water right applications for direct diversion to the Project Reservoir Islands. The State Water Board issued D-1643 in February 2001 approving the Project applicant's water right applications and associated petitions to change these applications, subject to terms and conditions. CDWA brought a petition for a writ of mandate challenging the State Water Board's issuance of D-1643 and certification of the FEIR in Sacramento County Superior Court. In April 2002, the Sacramento County Superior Court rejected each cause of action brought by CDWA. The Third District Court of Appeal in *Central Delta Water Agency v. State Water Resources Control Board*, 124 Cal. App. 4th 245 (2004), affirmed the Superior Court decision in most respects, but set aside the water right permits for failure "to specify an actual use of and the amounts of water to be appropriated."

Consistent with the Project description given in Chapter 2, the Project applicant has filed petitions with the State Water Board to add places of use and places of underground storage to the Project water right applications and is seeking the reissuance of water right permits for the Project. This CEQA document is intended to support the State Water Board review and approval of the Project water right application.

Local Plan Consistency and Regulatory Requirements

In addition to the federal and state regulatory and local plan requirements, the project may be subject to certain zoning or other ordinances and general plans of San Joaquin and Contra Costa Counties. For more discussion on local plans and requirements applicable to the project, refer to the specific resource sections of interest within this EIR.

Chapter 8
List of Preparers

The following persons contributed to preparation of this EIR. This list is consistent with the requirements set forth in CEQA (Section 15129 of the State CEQA Guidelines).

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Appendix A

Delta Wetlands Project
In-Delta Storage Model

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Acronyms and Abbreviations

Banks	SWP Harvey O. Banks Pumping Plant
BO	Biological Opinion
CA	California Aqueduct
CACMP	Common Assumptions Common Model Package
CALFED	CALFED Bay-Delta Program
CEQA	California Environmental Quality Act
cfs	cubic feet per second
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
D-1485	State Water Resources Control Board water right Decision 1485
D-1641	State Water Resources Control Board water right Decision 1641
Delta	Sacramento–San Joaquin River Delta
Delta Wetlands	Delta Wetlands Properties
DWR	California Department of Water Resources
E/I	export/inflow
EIR	Environmental Impact Report
FMWT	Fall Midwater Fish Trawl
FNA	Future No Action
IDSM	In-Delta Storage Model
Joint-Point	Joint Point of Diversion operations for the CVP and SWP
Jones	CVP Tracy C.W. “Bill” Jones Pumping Plant
LOD	Level of Development
MBK	MBK Engineers, Inc.
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NTU	Nephelometric Turbidity Units
OCAP	Operation Criteria and Plan
OMR	Old and Middle River
Project	Delta Wetlands Project
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
Semitropic	Semitropic Water Storage District
State Water Board	State Water Resources Control Board
SWP	State Water Project
USFWS	U.S. Fish and Wildlife Service
VAMP	Vernalis Adaptive Management Plan
WQCP	Water Quality Control Plan

Delta Wetlands Project In-Delta Storage Model

Introduction

Delta Wetlands Properties (Delta Wetlands) proposes to develop two island reservoirs in the Sacramento–San Joaquin River Delta (Delta) as part of the Delta Wetlands Project (Project). Bacon Island and Webb Tract are the designated sites for water storage. The intended operation is to divert water onto the islands during periods of Delta surplus (i.e., State Water Project [SWP] and Central Valley Project [CVP] pumping at permitted capacity with more than required Delta outflow) and release water for south-of-Delta export or increased Delta outflow for improved water quality or habitat conditions.

Delta Wetlands has identified specific places of use for the Project and will be submitting petitions with the State Water Resources Control Board (State Water Board) to add these proposed places of use to the Project's applications. Delta Wetlands and Semitropic Water Storage District (Semitropic), the implementing agency and lead agency for California Environmental Quality Act (CEQA) compliance, is preparing a Place of Use Environmental Impact Report (EIR) to examine the potential environmental effects associated with diverting water to storage and supplying water to the proposed places of use. The Place of Use EIR will update the Project's prior impact analyses to consider new information and changed circumstances, including the Old and Middle River (OMR) flow criteria for delta smelt protection and other regulatory and physical changes affecting the Delta.

Delta Wetlands needed to explore the benefits of integrating the in-Delta water storage facilities with groundwater banks located in the San Joaquin Valley and southern California and with designated places of use for the delivered water. In previous studies, there was no modeled linkage between the Project's water supply delivery at south Delta CVP or SWP pumping plants and south-of-Delta demands. The island reservoirs were intended to hold water for less than a year, and some of the water the Project diverted to storage was during wet and above normal runoff years. South-of-Delta groundwater banks would provide the means to store Project water for dry year supply.

To address designated place of use deliveries, the recent OMR flow criteria, groundwater bank integration, and the many issues of water operations in the Delta, MBK Engineers, Inc. (MBK) developed the In-Delta Storage Model (IDSM) to evaluate monthly Project operations under various regulatory requirements and rules of operation. The model provides the output necessary to perform environmental impact assessments for the EIR and provides flexibility to compare multiple alternatives for Project operating rules. This document provides a description of the IDSM logic and the necessary CalSim II results that are used as the baseline conditions for exploring Project operations. The document also discusses the IDSM calculations and user input and output interface (i.e., tables and graphs).

General Description

The IDSM was developed to simulate In-Delta Storage operations at a monthly time-step based on water years 1922–2003 hydrologic conditions as simulated by CALSIM II. The IDSM model is a Microsoft Excel spreadsheet. Each month of a simulation, IDSM simulates the diversion of water to storage or the discharge of water from the island reservoirs to export or increase Delta outflow, based on several Delta flow conditions including available Delta surplus (within the export/inflow [E/I] ratio), available island storage capacity, Delta water quality, available export capacity, available south-of-Delta conveyance capacity, and south-of-Delta water demand. IDSM tracks Webb and Bacon island storages, island diversions and discharges, Delta outflow, X2, Rock Slough salinity, QWEST, flow in Old and Middle Rivers, Delta exports, groundwater bank recharge and pumping, groundwater bank storage, and south-of-Delta delivery of Project water. IDSM output is provided in monthly and annual plots and tables.

The control worksheet provides the ability to easily modify project design, regulations, and operations to evaluate different Project alternatives. For instance, the user can choose different CalSim baselines to reflect changed Delta regulations; specify island diversion and discharge constraints; specify the island reservoirs and groundwater banks storage and flow capacities; identify the place of use demand parameters, and specify discharge operations for water quality improvement (increased outflow).

The Project is simulated without interference to the baseline CVP and SWP Delta operations. IDSM calculations change Delta outflow, Delta exports, and south-of-Delta conveyance and deliveries from the selected CalSim baseline without changing the baseline CVP and SWP operations. Upstream reservoir operations and Delta inflow are left unchanged, and CVP and SWP Delta exports, as simulated in the CalSim baseline, are not changed. The IDSM-calculated diversions to the Project are solely from Delta surplus—water that is unneeded for in-basin use and that no other diverters in the Sacramento-San Joaquin basins have the capacity or right to take. South-of-Delta exports of Project water are made using CVP Tracy C.W. “Bill” Jones Pumping Plant (Jones) and SWP Harvey O. Banks Pumping Plant (Banks) capacity that was unused by the SWP, CVP, and third party transfers to CVP and SWP contractors as represented in the CalSim baseline.

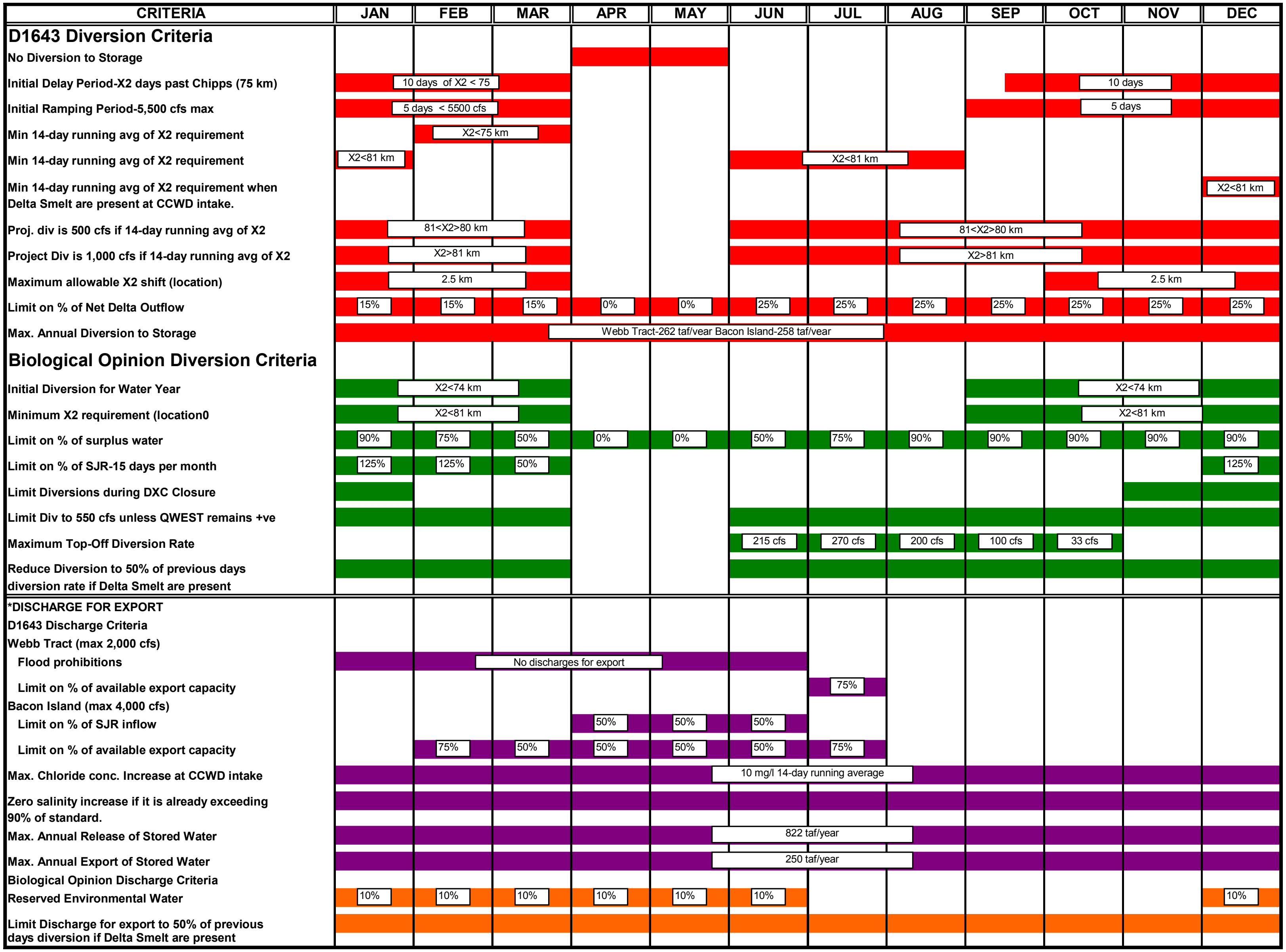


Figure A-1. D-1643 and Biological Opinion Constraints on Project Operations

CalSim Baselines

A standardized package of models have been developed for the California Department of Water Resources (DWR) and the U.S. Department of the Interior, Bureau of Reclamation (Reclamation) for use in feasibility analyses and CEQA and National Environmental Policy Act (NEPA) analyses of the CALFED Bay-Delta Program (CALFED) surface storage projects. These projects include expanded Lake Shasta, expanded Los Vaqueros Reservoir, Sites Reservoir, Upper San Joaquin River storage, and In-Delta Storage (DWR's proposed variation of the Project). The suite of tools include CalSim II (water supply planning), DSM2 (Delta hydrodynamics and water quality), LCPSIM and CVPM (water supply economics), LTGEN/SWP Power (power generation/consumption), and others.

Reclamation and DWR are currently using Common Assumptions Common Model Package (CACMP) Version 9B for the CEQA/NEPA analysis of several water resource projects currently in the planning stages.

Description of CalSim II Assumption

CalSim II is a planning model designed to simulate the operations of the CVP and SWP reservoirs and water delivery system for current and future facilities, flood control operating criteria, water delivery policies, instream flow and Delta outflow requirements. CalSim II is a widely accepted tool for modeling the CVP and SWP and is the primary system-wide hydrologic model being used by DWR and Reclamation to conduct planning and water supply analyses of potential projects using a monthly time-step.

CalSim II is a monthly simulation with optimization model. The model simulates operations by solving a mixed-integer linear program to maximize an objective function (i.e., meet constraints and flow objectives) for each month of the simulation. CalSim II was developed to simulate the operation of the CVP and SWP for defined facilities, hydrological conditions and a set of regulatory requirements. The model simulates the operations of the CVP and SWP using 82 years of historical hydrology from water year 1922–2003.

CalSim II is set up to simulate and account for the effects of various regulatory requirements through a multi-step algorithm. CalSim II model "steps" simulate operations of the system under select regulatory requirements and agreements. The model is run for one year for each step and end of year conditions from the final step become input to start the next year for the first step. The Version 9B model contains five steps. The only purpose for the steps is to calculate incremental effects of several sets of constraints and objectives. Only the results from the final step are used for the next year's simulation.

1. **State Water Board water right Decision 1641 (D-1641)**—D-1641 was issued in 1999, revised in 2000, and specifies how the 1995 Water Quality Control Plan (WQCP) is to be implemented. D-1641 provides both flow and water quality requirements at key locations in the Delta. D-1641 is the current basis for most regulatory requirements governing the Delta which in turn affects how the SWP and CVP operate upstream reservoirs and Delta export pumps. The Vernalis Adaptive Management Plan (VAMP) flows and export reductions are simulated in this step.
2. **State Water Board water right Decision 1485 (D-1485)**—Section b(2) of the Central Valley Project Improvement Act (CVPIA) dedicated 800,000 acre-feet of water to be made available for environmental purposes. Non-discretionary b(2) water, is the difference in water costs (either additional releases from upstream reservoirs or water available but not exported from the Delta) to meet the more stringent requirements of D-1641 instead of the previous requirements of D-1485.
3. **CVPIA b(2)**—Discretionary b(2) water may include additional winter releases from upstream reservoirs or export reductions in the weeks before and after the reductions that occur in the spring as part of the VAMP.
4. **Conveyance**—The conveyance and transfer steps of CalSim II are primarily used to simulate specific secondary aspects of Project operations. The conveyance step simulates Stage 1 water transfers associated with the Phase 8 Settlement and the Lower Yuba River Accord, which are included in the allocations for the CVP and SWP and include transfers.
5. **Transfer**—The CalSim II transfer step layers Stage 2 water transfers onto the operations and simulates Joint Point of Diversion operations for the CVP and SWP (Joint-Point). Stage 2 transfers are private party transfers moved through the Delta as a last priority for export capacity. Joint-Point operations increase the flexibility of CVP and SWP exports by allowing both Projects to utilize available export capacity at the other Project’s pumps. The transfer step also includes the wheeling of CVP water for Cross Valley Canal contractors at the Banks pumping plant. The Project could be considered as a third-party transfer in this step of the CALSIM model, but is not included in the common assumptions simulations (V9B).

Level of Development

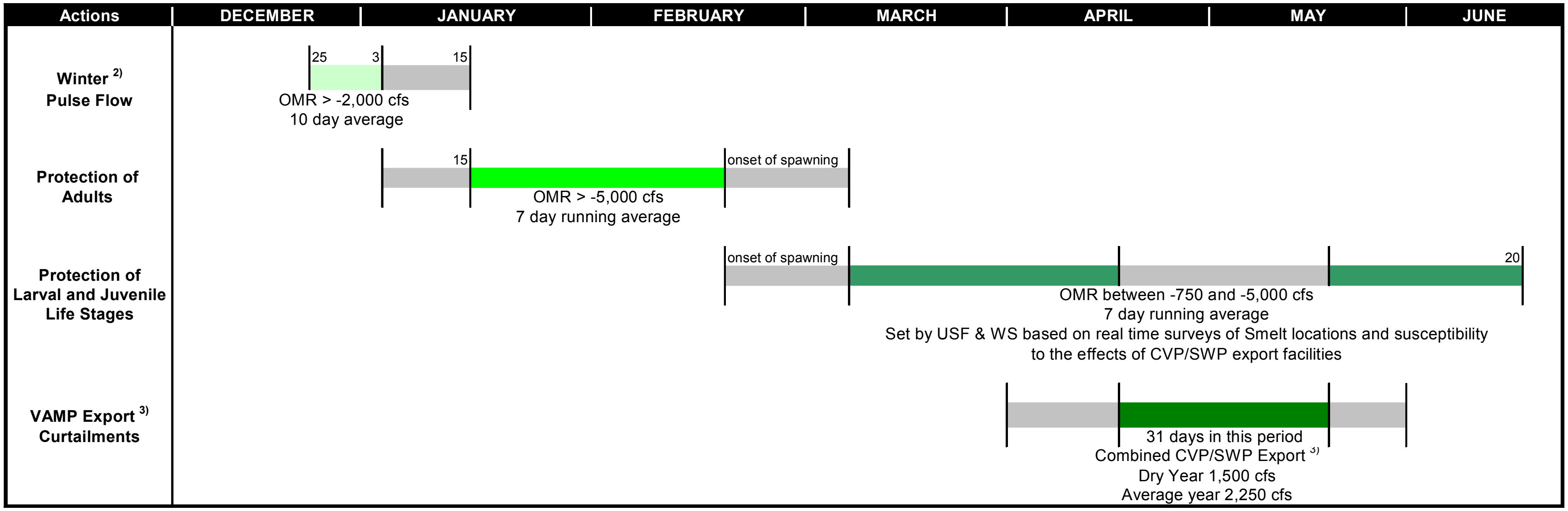
An existing Level of Development (LOD) study assumes that current land use, facilities and operational objectives are in place for each year of simulation (water year 1922–2003). The results are a depiction of the current water system operations which provides a basis for comparison of project effects for existing conditions (CEQA analysis). A Future LOD study is used to explore how the water system may perform under an assumed future set of physical and institutional circumstances. This future setting is developed by assuming year 2030 land use, facilities and operational objectives and is used for the Future No Action (FNA) conditions (NEPA analysis). The Project was simulated with IDSM using the CALSIM existing level of development (2005) results.

Old and Middle River Flow Criteria

Regulations and criteria governing operation of the Delta and upstream facilities sometimes change to reflect new concerns or protections. In December 2007, there was an interim court order (Wanger Decision-remedy actions) that established a set of Old and Middle River flow criteria to protect Delta smelt. The remedy actions are outlined in Table A-1. These remedy actions could significantly reduce SWP and CVP Delta exports from January to June since pumping at that time would be restricted to satisfy the maximum allowed reverse flow criteria. As a consequence, the OMR criteria could boost SWP and CVP reliance on summer exports to make up for lost winter and spring exports. Interim OMR flow criteria were simulated as an optional regulatory condition in CACMP V9B CalSim II.

Reclamation is currently developing its revised Operation Criteria and Plan (OCAP) that will include operating rules protecting Delta smelt, salmon, and other fish, as specified by the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS). The December 2008 USFWS Biological Opinion (BO) on OCAP for Delta smelt and the June 2009 NMFS BO on OCAP for Chinook salmon, steelhead, and green sturgeon supplanted Wanger's interim order. While there are similarities between the interim decision and the BO requirements, there are also some significant differences including a Fall Delta outflow requirement. To date, there is no CalSim simulation of the recent OCAP BOs in the Common Assumptions package.

Table A-1. 2007 Delta Smelt Interim Remedy Order1



1) This table only shows the parts of the December 14, 2007 Order that affect water supplies.

2) Triggered only if turbidity exceeds 12 NTU at any of 3 specific Delta Stations. Action lasts for 10 days once triggered.

3) The Vernalis Adaptive Management Plan (VAMP) includes San Joaquin River flow enhancements and curtailed CVP/SWP pumping.

As shown in Table A-1, application of the interim OMR criteria is dependent on turbidity in December and January, and the onset of smelt spawning along with the opinion of USFWS smelt working group from February to June. None of these adaptive management conditions can be simulated in CalSim II. Therefore, to formulate a CalSim baseline with OMR flow criteria, it was assumed that turbidity exceeds 12 Nephelometric Turbidity Units (NTU) at the sampling stations on December 25th of every year. Also, it was assumed that smelt spawning commences on February 19th, and that the USFWS imposes the strictest OMR criteria allowed from this day to the 20th of June. From a water supply perspective, both are conservative (i.e., minimum exports) assumptions. Table A-2 provides the resulting OMR criteria applied in the CalSim modeling. The CVP and SWP south-of-Delta delivery allocation procedures were modified to account for resulting reductions in available Delta export capacity.

Table A-2. Assumed Old and Middle River Flow Criteria in CalSim

Date	CalSim OMR Criteria (cfs)
December 25–January 3	-2,000
January 4–February 18	-5,000
February 19–April 14	-750
April 15–May 15	Exports controlled by VAMP criteria
May 16–June 20th	-750

cfs = cubic feet per second.

Two CalSim baselines have been included in IDSM. The first is a CACMP Version 9B CalSim II simulation at an existing level of development with no OMR flow criteria. In IDSM, this baseline is referred to as V9B. The second baseline is a CACMP Version 9B CalSim II simulation at existing level of development with interim OMR flow criteria as specified in Table A-2. This baseline is referred to as V9BOMR in IDSM.

IDSM Simulation Calculations

In IDSM, all monthly calculations are made in the worksheet titled Model. A full listing of the columns and equations contained in the Model worksheet is provided in the Attachment. The purpose of this section is to provide a qualitative discussion of the IDSM logic and assumptions for operating the island reservoirs.

Each month there are three possible modes of operation for Bacon Island and Webb Tract: (1) divert to storage, (2) discharge for export, or increased Delta outflow (improved water quality), and (3) do nothing. Operations are simulated based on hydrologic conditions from the CalSim baseline, and Project constraints and operations rules specified by the IDSM user. IDSM first looks for an opportunity to divert water onto Bacon Island or Webb Tract. Available surplus

Delta outflow is calculated from the CalSim baseline hydrology and consideration of the export to inflow limits found in D-1641. The Project diversions are assumed to satisfy the D-1641 E/I limits. All user specified constraints on island diversions are calculated, and the individual island maximum allowed diversions are taken as the controlling bounds (i.e., minimum of the individual constraints) for each reservoir island.

IDSM next calculates the Project discharges from both storage islands for export. Project discharges for export can go directly to designated places of use or be used to recharge groundwater banks; direct delivery takes priority over recharge. IDSM quantifies contractor unmet demands from the CalSim baseline and recharge capacity from user input. Contractor unmet demands may be further limited by place of use restrictions (i.e., percent of CVP and SWP unmet demands). The model calculates available permitted export capacity and California Aqueduct (CA) physical conveyance capacity from the CalSim baseline. IDSM calculates a maximum potential south-of-Delta export of Project water for the given month. Next, IDSM quantifies user defined bounds on island discharge, including whether Project exports are limited by the D-1641 E/I ratio.

Once export opportunities are taken, prospects for increasing Delta outflow to improve water quality or estuarine habitat benefits are calculated. Project discharges for Delta outflow are specified by the IDSM user and are based on the Delta outflow and salinity conditions in the CalSim baseline. Discharge for outflow is limited to the remaining specified discharge capacity or water on the island. Available capacity and storage may already be reduced due to Project discharges for export.

IDSM operates on a month-by-month basis with no attempt to optimize operations for a particular objective. For example, if the model can provide a Delta benefit in a given month, the model will discharge to provide this benefit without consideration of potential discharge for export opportunities in future months. The IDSM user must specify Delta outflow rules carefully to achieve a mix of water supply, water quality, and habitat benefits.

Some simplifications of Project operations were necessary due to the monthly time-step of CalSim and IDSM. For example, a single island can’t divert and discharge in the same month. If IDSM determines a given month is a diversion opportunity for Webb Tract, the discharge for Webb Tract will be set to zero. In real-time operations, this may not always be the case. It is reasonable to expect that the Project could divert during high Delta inflows in the first half of the month and discharge for export or Delta outflow benefits during the second half of the month.

IDSM may determine that one island has a diversion opportunity and the other has a discharge for export opportunity if the islands have different specified monthly operating criteria. For instance, consider the following rules for Project operations when OMR flow criteria controls south-of-Delta exports:

1. Webb Tract is allowed to divert Delta surplus
2. Webb Tract is not allowed to discharge for export

3. Bacon Island is not allowed to divert Delta surplus
4. Bacon Island is allowed to discharge for export

The reasoning behind these rules might be that Webb Tract diversions won't negatively impact (i.e., increase) reverse OMR flow whereas Webb Tract discharge for export would increase the measured reverse OMR flow. Bacon Island diversions would draw water (and fish) up the Old and Middle River channels, but Bacon Island discharge for export would not change the transport of fish towards the export pumps. Under these rules, when OMR criteria limit exports, and there is surplus Delta outflow, there are occasional diversion opportunities on Webb Tract in the same month that IDSM simulates a discharge for export opportunity for Bacon Island. Without the OMR criteria, the IDSM model does not simulate discharge for export when surplus Delta outflow is available, because Project diversions are generally more limiting, and CVP and SWP exports would already be at the maximum permitted level.

Filling of Bacon Island is given priority over filling Webb Tract. This priority is based on the discharge constraints placed on Webb Tract by D-1643. As specified in D-1643 Webb Tract can't discharge for export from February to June. No such restrictions are placed on Bacon Island by D-1643. So the idea is to fill Bacon Island first because there is greater opportunity for early discharge for export.

IDSM also has operating rules for the groundwater banks. As stated previously, exported Project water will first go to SWP/CVP contractor unmet demands within the identified place of use. Once that monthly demand is satisfied, the remainder of Project exports can go to recharge groundwater banks. The user specifies total bank capacity and maximum recharge rates. IDSM tracks storage in the groundwater banks. If SWP Table A allocations fall below a certain user specified threshold, water is pumped from the groundwater banks to identified SWP contractor unmet demand. In months where there is both island storage and groundwater available, island discharge for export takes priority over groundwater pumping for meeting demand within the identified place of use.

IDSM Spreadsheet Layout

IDSM is organized in worksheets. The worksheets are grouped by function such as user input, simulation calculations, simulation results, and input/output processing. The first worksheet of the model, Documentation, lists each worksheet and its purpose as shown in Figure A-2. Most IDSM users will focus only on worksheets containing user input, model calculations, and analysis of results.

Control

IDSM user input is organized in the Control worksheet. At the top of the Control worksheet, as shown in Figure A-3, a color coded user input key is provided along with a summary results table. Values that can be changed by the user are color coded yellow, pink and green. Yellow cells are parameters of particular interest to these studies such as the Old and Middle River Flow Criteria, place of use, and groundwater banks among others. Pink cells are used to implement rules associated with D-1643 and associated biological opinions and protest dismissal agreements. Green cells cover some of the physical constraints such as island reservoir capacity, storage area-curves, and monthly evaporation rates. After making changes, the user runs the model by pressing F9 (calculation).

Group	Worksheet	Description
User Input	Control	From this page, the user can change change IDS operational parameters and turn on or off various operational constraints
Model Calcs	Model	The simulation of IDS is performed in this worksheet. Decisions are made concerning island diversion, discharge, and destination of discharge according to baseline conditions and user specified operational controls.
View Results	TS_plot	Time series plot for entire simulation
	Ann_plot	Annual summary graphics and tables
	MonthlyStudyComparison	Monthly time series plots comparing current and saved studies
	AnnualStudyComparison	Annual summary graphics and tables comparing current and saved studies
	System schematic	Results viewer on system schematic
	Table	User defined output table
	TS_plot 10yr	Time series plots focusing on the last 10 years of the simulation (1994-2003)
Intermediate Calcs	SavedAnnualResults	Annual results saved by pushing the SAVE button on the CONTROL worksheet
	SavedPOEResults	Probability of exceedance results saved by pushing the SAVE button on the CONTROL worksheet
	SavedMonthlyResults	Monthly time series results saved by pushing the SAVE button on the CONTROL worksheet
	Saved Graph Calcs	Output to support plots of saved study
	Graph Calcs	Calculation to support output graphics of current simulation
	Schematic Data	Data used for system schematic
	Conversions	CFS-TAF conversion
CalSim Input and Output Processing	CalSimIn	Selected CalSim model inputs
	CalSimOut	CalSim model output used in IDSM
	Control Calc	Calculation of Delta outflow controls
	Export Control	Calculation of available export capacity
	CalSimOut_CA	CalSim output for California Aqueduct (CA) flows
	CA Avail	Available CA capacity at key locations
	Qwest	Calculation of Qwest that can vary by selected CalSim baseline
	OMR	Calculation of Old and Middle River flow which can vary by selected CalSim baseline
	River Indicies	Sacramento and San Joaquin River indicies
DSS Data Retrieval	DSSPathnames	Pathnames for CalSim DV DSS output and SV DSS input. Works for all applicable CalSim studies.
	DSSPathnames_CA	Pathnames for CalSim DV DSS output concerning California Aqueduct. Works for all applicable CalSim studies.
	DSSPathnames_B2	Pathnames for CalSim DV DSS output from b2 step
	DSSPathnames_RA	Pathnames for CalSim DV DSS output from Remedy Action study.

Figure A-2. Documentation—IDSM Worksheet Descriptions

The summary results table at the top of the control sheet (shown in Figure A-3) allows the user to modify operations rules or infrastructure and immediately see the effects on island operations on the same page. Summary results include average annual island discharge by destination and the overall deliveries to SWP and CVP contractors. Results are also averaged over different water year types so the user can see how Project benefits are distributed over dry and wet years. If the user likes a particular simulation, the monthly results can be saved for comparison to subsequent simulations by using the SAVE button (shown to the left of the summary table in Figure A-3). Tabular and graphical comparisons of results from the saved and current simulations are found in worksheets MonthlyComparison and AnnualComparison.

In-Delta Storage Model (IDSM)

Model Operations Control Worksheet

Color	Description
Yellow	Yellow cells are the parameters of interest for this study and can be changed by the user.
Pink	Pink cells are parameters set in the original permit application, D1643, or associated documents. They can also be varied by the user.
Green	Green cells are parameters pulled from the DWR IDS Feasibility Studies. These can be varied by the user.

Summary Results:

SAVE

	Island Discharge (TAF/year)								SOD Deliveries (TAF/year)		
Sac Index WY Type	Direct SWP Delivery	Direct CVP Delivery	AVWB Put	SWRU Put	OSWSD Put	SWSD Put	Delta Outflow Release	**Total**	SWP Delivery	CVP Delivery	**Total**
W	19	34	17	12	8	1	77	**167**	50	34	**84**
AN	27	63	29	24	9	1	33	**187**	55	63	**118**
BN	58	56	23	21	13	1	63	**236**	98	56	**154**
D	65	7	23	24	13	1	20	**152**	151	7	**158**
C	2	2	13	12	9	1	26	**64**	57	2	**59**
ALL	34	31	20	18	10	1	48	**163**	82	31	**113**

Figure A-3. IDSM Control Worksheet Provides a Summary Results Table at the Top

The first cell (yellow) for user input is to select the CalSim baseline as shown in Figure A-4. Currently, there are two baselines provided: (1) V9B and (2) V9BOMR. The user simply types "1" or "2" in the yellow cell to make the selection. The key difference between the two baselines is that V9B does not include Old and Middle River flow criteria, whereas V9BOMR does. This affects the availability of Delta surplus for island diversion and export pumping capacity for island discharge. It also affects unmet south-of-Delta water demand and available conveyance capacity in the California Aqueduct. By selecting the CalSim baseline, the IDSM user defines the Delta conditions for evaluation of the Project. IDSM can incorporate new CalSim baselines as necessary.

CalSim II baseline and fish action selection

This section allows the user to select a fish action regulatory baseline. The two baselines provided are (1) V9B with no OMR criteria and (2) V9BOMR which includes the most stingent OMR criteria in the Wanger Decision.

Select Baseline Fish Action 1

1	V9B	CalSimO	CalSimO	Remedy/	QwestV9	OMR_Hu	CalSimInputV9B	CalSimOutV9B
2	V9BOMR	CalSimO	CalSimO	Remedy/	QwestV9	OMR_Hu	CalSimInputV9B	CalSimOut_CAV9B
								RemedyActionV9B
								QwestV9B
								OMR_Hutton
								CalSimInputV9B

Figure A-4. User Selection of the CalSim Baseline in the Control Worksheet

The next section of user input is to define diversion and discharge for export rules for the island reservoirs when OMR flow criteria are controlling Delta exports (Figure A-5). Rules can vary by island and month. For diversion or discharge, the first option the user has is to turn the rules off or on: "0" or "1", respectively. In the monthly tables, the user can specify a flow diversion or discharge restriction to apply (0 cfs or greater) when OMR flow criteria restrict Delta exports. (Note that these restrictions will only be applied when the CalSim baseline with OMR flow criteria is selected-V9BOMR.) IDSM also reevaluates OMR flow under Project operations to determine if island diversion or discharge for export creates an OMR flow criteria control. Diversions to Bacon or Webb will not change OMR flow, but discharges for export from Bacon or Webb will reduce OMR flow (i.e., greater reverse OMR).

IDS Allowed Diversions/Discharges Under Remedy Actions (Only applies for OMR flow criteria baselines)

Webb Tract allowed diversion when a Remedy Action is controlling exports.

		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
	Off(0)/On(1)	1	2	3	4	5	6	7	8	9	10	11	12	
Webb maximum diversion	0	0	0	0	0	0	0	0	0	0	0	0	0	cfs
		0	0	0	0	0	0	0	0	0	0	0	0	off(0)/on(1)

Webb Tract allowed discharge for export when a Remedy Action is controlling. Allowance of diversions preempts allowance of discharge.

		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
	Off(0)/On(1)	1	2	3	4	5	6	7	8	9	10	11	12	
Webb max. exp. dis.	1	0	0	0	0	0	0	0	0	0	0	0	0	cfs
		0	0	0	0	0	0	0	0	0	0	0	0	cfs
		1	1	1	1	1	1	1	1	1	1	1	1	off(0)/on(1)

Bacon Island allowed diversion when a Remedy Action is controlling exports.

		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
	Off(0)/On(1)	1	2	3	4	5	6	7	8	9	10	11	12	
Bacon maximum diversion	1	0	0	0	0	0	0	0	0	0	0	0	0	cfs
		1	1	1	1	1	1	1	1	1	1	1	1	off(0)/on(1)

Bacon Island allowed discharge for export when a Remedy Action is controlling. Allowance of diversions preempts allowance of discharge.

		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
	Off(0)/On(1)	1	2	3	4	5	6	7	8	9	10	11	12	
Bacon max. exp. Dis.	0	0	0	0	0	0	0	0	0	0	0	0	0	cfs
		0	0	0	0	0	0	0	0	0	0	0	0	cfs
		0	0	0	0	0	0	0	0	0	0	0	0	off(0)/on(1)

Figure A-5. User-Defined Project Diversion and Discharge Operations under OMR Flow Criteria

IDSM allows user-specified diversions under the OMR criteria. It also allows user- specified discharge for export under the criteria. However, for a given island in a given month, IDSM does not allow the user to specify both allowed diversions and discharges. If the user specifies both, IDSM ignores the discharge for export allowance. Enabling both diversion and discharge in a given month would defeat the purpose of the fish protection measures

The user-specified controls for Project diversions, as shown in Figure A-6, take the form of the major D-1643 constraints (shown in Figure A-1). The purpose was to allow the user to apply the original D-1643 constraints, or to test changes in those constraints to match changes in Delta regulations. In the Diversion Criteria section of the Control worksheet, there is a cell for specifying an initial X2 trigger location, a monthly table for limiting diversions by percentage of Delta surplus and maintaining a minimum QWEST. Monthly allowances for topping off—diversions to replenish storage lost to evaporation—are also included. Similar constraints on Project operations were part of D-1643. In some cases, the original D-1643 daily constraints were simplified to fit the monthly time-step of IDSM.

Diversion Criteria

Total diversion capacity to the islands was specified as 9000 cfs in the original permit application. At a monthly timestep, this will never bound diversions due to storage capacity limits.

Total Diversion

Max. Total Diversion Rate	4000	cfs
Initial X2 trigger	81	D1643 specifies that X2 must be downstream of Chipps Island (75 km) for 10 days prior to initial water year diversions

The following table sets montly diversion constraints and triggers as expressed in D1643 and associated documents.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
	1	2	3	4	5	6	7	8	9	10	11	12	month number
Diversion Allowed (1=yes, 0=no)	1	1	1	1	1	1	0	0	1	1	1	1	trigger
no div is X2 east of	81	81	81	81	74	74	74	74	81	81	81	81	km
% of Delta Surplus	100	100	100	100	100	100	100	100	100	100	100	100	%
% of previous outflow	25	25	25	25	25	25	0	0	25	25	25	25	%
% of SJR	999	999	999	999	999	999	999	999	999	999	999	999	%
Qwest Minimum (cfs)	-20000	-20000	-20000	-20000	-20000	-20000	-20000	-20000	-20000	-20000	-20000	-20000	cfs
Qwest Diversion Limit (cfs)	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	cfs
DXC closed													
Delta inflow <30,000 cfs	9999	3000	3000	3000	9999	9999	9999	9999	9999	9999	9999	9999	cfs
Delta inflow >30,000 cfs	9999	4000	4000	4000	9999	9999	9999	9999	9999	9999	9999	9999	cfs

Lookup table to constrain diversions according to X2 location as specified in D1643.

	X2	div rate
X2<80km	0	9999
X2>80km	80	2000
X2>81km	81	1000

Habitat Island Diversion	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
	1	2	3	4	5	6	7	8	9	10	11	12	
Diversion (cfs)	30.9	28.6	30.9	3.3	19.8	0.0	0.0	6.5	50.4	58.5	42.3	45.4	cfs

Allowed Topping Off (must subtract Habitat Isl. Div)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
	1	2	3	4	5	6	7	8	9	10	11	12	
Diversion (cfs)	33	0	0	0	0	0	0	0	215	270	200	100	cfs

Webb Tract

Max. Webb Diversion Rate	2000	cfs
Maximum annual diversion	155	taf
Maximum diversion Dec 15 -Mar 31	106.900	taf

Bacon Island

Max. Bacon Diversion Rate	2000	cfs
Maximum annual diversion	147.000	taf
Maximum diversion Dec 15 - Mar31	110.570	taf

Figure A-6. User-Defined Project Diversion Criteria with Flexibility to Implement D-1643 Specifications

Figure A-7 shows Project discharge criteria input in the Control worksheet. Again, input flexibility to apply D-1643 discharge criteria or test changes in these criteria was provided. This included limits on the percentage of available export capacity available for Project transfers, limits on Webb Tract discharge for export from February to June, and percentage of San Joaquin River flow limits placed on Bacon Island. The Project discharges can be constrained by the D-1641 E/I ratio or allowed to exceed the E/I ratio. The user can modify these constraints as necessary.

Discharge Criteria

Combined Discharge

Maximum discharge rate	4000	cfs
Maximum export of stored water	250	taf

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
	1	2	3	4	5	6	7	8	9	10	11	12	month number
% of available export capacity	100	100	100	100	75	50	50	50	50	75	100	100	%

Webb Island

Maximum discharge rate	2000	cfs

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
	1	2	3	4	5	6	7	8	9	10	11	12	month number
Discharge (1=yes, 0=no)	1	1	1	0	0	0	0	0	0	1	1	1	trigger
% of available export capacity	100	100	100	100	0	0	0	0	0	75	100	100	%

Bacon Island

Maximum discharge rate	2000	cfs

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
	1	2	3	4	5	6	7	8	9	10	11	12	month number
Discharge (% of SJR)	999	999	999	999	999	999	50	50	50	999	999	999	%
% of available export capacity	100	100	100	100	75	50	50	50	50	75	100	100	%

Figure A-7. User-Defined Project Discharge for Export Criteria with Flexibility to Implement D-1643 Specifications

Some D-1643 constraints, such as those tied to the Fall Midwater Fish Trawl (FMWT) delta smelt index, cannot be modeled in a simulation model like IDSM. Accordingly, there is no alteration of diversion or discharge constraints based on the FMWT index value. The diversion and discharge constraints are consistently applied as specified in the Control worksheet for each year of the simulation. Furthermore, IDSM does not constrain island diversions or discharge based on water quality operating criteria which are specified in various Protest Dismissal Agreements. Analyses related to FMWT criteria and water quality operating criteria must be conducted outside the context of the IDSM.

In the section shown in Figure A-8, the IDSM user can specify a month at which the contents of the reservoir will be released for Delta outflow when storage exceeds a user specified level. Unique rules can be applied to each island. The current model implementation gives priority to discharge for export, if the opportunity arises, over discharge for outflow. The purpose of this control is to allow the user to empty the island reservoirs by a given month each year to reduce the accumulation of salinity and TOC in the stored water.

End of Year Storage Release

Select the wateryear month to release all remaining Delta Wetlands storage (Oct = 1). To turn off select 0 for month.

	WY Month	Storage Trigger Level (TAF)
Select month to release remaining water from Webb	2	0
Select month to release remaining water from Bacon	2	0

Figure A-8. User-Defined Month to Release Reservoir Contents when Storage Exceeds a Specified Level

Figure A-9 shows the Control worksheet section where the user specifies the project allocation under which SWP and CVP contractors would request Project water from the islands or stored in groundwater banks. The allocation trigger for both the SWP and CVP is set at 90% in Figure A-9. In this case, if SWP allocations were higher than 90% in a given year, SWP contractors would not request Project water in that year. Project water could still be stored in groundwater banks when not needed for direct delivery. Place of use can be limited by specifying the percent of unmet SWP and CVP demand that can be delivered from the Project islands or groundwater bank.. For instance, assume the Project identifies a number of SWP contractors that represent 50% of Table A water demands. The IDSM user would enter 50% next to SWP for "percent of demand to meet." This would limit delivery of Project water to SWP contractors with 50% of unmet Table A demands.

SWP and CVP Demand Triggers, Place of Use Limitations, and Direct Transfer Restrictions

Enter percent allocation below which Delta Wetlands water will be purchased for direct delivery or groundwater extraction. Presently, groundwater reserved for SWP use.

	Allocation Trigger	Percent Demand to meet
SWP	90%	50%
CVP	90%	50%

The following triggers are for direct delivery from IDS to SWP and CVP contractors.

Use Banks and Jones to meet unmet CVP demands, JPOD (1=yes,0=no)	1
Use Banks to meet unmet SWP demands (1=yes,0=no)	1

Figure A-9. Direct Transfer and Place of Use Limits

The Project has identified four groundwater banks to store its water during wet years when unmet demand in the designated places of use are low. They are Antelope Valley Water Bank, Stored Water Recovery Unit, Original Semitropic Water Storage District, and Semitropic Water Storage District. In the Control worksheet, as shown in Figure A-10, the user can define, for each bank, maximum storage capacity, maximum monthly and annual put rates, and maximum monthly and annual take rates. Also, a loss factor can be set for each water bank. The loss is set as a percentage of groundwater bank puts.

Ground Water Banks		
Antelope Valley Water Bank (AVWB)		
Maximum storage (1000 AF)	500	*Set to 0 to turn off AVWB.*
Initial Storage	0	
Losses (% of put)	0%	
Maximum Put (cfs)	350	
Maximum Put (TAF / Year)	100	
Maximum Take (cfs)	250	
Maximum Take (TAF / Year)	100	
Stored Water Recovery Unit (SWRU)		
Maximum storage (1000 AF)	450	*Set to 0 to turn off SWRU.*
Initial Storage	0	
Losses (% of put)	0%	
Maximum Put (cfs)	420	270-420
Maximum Put (TAF / Year)	50	
Maximum Take (cfs)	420	
Maximum Take (TAF / Year)	150	150-283
Original Semitropic Water Storage District (OSWSD)		
Maximum storage (1000 AF)	1000	*Set to 0 to turn off OSWSD.*
Initial Storage	0	
Losses (% of put)	0%	
Maximum Put (cfs)	530	
Maximum Put (TAF / Year)	100	90.5-350
Maximum Take (cfs)	300	
Maximum Take (TAF / Year)	100	90-223
Semitropic Water Storage District (SWSD)		
Maximum storage (1000 AF)	66.7	*Set to 0 to turn off SWSD.*
Initial Storage	0	
Losses (% of put)	0%	
Maximum Put (cfs)	100	
Maximum Put (TAF / Year)	30.015	
Maximum Take (cfs)	100	
Maximum Take (TAF / Year)	19.143	

Figure A-10. Groundwater Bank Specifications

IDSM tracks salinity impacts at various Delta locations using the G-Model[1]. (The G-Model is a salinity-outflow relationship based on a set of empirical equations.) The islands divert water during high flow periods when Delta salinity is low, and the islands release water during low flow periods when Delta salinity is high. Project releases for Delta outflow can help push seawater downstream. The Control worksheet section shown in Figure A-11 provides the user some options for Project water quality releases along with some discharge for export flexibility under D-1641 regulations. The first yellow cell in Figure A-11 allows the user to decide whether the Project can discharge for export when the export to inflow ratio specified in D-1641 is controlling exports. If yes (1), Project discharge can be exported without regard to the E/I ratio. The next user settings are for "carriage water" (fraction of discharge reserved for outflow) to be paid for export of Project water. The constraints can be turned on (1) or off (0), and the carriage is set as a percentage of discharge for export by month. The next user control in Figure A-11 allows discharge for export when D-1641 Delta salinity standards are otherwise controlling Delta inflow or exports. The user enters "1" to allow it, or "0" to not. The last user control in Figure A-11 allows for Project water quality releases at specified Rock Slough chloride concentrations. The constraint can be turned on or off and the maximum water quality release and the water quality trigger are specified by month.

[1] Denton, R.A. (1993). *Accounting for Antecedent Conditions in Seawater Intrusion Modeling – Applications for the San Francisco Bay-Delta.* Hydraulic Engineering 93, Vol1 pp. 448-453. Proceedings of the ASCE National Conference on Hydraulic Engineering, San Francisco.

Delta Salinity and Export to Inflow Ratio

G model parameters for water quality

	Rock Slough	Rock Slough	Jersey Point	Emmaton	Collinsville	Mallard
	Chloride	EC	EC	EC	EC	EC
A	16.5	150	150	150	150	150
B	2200	5000	8000	10000	25000	30000
C	0.0006	0.0005	0.0004	0.0004	0.0003	0.00025

Quality = A + B * EXP(-C * Delta Outflow)

Export to Inflow Ratio

Allow discharge export when EI Ratio controls (1=yes, 0=no): 1 — 1 indicates that E/I does not limit discharge for export, suggest setting to 0

Carriage Water

Manual Carriage Setting: 0 — Turns on/off discharge for export carriage costs in table below.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	1	2	3	4	5	6	7	8	9	10	11	12
CW all months	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%

ANN Control of Discharge for Export

Allow export when ANN controls WQ (1=yes, 0=no): 1

The water quality release will occur when concentrations exceed the specified trigger level.

Release for Delta water quality (1=yes, 0=no): 0

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	1	2	3	4	5	6	7	8	9	10	11	12
Max release for WQ (cfs)	1000	1000	1000	0	0	0	0	0	0	0	0	1000
Rock Slough CL trigger (mg/L)	150	150	150	150	150	150	150	150	150	150	150	150

Figure A-11. Discharge for Export Constraints Pertaining to Water Quality Standards and the Delta Export to Inflow Ratio

Figure A-12 shows a section in the Control worksheet where the user can expand Banks permitted capacity by month. The user specified flow is added to the monthly permitted capacity as determined from the CalSim baseline. The user can turn off any specified additional monthly permitted capacity by using the switch at the top of the table.

Expanded Banks Permitted Pumping Capacity

Expand Permitted Capacity (0 = no, 1 = yes): 0

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	1	2	3	4	5	6	7	8	9	10	11	12
Expanded Capacity (cfs)	0	0	0	0	0	0	0	0	0	1820	1820	1820

Figure A-12. User Defined Additional Permitted Banks Pumping Capacity

Figure A-13 allows the user to open the Delta Cross Channel gates in months that the CalSim baseline closes the gates for a portion or the entire month. The purpose is to boost QWEST when Project diversion operations are constrained by QWEST minimum flows. A switch is provided for the user to turn the monthly Delta Cross Channel settings off.

Delta Cross Channel Operation

Reoperate Gate (0 = no, 1 = yes): 0

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	1	2	3	4	5	6	7	8	9	10	11	12
Month to open (1 = open all month, 0 = base operation)	0	0	0	1	1	1	1	1	1	0	0	0

Figure A-13. User Control of the Delta Cross Channel Operation

A section in the Control worksheet also allows the user to size the island reservoirs and set monthly evaporation rates. This section is shown in Figure A-14.

Webb and Bacon Storage Capacity, Storage-Area Curves and Evaporation Rates

Webb Tract Max Storage	100.664	TAF		
Webb Tract Storage-Area Curve				
Storage (acre-ft)	0	37442	100664	
Area (acres)	0	5097	5374	
Bacon Island Max Storage	114.965	TAF		
Bacon Island Storage Area Curve				
Storage (acre-ft)	0	18707	114965	
Area (acres)	0	5301	5450	

Evaporation Rates were obtained from the DWR CalSim studies. As I recall, they were based on historical pan evaporation rates as measure on some Delta island.

	Off(0)/On(1)												
IDS Evap Rate	1												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
	1	2	3	4	5	6	7	8	9	10	11	12	
Evap (inches)	1.4	1.1	0.6	0.7	1.5	2.1	2.7	3.8	4.9	5.8	4.3	2.3	inches

Figure A-14. Webb and Bacon Storage Capacity, Storage-Area Curve, and Evaporation Rate Settings

IDSM Output Tables and Graphs

There are several IDSM worksheets provided to help the user review simulation results. In worksheet TS_plot, monthly Project operations with resulting changes in Delta outflow, exports, groundwater bank storage, and south-of-Delta operations are plotted over the water year 1922–2003 period of simulation. An example plot, containing 10 years of the 82 year simulation, of Webb Tract and Bacon Island storage is provided in Figure A-15. The timeseries plots are organized so that the model user can trace operations from month to month and determine the reasons for diversion and discharge decisions and the destination of island discharge.

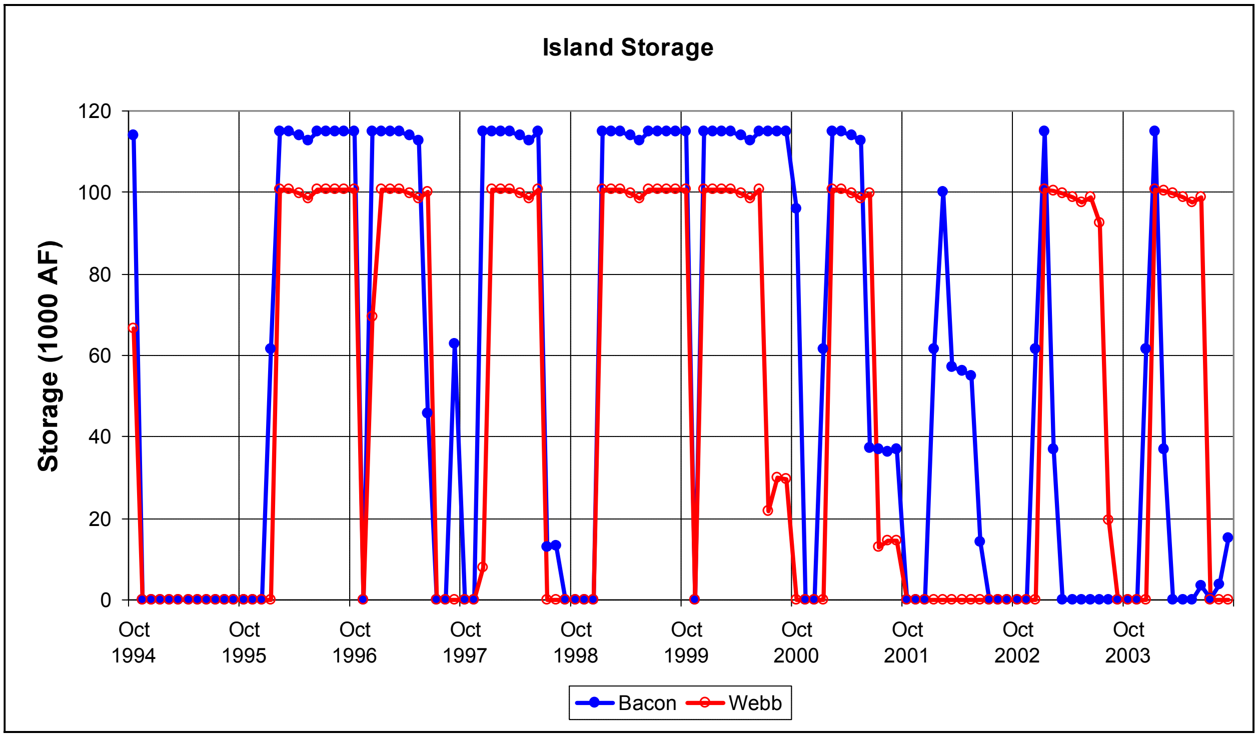


Figure A-15. Example Plot of Monthly Island Storage from the TS_plot Worksheet

IDSM results are also summarized in annual plots and tables. Figure A-16 contains a plot of annual discharge for export and specifies whether the water is delivered to SWP contractors, CVP contractors, or groundwater banks. Figure A-17 is an example table of annual average analysis of Project operations provided in Ann_plot. The Ann_plot worksheet also includes information on available Delta surplus, island diversions, discharge for Delta outflow, SWP and CVP contractor deliveries, and other key operational variables.

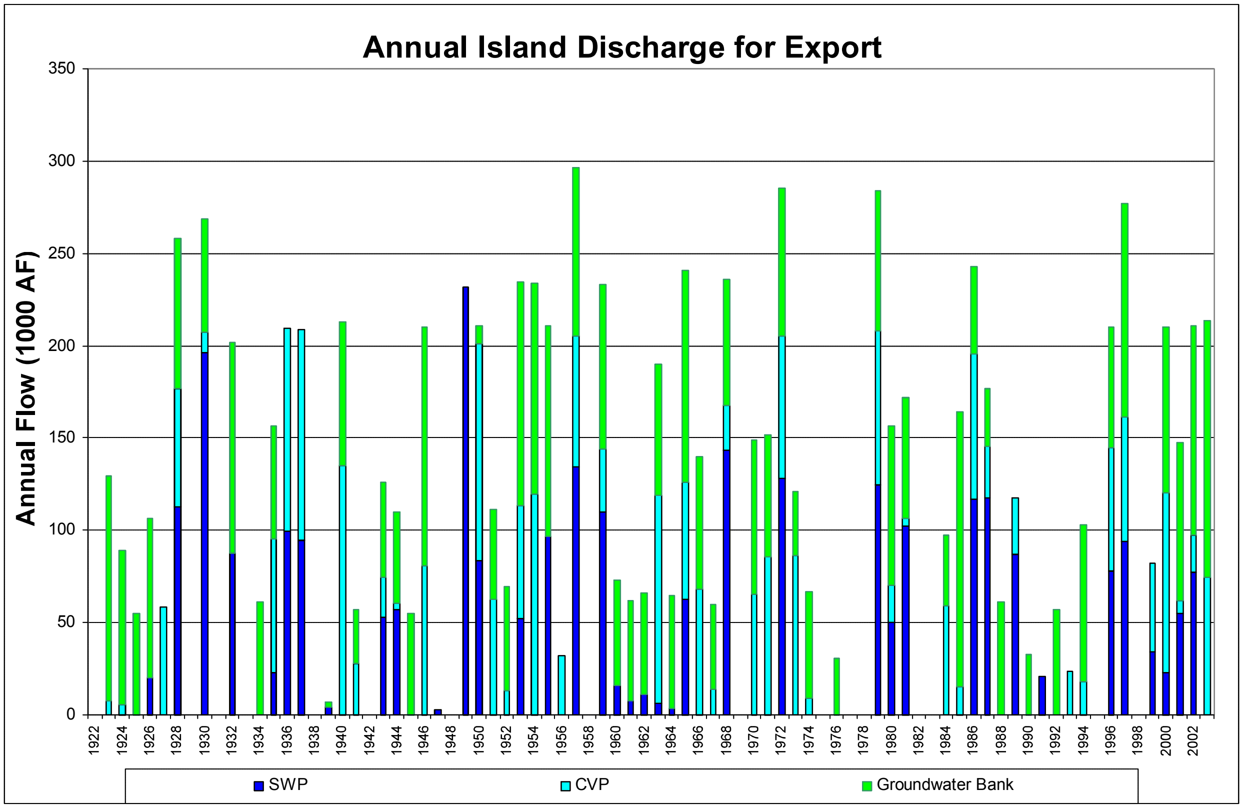


Figure A-16. Example Annual Plot of Island Discharge for Export from the Ann_plot Worksheet

Island Discharge (TAF/year)								
Sac Index WY Type	Direct SWP Delivery	Direct CVP Delivery	AVWB Put	SWRU Put	OSWSD Put	SWSD Put	Delta Outflow Release	Total
W	19	34	17	12	8	1	77	167
AN	27	63	29	24	9	1	33	187
BN	58	56	23	21	13	1	63	236
D	65	7	23	24	13	1	20	152
C	2	2	13	12	9	1	26	64
ALL	34	31	20	18	10	1	48	163

Figure A-17. Example Table of Annual Average Island Discharge by Purpose and Water Year Type as Found in the Ann_plot Worksheet

Another helpful tool for reviewing IDSM output is the IDSM schematic (worksheet System Schematic) as shown in Figure A-18. Using the buttons seen at the top left corner, the user can step through the current IDSM simulation month by month and view the CalSim baseline boundary conditions and associated Project operations. Enough detail is provided to allow the user to diagnose the controlling constraints in each time-step whether its available Delta surplus, available export capacity, or south-of-Delta demand. The schematic also compares baseline X2, Delta outflow, Qwest, OMR flow, and exports to the updated values that incorporate the effects of island diversion and discharge.

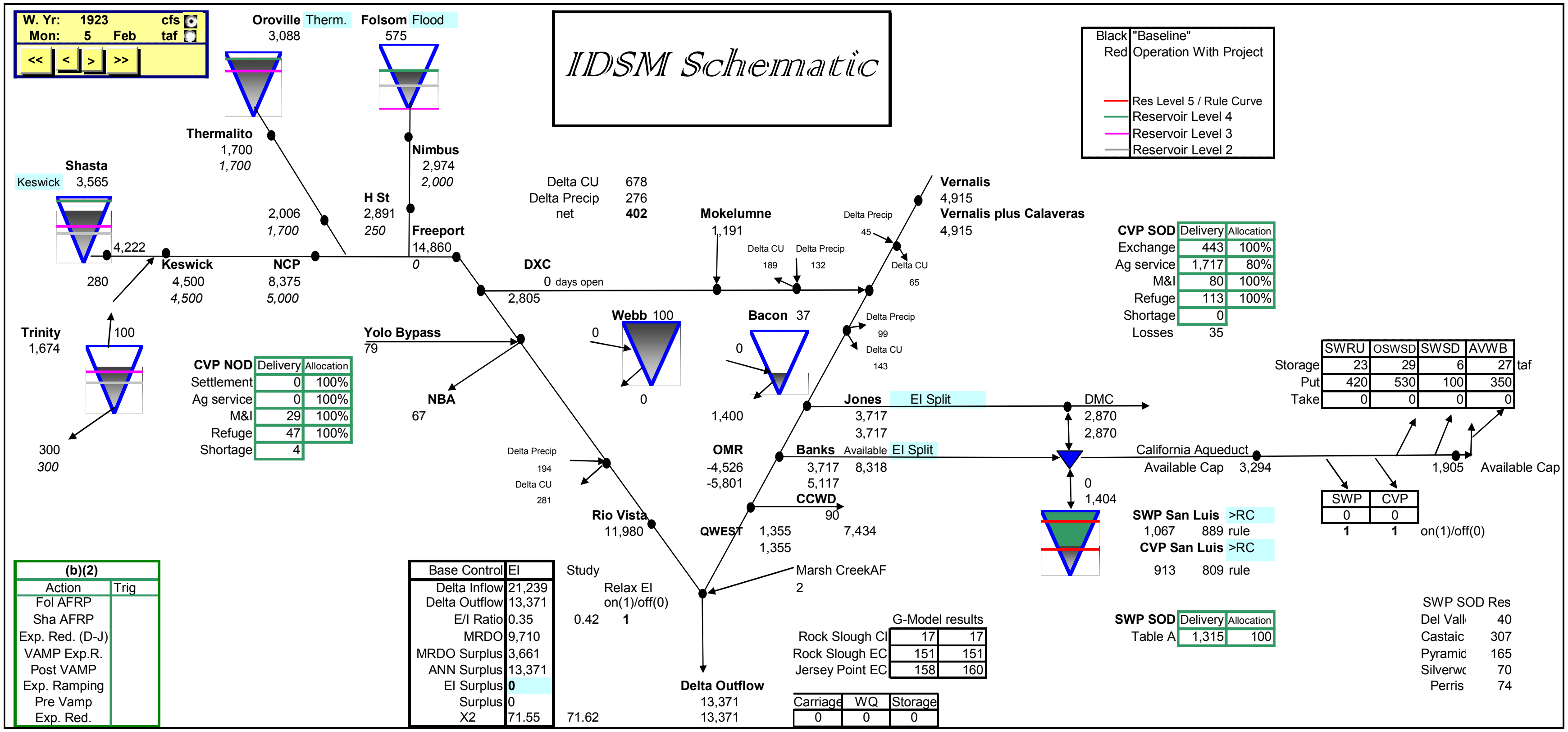


Figure A-18. IDSM Schematic Allows Model Users to Step Through Simulations Month-by-Month to View Results and Analyze Constraints

Attachment 1
Columns and Simulation Equations in the IDSM Worksheet Model

Heading	Sub-Heading / variable description	Column Title	Units:	Column	Formula / data
		Wateryear.mon		A	1922.01
		Water year		B	=INT(A13)
		Mon Num		C	1
		Month		D	Oct
		Sac River Index SRI		E	=VLOOKUP($B13,'River Indices'!$A$3:$C$84,3)
		San Joaquin River Index SJRI		F	=VLOOKUP($B13,'River Indices'!$A$3:$F$84,6)
		Days in month	Units:	G	=Conversions!D13
From CalSim "Baseline"	INFLOW	Delta inflow	cfs	H	=HLOOKUP(H$9,CalSimOut!$C$2:$IV$996,'Control Calc'!$A13,FALSE)
	X2_PRV	"Baseline" Previous month X2 position	km	I	=HLOOKUP(I$9,CalSimOut!$C$2:$IV$996,'Control Calc'!$A13,FALSE)
	D419	Banks Pumping	cfs	J	=HLOOKUP(J$9,CalSimOut!$C$2:$IV$996,'Control Calc'!$A13,FALSE)
		Available Banks capacity	cfs	K	=MAX('Export Control'!M13-'Export Control'!E13,0)
	S12	SWP San Luis	TAF	L	=HLOOKUP(L$9,CalSimOut!$C$2:$IV$996,'Control Calc'!$A13,FALSE)
	swp_in_total	Total Article 21	cfs	M	=HLOOKUP(M$9,CalSimOut!$C$2:$IV$996,'Control Calc'!$A13,FALSE)
	D418	Jones Pumping	cfs	N	=HLOOKUP(N$9,CalSimOut!$C$2:$IV$996,'Control Calc'!$A13,FALSE)
		Available Jones capacity	cfs	O	=MAX('Export Control'!AB13-'Export Control'!D13,0)
	S11	CVP San Luis	TAF	P	=HLOOKUP(P$9,CalSimOut!$C$2:$IV$996,'Control Calc'!$A13,FALSE)
		EI Surplus	cfs	Q	='Control Calc'!CN13
		WQ (ANN) Surplus	cfs	R	='Control Calc'!CM13
		Exportable Delta Surplus	cfs	S	='Control Calc'!CQ13
		"Baseline" Total Delta Outflow	cfs	T	='Control Calc'!CL13
	D407	Required Delta Outflow	cfs	U	=HLOOKUP(U$9,CalSimOut!$C$2:$IV$996,'Control Calc'!$A13,FALSE)
	C639	San Joaquin River at Vernalis	cfs	V	=HLOOKUP(V$9,CalSimOut!$C$2:$IV$996,'Control Calc'!$A13,FALSE)
	C400	Sac River at Freeport	cfs	W	=HLOOKUP(W$9,CalSimOut!$C$2:$IV$996,'Control Calc'!$A13,FALSE)
	DXC	Number of Days Cross Channel Gate Open	days/month	X	=HLOOKUP(X$9,CalSimOut!$C$2:$IV$996,'Control Calc'!$A13,FALSE)
	Qwest	Qwest	cfs	Y	=HLOOKUP(Y$9,Qwest!$C$2:$E$996,'Control Calc'!$A13,FALSE)
	C401B	DXC + Geo. Slough	cfs	Z	=HLOOKUP(Z$9,CalSimOut!$C$2:$IV$996,'Control Calc'!$A13,FALSE)
	EXPRATIO_	E/I Ratio		AA	=HLOOKUP(AA$9,CalSimOut!$C$2:$IV$996,'Control Calc'!$A13,FALSE)
		AprMay Exp Ctrl		AB	='Export Control'!AC13
		AprMay Tracy Ctrl		AC	='Export Control'!AD13
		AprMay Banks Ctrl		AD	='Export Control'!AE13
	SWP_PERDELDV	SWP Allocation (%)		AE	=HLOOKUP(AE$9,CalSimOut!$C$2:$IV$996,'Control Calc'!$A13,FALSE)
		SWP Demand Trigger		AF	=IF(AE13<$AF$1,IF(OR(C13<3,C13>7,),1,0),0)
	SWP_TA_TOTAL	SWP Table A Delivery		AG	=HLOOKUP(AG$9,CalSimOut!$C$2:$IV$996,'Control Calc'!$A13,FALSE)
	SHORT_SWP_TOT_	SWP SOD Shortage		AH	=HLOOKUP(AH$9,CalSimOut!$C$2:$IV$996,'Control Calc'!$A13,FALSE)
		SWP Table A Request		AI	=MIN((AG13+AH13)/AE13,500/Conversions!C13)
		Unmet SWP demand		AJ	=MAX(0,MIN(AI13-AG13,'Graph Calcs'!AS13/Conversions!C13-Model!AG13))
		SWP Demand for Additional Supply		AK	=AJ13*AF13*AK$1
	SWP_CO_TOTAL	SWP Article 56 Delivery		AL	=HLOOKUP(AL$9,CalSimOut!$C$2:$IV$996,'Control Calc'!$A13,FALSE)
	PERDV_CVPAG_S	CVP Allocation (%)		AM	=HLOOKUP(AM$9,CalSimOut!$C$2:$IV$996,'Control Calc'!$A13,FALSE)
		CVP Demand Trigger		AN	=IF(AM13<$AN$1,IF(OR(C13<3,C13>8,),1,0),0)
	DEL_CVP_PAG_S	CVP SOD AG Delivery		AO	=HLOOKUP(AO$9,CalSimOut!$C$2:$IV$996,'Control Calc'!$A13,FALSE)
		CVP SOD AG Request		AP	=IF(AM13=0,0,AO13/AM13)
		Unmet CVP demand		AQ	=AP13-AO13
		CVP Demand for Additional Supply		AR	=AQ13*AN13*AR$1
	I410	Delte Precipitation	cfs	AS	=HLOOKUP(AS$9,CalSimIn!$C$2:$IV$996,'Control Calc'!$A13,FALSE)
	I412	Delte Precipitation	cfs	AT	=HLOOKUP(AT$9,CalSimIn!$C$2:$IV$996,'Control Calc'!$A13,FALSE)
	DEMAND_D410	Delta CU	cfs	AU	=HLOOKUP(AU$9,CalSimIn!$C$2:$IV$996,'Control Calc'!$A13,FALSE)/Conversions!C13
	DEMAND_D412	Delta CU	cfs	AV	=HLOOKUP(AV$9,CalSimIn!$C$2:$IV$996,'Control Calc'!$A13,FALSE)/Conversions!C13
		NDCU for South Delta	cfs	AW	=AU13-AS13+AV13-AT13
	D418	Jones Delta Export	cfs	AX	=HLOOKUP(AX$9,CalSimOut!$C$2:$IV$996,'Control Calc'!$A13,FALSE)
	D419	Banks Delta Export	cfs	AY	=HLOOKUP(AY$9,CalSimOut!$C$2:$IV$996,'Control Calc'!$A13,FALSE)
	D408	CCWD Export	cfs	AZ	=HLOOKUP(AZ$9,CalSimOut!$C$2:$IV$996,'Control Calc'!$A13,FALSE)
		South Delta Diversions	cfs	BA	=SUM(AW13:AZ13)
		Trigger for Water Quality Demand		BB	='Control Calc'!DM13
		B2 Delta Action (0=yes, 1=no)		BC	='Control Calc'!DN13

Base Delta Conditions		"Baseline" Previous month X2 position	km	BD	=122.2+0.3278*BD13-17.65*LOG(BE13,10)
		Delta Outflow	cfs	BE	=T13
		Gmodel Ending Antecedent		BF	=BE13/(1+(BE13/BF12-1)*EXP(-BE13/6000))
		Gmodel Effective Outflow		BG	=BE13+6000*LN(BF12/BF13)
	OMR	OMR Flow	cfs	BH	=HLOOKUP(BH$9,OMR!$C$2:$D$996,'Control Calc'!$A13,FALSE)
		QWEST	cfs	BI	=Y13
		QWEST with DXC gate reop	cfs	BJ	=BI13+Control!$B$250*HLOOKUP($C13,Control!$B$252:$M$253,2,FALSE)*(0.133*W13+829+0.16*W13+1261-Z13)
	Water Quality from G Model	Rock Slough	Chloride	BK	=Control!C$200+Control!C$201*EXP(-Control!C$202*$BG13)
		Rock Slough	EC	BL	=Control!D$200+Control!D$201*EXP(-Control!D$202*$BG13)
		Jersey Point	EC	BM	=Control!E$200+Control!E$201*EXP(-Control!E$202*$BG13)
		Emmaton	EC	BN	=Control!F$200+Control!F$201*EXP(-Control!F$202*$BG13)
		Collinsville	EC	BO	=Control!G$200+Control!G$201*EXP(-Control!G$202*$BG13)
		Mallard	EC	BP	=Control!H$200+Control!H$201*EXP(-Control!H$202*$BG13)
Study Delta Conditions		Previous month X2 position	km	BQ	=122.2+0.3278*BQ13-17.65*LOG(BS13,10)
		Delta Water Quality Demand	cfs	BR	=IF(BK13>HLOOKUP(C13,Control!$B$221:$M$223,3,FALSE),HLOOKUP(C13,Control!$B$221:$M$222,2,FALSE),0)*$BR$1
		Delta Outflow	cfs	BS	=BE13-DO13-EB13+ET13
		Gmodel Ending Antecedent		BT	=BS13/(1+(BS13/BT12-1)*EXP(-BS13/6000))
		Gmodel Effective Outflow		BU	=BS13+6000*LN(BT12/BT13)
		Change in Banks Export	cfs	BV	=MIN(DI13,EP13)
		Change in Jones Export	cfs	BW	=EP13-BV13
		Banks Export	cfs	BX	=BV13+AY13
		Jones Export	cfs	BY	=BW13+AX13
		OMR Flow	cfs	BZ	=BH13+EP13*OMR!D13
		Qwest with DXC gate reop	cfs	CA	=BJ13+DP13+EC13-DO13-EB13-BV13-BW13
	Water Quality from G Model	Rock Slough	Chloride	CB	=Control!C$200+Control!C$201*EXP(-Control!C$202*$BU13)
		Rock Slough	EC	CC	=Control!D$200+Control!D$201*EXP(-Control!D$202*$BU13)
		Jersey Point	EC	CD	=Control!E$200+Control!E$201*EXP(-Control!E$202*$BU13)
		Emmaton	EC	CE	=Control!F$200+Control!F$201*EXP(-Control!F$202*$BU13)
		Collinsville	EC	CF	=Control!G$200+Control!G$201*EXP(-Control!G$202*$BU13)
		Mallard	EC	CG	=Control!H$200+Control!H$201*EXP(-Control!H$202*$BU13)

Diversion to Storage Constraints	Initial X2 delay and ramping	Days in month X2 west of Chipps	days/month	CH	=INT(IF(AND(BD13<Control!$B$56,BD14<Control!$B$56),G13,IF(AND(BD14<Control!$B$56,BD13>=Control!$B$56),G13/(BD14-BD13)*(BD14-Control!$B$56),0)))
		10 day X2 west of Chipps trigger	days	CI	=IF(C13=1,MIN(CH13,10),IF(CI12+CH13>=10,10,CH13))
		Diversion days	days/month	CJ	=IF(AND(C13=1,CI13>=10),CH13-CI13,IF(AND(CI13>=10,CI12>=10),G13,IF(AND(CH12>0,CI13>=10),G13-CI13+CI12,IF(CI13>=10,CH13-CI13,0))))
		Diversion Ramping days	days/month	CK	=IF(C13=1,MIN(CJ13,5),IF(CJ12>=5,0,IF(CJ13<5,CJ13,5-CK12)))
		Percent of month full diversion allowed	%	CL	=MIN(1,(CJ13-CK13)/G13)*100
		Percent of month diversion up to 5,500cfs allowed	%	CM	=CK13/G13*100
		X2 delay and ramping diversion constraint	cfs	CN	=CL13/100*9000+CM13/100*5500
		X2 constraint X2>81=500 cfs X2>80=1000cfs	cfs	CO	=VLOOKUP(BQ13,Control!$B$74:$C$76,2)
		No diversion if X2>value	cfs	CP	=IF(AND(BQ13>HLOOKUP(C13,Control!$B$60:$M$62,3),I14>HLOOKUP(C13,Control!$B$60:$M$62,3)),0,9000)
		Diversion Allowed	cfs	CQ	=IF(HLOOKUP($C13,Control!$B$60:$M$61,2)=0,0,9000)
		X2 Shift diversion constraint	cfs	CR	=MAX(0,IF(AND(C13>=1,C13<=6),T13-10^((122.2 + 0.3278*I13-I14-2.5)/17.65),9000))
	Total	Maximum Diversion Rate	cfs	CS	=CS$1
	Webb	Maximum Diversion Rate to Webb	cfs	CT	=CT$1
	Bacon	Maximum Diversion Rate to Bacon	cfs	CU	=CU$1
		Percent of Delta Surplus	cfs	CV	=HLOOKUP($C13,Control!$B$60:$M$63,4)/100*S13
		Percent of Delta Outflow	cfs	CW	=HLOOKUP($C13,Control!$B$60:$M$64,5)/100*T13
		Max Diversions from Dec to Mar	cfs	CX	=IF(OR(C13<4,C13>6),0,MAX(CX12,EO12))
		Percent of SJR from Dec to Mar	cfs	CY	=IF(OR(C13<3,C13>6,AND(C13>3,OR(CX12>1000,CX12>CY12-100))),9000,HLOOKUP($C13,Control!$B$60:$M$65,6)/100*V13)
		Qwest Constraint	cfs	CZ	=MAX(0,BJ13-HLOOKUP(C13,Control!$B$60:$M$70,7,FALSE),HLOOKUP(C13,Control!$B$60:$M$70,8,FALSE))
		DXC Constraint	cfs	DA	=IF(H13>30000,HLOOKUP(C13,Control!$B$60:$M$70,11,FALSE)*(G13-X13)/G13,HLOOKUP(C13,Control!$B$60:$M$70,10,FALSE)*(G13-X13)/G13)+MIN(CN13,CO13,CP13,CQ13,CR13,CS13,CV13,CW13,CY13,CT13+CU13,CZ13)*X13/G13
		Maximum diversion to IDS	cfs	DB	=MIN(CN13,CO13,CP13,CQ13,CR13,CS13,CV13,CW13,CY13,CT13+CU13,CZ13,DA13)
Discharge Constraints		Carriage Water %		DC	=HLOOKUP($C13,Control!$B$212:$M$213,2,FALSE)*DC$1
		Maximum Discharge Rate	cfs	DD	=DD$1
		Max Export under VAMP	cfs	DE	=IF(OR(C13<7,C13>8,DE$1=0),15000,MIN(AB13-AX13-AY13,AC13+AD13-AX13-AY13))
		Max Export under EI	cfs	DF	=MAX(99999*DF$1,'Export Control'!T13-'Export Control'!C13)
		Max Export under ANN	cfs	DG	=MAX(99999*DG$1,'Export Control'!AF13-'Export Control'!C13)
		Available Banks Capacity plus specified increase		DH	=MAX(K13+HLOOKUP($C13,Control!$B$246:$M$247,2,FALSE)*Control!$B$244,0)
		Max Use of Available SWP Exports	cfs	DI	=HLOOKUP(C13,Control!$B$120:$M$121,2,FALSE)/100*DH13
	Combined	Max Use of Available CVP Exports (w/ B2)	cfs	DJ	=HLOOKUP(C13,Control!$B$120:$M$121,2,FALSE)/100*O13*BC13
	Webb	Release for Export max 3000 no dis from Jan to Jun	cfs	DK	=HLOOKUP(C13,Control!$B$128:$M$129,2)*DK$1
		Balanced Condition or RA controlling	cfs	DL	=IF(OR(S13<0.1,RemedyAction!C13-AX13-AY13<0.1),9999,0)
	Bacon	SJR constraint	cfs	DM	=IF(HLOOKUP(C13,Control!$B$136:$M$137,2)=999,DM$1,MIN(DM$1,HLOOKUP(C13,Control!$B$136:$M$137,2)/100*V13/(1-DC13)))
		Balanced Condition or RA controlling	cfs	DN	=IF(OR(S13<0.1,RemedyAction!C13-AX13-AY13<0.1),9999,0)

Island operation	Bacon	Diversion to Bacon Island	cfs	DO	=IF(AND(C13=Control!$B$144,EA12>Control!$C$144),0,MAX(0,MIN(DR13,DS13,DB13,CU13)))
		Discharge from Bacon Island	cfs	DP	=MAX(IF(AND(C13'=Control!$B$144,EA12>Control!$C$144),DU13,0),MIN(3000,DD13-EC13,MIN(DE13,DF13,DG13)/(1-DC13)-EC13+BR13,DN13-EC13+BR13,DI13/(1-DC13)+MIN(DJ13,AR13)/(1-DC13)*Control!$B$155+BR13-EC13,DM13+MAX(0,BR13-EC13),DT13,DU13,(AK13*Control!$B$156+FD13+FN13+FX13+GH13+AR13*Control!$B$155)/(1-DC13)+BR13-EC13))
		Bacon Island Change in Storage	taf	DQ	=(DO13-DP13)*Conversions!C13
		Remedy Action bound on diversion	cfs	DR	=MIN(9999, MAX(RemedyAction!C13-AX13-AY13+HLOOKUP(C13,Control!$C$39:$N$41,2,FALSE),9999-9999*DR$1))
		Max rate to island	cfs	DS	=(DS$1-EA12+DW13)/Conversions!C13
		Remedy Action bound on discharge	cfs	DT	=MIN(9999,MAX((RemedyAction!C13-AX13-AY13+HLOOKUP(C13,Control!$C$45:$N$48,3,FALSE))/(1-DC13)+BR13,9999-9999*HLOOKUP(C13,Control!$C$45:$N$48,4,FALSE)))
		Max discharge rate	cfs	DU	=EA12/Conversions!C13-DW13/Conversions!C13
		Bacon Initial Surface Area	acres	DV	=IF(EA12*1000>Control!$C$265,Control!$C$266+(EA12*1000-Control!$C$265)/(Control!$D$265-Control!$C$265)*(Control!$D$266-Control!$C$266),EA12*1000/Control!$C$265*Control!$C$266)
		Bacon Prev. Month Evap Estimate	taf	DW	=MIN(EA12,HLOOKUP($C12,Control!$B$82:$M$83,2,FALSE)/12*DV13/1000)*DW$1
		Bacon Top Off	taf	DX	=MIN(DZ13,(Control!$B$106-DZ13),DY12,Conversions!$C13*MAX(0,HLOOKUP($C13,Control!$B$91:$M$92,2,FALSE)-HLOOKUP($C13,Control!$B$86:$M$87,2,FALSE)))
		Bacon Top Off Account	taf	DY	=IF($C13=2,0,DY12+DW13-DX13)
		Bacon Island Storage before topoff	taf	DZ	=EA12+DQ13-DW13
		Bacon Island Storage after topoff	taf	EA	=DZ13+DX13
	Webb	Diversion to Webb Tract	cfs	EB	=IF(AND(C13=Control!$B$143,EN12>Control!$C$143),0,MAX(0,MIN(EE13,EF13,DB13-DO13,CT13)))
		Discharge from Webb Tract	cfs	EC	=MAX(IF(AND(C13=Control!$B$143,EN12>Control!$C$143),EH13,0),MIN(3000,DD13,MIN(DE13,DF13,DG13)/(1-DC13)+BR13,DL13+BR13,DI13/(1-DC13)+MIN(DJ13,AR13)/(1-DC13)*Control!$B$155+BR13,DK13+BR13,EG13,EH13,(AK13*Control!$B$156+FD13+FN13+FX13+GH13+AR13*Control!$B$155)/(1-DC13)+BR13))
		Webb Tract Change in Storage	taf	ED	=(EB13-EC13)*Conversions!C13
		Remedy Action bound on diversion	cfs	EE	=MIN(9999, MAX(RemedyAction!C13-AX13-AY13+HLOOKUP(C13,Control!$C$26:$N$28,2,FALSE),9999-9999*EE$1))
		Max Diversion Rate to Webb Tract	cfs	EF	=(EF$1-EN12+EJ13)/Conversions!C13
		Remedy Action bound on discharge	cfs	EG	=MIN(9999,MAX((RemedyAction!C13-AX13-AY13+HLOOKUP(C13,Control!$C$32:$N$35,3,FALSE))/(1-DC13)+BR13,9999-9999*HLOOKUP(C13,Control!$C$32:$N$35,4,FALSE)))
		Max DischargeRate from Webb Tract	cfs	EH	=EN12/Conversions!C13-EJ13/Conversions!C13
		Webb Initial Surface Area	acres	EI	=IF(EN12*1000>Control!$C$260,Control!$C$261+(EN12*1000-Control!$C$260)/(Control!$D$260-Control!$C$260)*(Control!$D$261-Control!$C$261),EN12*1000/Control!$C$260*Control!$C$261)
		Webb Prev. Month Evap Estimate	taf	EJ	=MIN(EN12,HLOOKUP($C12,Control!$B$82:$M$83,2,FALSE)/12*EI13/1000)*EJ$1
		Webb Top Off	taf	EK	=MIN(EM13,(Control!$B$98-EM13),EL12,Conversions!$C13*MAX(0,HLOOKUP($C13,Control!$B$91:$M$92,2,FALSE)-HLOOKUP($C13,Control!$B$86:$M$87,2,FALSE)-DX13))
		Webb Top Off Account	taf	EL	=IF($C13=2,0,EL12+EJ13-EK13)
		Webb Tract Storage before topoff	taf	EM	=EN12+ED13-EJ13
		Webb Tract Storage after topoff	taf	EN	=EM13+EK13
	Total IDS	Diversion to Islands	cfs	EO	=EB13+DO13
		Discharge for Export	cfs	EP	=MIN(MIN(EC13*(1-DC13),DK13,EG13)+MIN(DP13*(1-DC13),DM13,DT13),DI13+DJ13*Control!$B$155,DE13,DF13,DG13,(AK13*Control!$B$156+FD13+FN13+FX13+GH13+AR13*Control!$B$155))
		Carriage Water	cfs	EQ	=EP13/(1-DC13)-EP13
		WQ Release	cfs	ER	=MIN(EC13+DP13-EP13-EQ13,BR13)
		Storage Release	cfs	ES	=EC13+DP13-EP13-EQ13-ER13
		Discharge for Delta	cfs	ET	=EC13+DP13-EP13
		Evaporation	taf	EU	=DW13+EJ13
		Topoff	taf	EV	=DX13+EK13
		Storage	taf	EW	=EN13+EA13

South of Delta Operation	Aqueduct Capacity	Available CA Capacity O'Neill to Semitropic	cfs	EX	='CA Avail'!CM13
		Available CA Capacity Semitropic to Edmonston	cfs	EY	='CA Avail'!CN13
		Available CA Capacity Edmonston to Antelope Valley	cfs	EZ	='CA Avail'!CO13
		SWP Direct Delivery	cfs	FA	=MIN(AK13*Control!$B$156,EP13)
		CVP Direct Delivery	cfs	FB	=MIN(EP13-FA13,AR13*Control!$B$155)
	Antelope Valley Water Bank (AVWB)	AVWB Maximum Put	cfs	FC	=MIN((FL$1-FL12)/Conversions!$C13,(FH$1-FH12)/Conversions!$C13,$FC$1)
		Maximum Put Constrained by Conveyance	cfs	FD	=MIN(FC13,EX13:EZ13)
		Remaining Available CA Capacity O'Neill to Semitropic		FE	=MAX(0,EX13-MIN(FC13,EY13,EZ13))
		Maximum Take	cfs	FF	=MIN($AK13-FA13,FL12/Conversions!$C13,FF$1,(FJ$1-FJ12)/Conversions!$C13)
		AVWB Put	cfs	FG	=MIN(EP13-FA13-FB13,FD13)
		Cumulative Annual Put	taf	FH	=IF($C13=1,0,FH12+FG13*Conversions!C13)
		AVWB Take	cfs	FI	=FF13
		Cumulative Annual Take	taf	FJ	=IF($C13=1,0,FJ12+FI13*Conversions!C13)
		AVWB Losses	cfs	FK	=FK$1*FG13
		AVWB Storage	taf	FL	=FL12+(FG13-FI13-FK13)*Conversions!$C13
	Stored Water Recovery Unit (SWRU)	SWRU Maximum Put	cfs	FM	=MIN((FV$1-FV12)/Conversions!$C13,(FR$1-FR12)/Conversions!$C13,FM$1)
		Maximum Put Constrained by Conveyance	cfs	FN	=MIN(FM13,$FE13)
		Remaining Available CA Capacity O'Neill to Semitropic		FO	=MAX(0,FE13-FM13)
		Maximum Take	cfs	FP	=MIN($AK13-FA13-FI13,FV12/Conversions!$C13,FP$1,(FT$1-FT12)/Conversions!$C13)
		SWRU Put	cfs	FQ	=MIN($EP13-$FA13-$FB13-$FG13,FN13)
		Cumulative Annual Put	taf	FR	=IF($C13=1,0,FR12+FQ13*Conversions!$C13)
		SWRU Take	cfs	FS	=FP13
		Cumulative Annual Take	taf	FT	=IF($C13=1,0,FT12+FS13*Conversions!$C13)
		SWRU Losses	cfs	FU	=FU$1*FQ13
		SWRU Storage	taf	FV	=FV12+(FQ13-FS13-FU13)*Conversions!$C13
	Original Semitropic Water Storage District (OSWSD)	OSWSD Maximum Put	cfs	FW	=MIN((GF$1-GF12)/Conversions!$C13,(GB$1-GB12)/Conversions!$C13,FW$1)
		Maximum Put Constrained by Conveyance	cfs	FX	=MIN(FW13,$FO13)
		Remaining Available CA Capacity O'Neill to Semitropic		FY	=MAX(0,FO13-FW13)
		Maximum Take	cfs	FZ	=MIN($AK13-FA13-FI13-FS13,GF12/Conversions!$C13,FZ$1,(GD$1-GD12)/Conversions!$C13)
		OSWSD Put	cfs	GA	=MIN($EP13-$FA13-$FB13-$FG13-$FQ13,FX13)
		Cumulative Annual Put	taf	GB	=IF($C13=1,0,GB12+GA13*Conversions!$C13)
		OSWSD Take	cfs	GC	=FZ13
		Cumulative Annual Take	taf	GD	=IF($C13=1,0,GD12+GC13*Conversions!$C13)
		OSWSD Losses	cfs	GE	=GE$1*GA13
		OSWSD Storage	taf	GF	=GF12+(GA13-GC13-GE13)*Conversions!$C13
	Semitropic Water Storage District (SWSD)	SWSD Maximum Put	cfs	GG	=MIN((GO$1-GO12)/Conversions!$C13,(GK$1-GK12)/Conversions!$C13,GG$1)
		Maximum Put Constrained by Conveyance	cfs	GH	=MIN(GG13,$FY13)
		Maximum Take	cfs	GI	=MIN($AK13-FA13-FI13-FS13-GC13,GO12/Conversions!$C13,GI$1,(GM$1-GM12)/Conversions!$C13)
		SWSD Put	cfs	GJ	=MIN($EP13-$FA13-$FB13-$FG13-$FQ13-$GA13,GH13)
		Cumulative Annual Put	taf	GK	=IF($C13'=1,0,GK12+GJ13*Conversions!$C13)
		SWSD Take	cfs	GL	=GI13
		Cumulative Annual Take	taf	GM	=IF($C13=1,0,GM12+GL13*Conversions!$C13)
		SWSD Losses	cfs	GN	=GN$1*GJ13
		SWSD Storage	taf	GO	=GO12+(GJ13-GL13-GN13)*Conversions!$C13
	Total SOD Deliveries	SWP Direct Delivery	cfs	GP	=FA13
		SWP GWB Delivery	cfs	GQ	=FI13+FS13+GC13+GL13
		Total SWP Delivery	cfs	GR	=GP13+GQ13
		CVP Direct Delivery	cfs	GS	=FB13

Appendix B

Detailed Description of Recent OCAP Biological Opinions and Delta Wetlands Fishery Resources Impact Assessment Methods and Results

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Detailed Description of Recent OCAP Biological Opinions and Delta Wetlands Fishery Resources Impact Assessment Methods and Results

Introduction

This appendix describes in detail the Reasonable and Prudent Alternatives detailed in the Biological Opinions in the Operations, Criteria, and Plan (OCAP) for the State Water Project (SWP) and Central Valley Project (CVP) (USFWS 2008; NMFS 2009), and also describes the methods and results of the fishery resources impact analysis (Chapter 4.6) for the Delta Wetlands Project.

Recent OCAP Biological Opinions

The recently issued Biological Opinions (USWFS 2008; NMFS 2009) on the long-term coordinated operations of the State Water Project and Central Valley Project represent considerable potential changes to the affected the environment in which the Delta Wetlands project must operate. The main aspects of the Reasonable and Prudent Alternatives (RPA) detailed in the BOs are described below.

USFWS (2008) OCAP Biological Opinion

The USFWS (2008, 276) OCAP BO concluded that "the coordinated operations of the CVP and SWP, as proposed, are likely to jeopardize the continued existence of the delta smelt" and prescribed a RPA to allow continued SWP and CVP operations under the jeopardy opinion. The following details the actions associated with the RPA.

Action 1. Adult Migration and Entrainment (First Flush)

Action 1 aims to protect pre-spawning adult delta smelt from entrainment during the first flush (high Delta outflow caused by elevated river flow that triggers upstream migration), and also aims to provide advantageous hydrodynamic conditions early in the migration period (Table B-1).

Table B-1. Timing, triggers, and actions related to the USFWS (2008) RPA Action 1

Date	Triggers	Action
December 1–20	Examination of relevant turbidity, salvage, flow, survey, and other data by the Smelt Working Group, with a recommendation to USFWS.	Exports are limited so that average daily Old and Middle River (OMR) flow is no more negative than -2,000 cfs for a total duration of 14 days, with a 5-day running average no more negative than -2,500 cfs (within 25 %).
After December 20	Three-day average turbidity of 12 NTU or greater at measurement stations at Prisoner's Point, Holland Cut, and Victoria Canal; or three days of delta smelt salvage at either SWP or CVP fish facility or cumulative daily salvage count that is above a risk threshold based upon the "daily salvage index" approach reflected in a daily salvage index value ≥0.5 (daily delta smelt salvage > one-half prior year fall midwater trawl [FMWT] index value)	Exports are limited so that average daily Old and Middle River (OMR) flow is no more negative than -2,000 cfs for a total duration of 14 days, with a 5-day running average no more negative than -2,500 cfs (within 25 %).
Determined from Monitoring	Water temperature reaches 12°C based on a three-station daily mean at Mossdale, Antioch, and Rio Vista; or onset of spawning (presence of spent females in Spring Kodiak Trawl [SKT] or at SWP/CVP fish facilities)	Progression to Action 2 or 3

Action 2. Adult Migration and Entrainment

Action 2 also aims to protect pre-spawning adult delta smelt from entrainment adverse hydrodynamic conditions (Table B-2). The limits on exports are determined by USFWS based on recommendations by the Smelt Working Group (SWG) and reflect distribution of delta smelt in the Delta from monitoring data.

Table B-2. Timing, triggers, and actions related to the USFWS (2008) RPA Action 2

Date	Triggers	Action
Following Action 1 or upon determination by SWG/USFWS	Examination of relevant turbidity, salvage, flow, survey, and other data by the Smelt Working Group, with a recommendation to USFWS.	Exports are limited so that average daily Old and Middle River (OMR) flow is no more negative than -1,250 cfs to -5,000 cfs
Determined from River Flow Monitoring	OMR flow requirements do not apply whenever a three-day flow average is greater than or equal to 90,000 cfs in Sacramento River at Rio Vista and 10,000 cfs in San Joaquin River at Vernalis. Once such flows have abated, the OMR flow requirements of the Action are again in place.	Suspension of Action
Determined from Monitoring	Water temperature reaches 12°C based on a three-station daily mean at Mossdale, Antioch, and Rio Vista; or onset of spawning (presence of spent females in Spring Kodiak Trawl [SKT] or at SWP/CVP fish facilities)	Progression to Action 3

Action 3. Entrainment Protection of Larval Smelt

Action 3 aims to minimize the number of larval smelt entrained at the fish facilities by reducing export pumping during an appropriate time period (Table B-3). The limits on exports are determined by USFWS based on recommendations by the SWG and reflect distribution of delta smelt in the Delta from monitoring data.

Table B-3. Timing, triggers, and actions related to the USFWS (2008) RPA Action 3

Date	Triggers	Action
Determined from Monitoring	Water temperature reaches 12°C based on a three-station daily mean at Mossdale, Antioch, and Rio Vista; or onset of spawning (presence of spent females in Spring Kodiak Trawl [SKT] or at SWP/CVP fish facilities)	Net daily OMR flow will be no more negative than -1,250 to -5,000 cfs based on a 14-day running average with a simultaneous 5-day running average within 25 percent of the applicable requirement for OMR.
June 30	June 30; or water temperature in Clifton Court Forebay reaches a 3-day daily average of 25°C.	Action ceases.

Action 4. Estuarine Habitat during Fall

Action 4 aims to improve the fall habitat for delta smelt by managing X2 through an adaptive process by increasing outflow when the preceding water year was wetter than normal (Table B-4).

Table B-4. Timing, triggers, and actions related to the USFWS (2008) RPA Action 4

Date	Triggers	Action
September 1–November 30	Wet and above normal Water Year (WY) type classification from the 1995 Water Quality Control Plan that is used to implement D-1641.	Provide sufficient Delta outflow to maintain average X2 for September and October no greater (more eastward) than 74 km in the fall following wet years and 81km in the fall following above normal years. The monthly average X2 must be maintained at or seaward of these values for each individual month and not averaged over the two month period. In November, the inflow to CVP/SWP reservoirs in the Sacramento Basin will be added to reservoir releases to provide an added increment of Delta inflow and to augment Delta outflow up to the fall target

Action 5. Temporary Spring Head of Old River Barrier (HORB) and the Temporary Barrier Project

Action 5 aims to minimize the entrainment of larval and juvenile delta smelt by the SWP and CVP export facilities by limiting operation of the TBP (Table B-5). Beginning in 2009, an experimental non-physical barrier (‘bubble curtain’) is being tested at the HORB sites; this may diminish the need for Action 5 if it proves to be successful at deterring migrating Chinook salmon from entering Old River from the San Joaquin River.

Table B-5. Timing, triggers, and actions related to the USFWS (2008) RPA Action 5

Date	Triggers	Action
Variable, generally April	Installation of HORB will only occur when Particle Tracking Model results show that entrainment levels of delta smelt will not increase beyond 1% at Trawl Station 815 as a result of installing the HORB.	Do not install the HORB if delta smelt entrainment is a concern. If installation of the HORB is not allowed, the agricultural barriers would be installed as described in the Project Description. If installation of the HORB is allowed, the TBP flap gates would be tied in the open position until May 15.
May 15 or end of Action 3		Action ceases

Action 6. Habitat Restoration

Action 6 aims to improve habitat conditions for delta smelt by enhancing food production and availability. The action involves creation or restoration of at least 8,000 acres of intertidal and associate subtidal habitat in the Delta and Suisun

Marsh with a 10-year period commencing one year from the issuance of the USFWS (2008) BO. Associated with the restoration is the development of a monitoring program to assess the restoration's effectiveness.

NMFS (2009) OCAP Biological Opinion

The NMFS OCAP BO released in June 2009 concluded that the CVP and SWP OCAP would jeopardize the continued existence of federally listed Endangered Sacramento River winter-run Chinook salmon, Threatened Central Valley spring-run Chinook salmon, Threatened Central Valley steelhead, Threatened Southern Distinct Population Segment (DPS) of North American green sturgeon, and Endangered Southern Resident Killer Whales. The 2009 NMFS BO contained several suites of RPA measures to avoid the likelihood of jeopardy to the species and to avoid adverse modification of designated and proposed critical habitat. The RPA grouped action measures according to geographic divisions of the SWP/CVP project area, including the Sacramento River Division, American River Division, East Side Division, and Delta Division, as well as a Fish Passage Program incorporating Near- and Long-Term measures (Table B-6).

Table B-6. NMFS 2009 BO actions to be included as part of the RPA to the SWP/CVP OCAP

Actions	Objectives
I. Sacramento River Division	
Action Suite I.1. Clear Creek	Address adverse effects of flow and water temperature that reduce viability of spring-run Chinook and steelhead in Clear Creek
Action Suite I.2. Shasta Operations	1. Sufficient cold water for winter-run spawning between Balls Ferry and Bend Bridge in most years; 2. Suitable spring-run temperatures, esp. in Sep–Oct; 3. Establishment of a second population of winter-run Chinook salmon, in Battle Creek; 4. Passage restoration at Shasta Reservoir (winter-run in upper Sacramento and/or McCloud rivers)
Action Suite I.3. Red Bluff Diversion Dam (RBDD) Operations	Reduce mortality and delay of juvenile and adult migrations of listed anadromous species at RBDD
Action I.4. Wilkins Slough Operations	Enhancement of water temperature management ability for anadromous fish below Shasta Dam
Action I.5. Funding for CVPIA Anadromous Fish Screen Program (AFSP)	Reduction of entrainment of juvenile anadromous fish in unscreened diversions
Action Suite I.6. Sacramento River Basin Salmonid Rearing Habitat Improvements	Restoration of floodplain rearing habitat for juvenile winter-run and spring-run Chinook salmon and steelhead in the lower Sacramento River basin
Action I.7. Reduce Migratory Delays and Loss of Salmon, Steelhead, and Sturgeon at Fremont Weir and Other Structures in the Yolo Bypass	Reduce migratory delays and loss of listed anadromous fish within the Yolo Bypass
II. American River Division	
Action II.1. Lower American River Flow Management	Provision of minimum flows for all steelhead life stages

Actions	Objectives
Action II.2. Lower American River Temperature Management	Maintenance of suitable temperatures to support over-summer rearing of juvenile steelhead in the lower American River
Action II.3. Structural Improvements	Through dam improvements, improvement of the ability to manage the cold water pool for suitable temperatures for listed species
Action II.4. Minimize Flow Fluctuation Effects	Reduce stranding and isolation of juvenile steelhead
Action II.5. Fish Passage at Nimbus and Folsom Dams	Access provision to above-dam, historic cold water habitat for steelhead
Action Suite II.6. Actions to Reduce Genetic Effects of Nimbus and Trinity River Fish Hatchery Operations	1. Reduction of introgression of out-of-basin hatchery stock with wild steelhead in the Central Valley; 2. Increase in diversity of fall-run production to increase Southern Resident Killer Whale prey availability and reduction of adverse effects of hatchery fall-run Chinook straying on genetic diversity of natural fall-run and spring-run Chinook
III. East Side Division	
Actions III.1.1–III.1.3.	Definition of operational criteria for East Side division to ensure viability of the Stanislaus River steelhead population
Action Suite III.2. Stanislaus River CV Steelhead Habitat Restoration	Partial alleviation of adverse modification of steelhead critical habitat (i.e., dam-related channel-forming flow suppression and normal sediment transportation)
IV. Delta Division	
Action Suite IV.1. Delta Cross Channel (DCC) Gate Operation, and Engineering Studies of Methods to Reduce Loss of Salmonids in Georgiana Slough and Interior Delta	Reduction of the proportion of emigrating listed salmonids and green sturgeon that enter the interior delta either through the open DCC gates or Georgiana Slough
Action Suite IV.2. Delta Flow Management	Maintenance of adequate flows in the Sacramento/San Joaquin rivers to increase survival of steelhead emigrating to the estuary from the San Joaquin River and of winter-run and spring-run Chinook, steelhead, and green sturgeon emigrating from the Sacramento River through the Delta to Chipps Island
Action IV.3. Reduce Likelihood of Entrainment or Salvage at the Export Facilities	Reduction of losses of winter-run and spring-run Chinook, steelhead, and green sturgeon by reducing exports when large numbers of juvenile Chinook are migrating into the upper Delta and are at risk of entrainment by the export pumps
Action Suite IV.4. Modifications of the Operations and Infrastructure of the CVP and SWP Fish Collection Facilities	1. Achievement of 75% salvage efficiency at both facilities; 2. Increase in efficiency of the fish collection facilities to improve survival of listed anadromous fishes
Action IV.5. Formation of Delta Operations for Salmon and Sturgeon (DOSS) Technical Working Group	Creation of a technical advisory team to provide recommendations to the water operations management team (WOMT) and NMFS regarding measures to reduce adverse effects of SWP/CVP Delta operations on listed anadromous fishes and coordination of other technical teams' work
Action IV.6. South Delta Improvement Program—Phase I (Permanent Operable Gates)	No implementation of DWR's South Delta Improvement Program (replacement of temporary barriers with permanent operable gates)

Actions	Objectives
V. Fish Passage Program	
NF1. Formation of Interagency Fish Passage Steering Committee	To charter, and support through funding agreements, an interagency committee to provide oversight and technical, management, and policy direction for the Fish Passage Program
NF2. Evaluation of Salmonid Spawning and Rearing Habitat Above Dams	Quantification and characterization of the location, amount, suitability, and functionality of existing and/or potential spawning and rearing habitat for listed species above Reclamation-operated dams
NF3. Development of Fish Passage Pilot Plan	Completion of a 3-year plan for the Fish Passage Pilot program
NF4. Implementation of Pilot Reintroduction Program	Implementation of short-term fish passage actions that will inform planning for long-term passage actions
NF5. Comprehensive Fish Passage Report	To evaluate the effectiveness of fish passage alternatives and make recommendations for the development and implementation of long-term passage alternatives and a long-term fish passage program
LF1. Long-term Funding and Support to the Interagency Fish Passage Steering Committee	Continued convening, funding, and staffing of the Fish Passage Steering Committee should the Comprehensive Fish Passage Report indicate that long-term fish passage is feasible and desirable
LF2. Long-Term Fish Passage Plan and Program	Provision of structural and operational modification to allow safe fish passage and access to habitat above and below SWP/CVP Central Valley project dams

With regard to operations in the Delta, the main actions included changes in operations to the Delta Cross Channel to reduce the number of salmonids entering the central Delta; maintenance of adequate flows in the Sacramento and San Joaquin rivers to increase survival of migrating salmonids; reduction of the likelihood of entrainment/salvage at the south Delta fish collection facilities; and improved efficiency of the fish collection facilities. The NMFS (2009) BO is similar to the USWFS (2008) BO for delta smelt in that flow-based actions are detailed, including restrictions to Old and Middle River reverse flows, as well as other measures such as minimum flows required at Vernalis (San Joaquin River). In addition, actions to reduce the risk of Sacramento River-origin outmigrating fish entering the central Delta are detailed, as are actions to improve salvage efficiency at the SWP/CVP fish facilities in the south Delta. The following describes the RPA that are applicable to the Delta division.

Action IV.1.1 Monitoring and Alerts to Trigger Changes in Delta Cross Channel Operations

In order to reduce the likelihood of emigrating salmonids entering the central Delta through the DCC, this action continues funding for monitoring programs that provide information used to alert managers as to when juvenile Chinook salmon will be approaching the Delta. The *First Alert* is triggered by one of two conditions and determines when the DCC gates should be closed: either capture of yearling-sized (>70 mm) spring-run Chinook salmon at the mouths of natal tributaries between October and April, or an increase in tributary flow of more than 50% over levels preceding the flow spike from October onward. The *Second Alert* is triggered by Sacramento River flows greater than 7,500 cfs at Wilkins Slough and water temperatures less than 13.5ºC (56.3ºF) at Knights Landing.

Action IV.1.2 DCC Gate Operation

The DCC gates will be operated to reduce mortality of emigrating juvenile salmonids and green sturgeon in November, December, and January (Table B-7).

Table B-7. Decision Tree Related to the Operation of the Delta Cross Channel, as Stated in the Reasonable and Prudent Alternative from the National Marine Fisheries Service Operations Criteria and Plan Biological Opinion

Date	Triggers	Actions
October 1–November 30	Water quality criteria per D-1641 are met and either the KLCI or the SCI is greater than three fish per day but less than or equal to five fish per day	Within 24 hours of trigger, DCC gates are closed. Gates will remain closed for 3 days.
	Water quality criteria per D-1641 are met and either the KLCI or SCI is greater than five fish per day	Within 24 hours, close the DCC gates and keep them closed until the catch index is less than three fish per day at both the Knights Landing and Sacramento monitoring sites.
	The KLCI or SCI triggers are met but water quality criteria are not met per D-1641 criteria	DOSS reviews monitoring data and makes recommendation to NMFS and WOMT per procedures in Action IV.5.
December 1–December 14	Water quality criteria are met per D-1641	DCC gates are closed. If Chinook salmon migration experiments are conducted during this time period (e.g., Delta Action 8 or similar studies), the DCC gates may be opened according to the experimental design, with NMFS's prior approval of the study.
	Water quality criteria are not met but both the KLCI and SCI are less than three fish per day	DCC gates may be opened until the water quality criteria are met. Once water quality criteria are met, the DCC gates will be closed within 24 hours of compliance.
	Water quality criteria are not met but either of the KLCI or SCI is greater than three fish per day	DOSS reviews monitoring data and makes recommendation to NMFS and WOMT per procedures in Action IV.5.
December 15–January 31	December 15–January 31	DCC gates are closed.
	NMFS-approved experiments are being conducted	Agency sponsoring the experiment may request gate opening for up to 5 days; NMFS will determine whether opening is consistent with ESA obligations.
	One-time event between December 15 and January 5, when necessary to maintain Delta water quality in response to the astronomical high tide, coupled with low inflow conditions	Upon concurrence of NMFS, DCC gates may be opened 1 hour after sunrise to 1 hour before sunset, for up to 3 days, then returned to full closure. Reclamation and DWR also will reduce Delta exports down to a health and safety level during the period of this action.

Date	Triggers	Actions
February 1–May 15	D-1641 mandatory gate closure	Gates closed, per WQCP criteria.
May 16–June 15	D-1641 gate operations criteria	DCC gates may be closed for up to 14 days during this period, per 2006 WQCP, if NMFS determines it is necessary.
WQCP = water quality control plan. NMFS = National Marine Fisheries Service. KLCI = Knights Landing Catch Index . SCI = Sacramento Catch Index. DCC = Delta Cross Channel.		DOSS = Delta Operations for Salmon and Sturgeon. DWR = California Department of Water Resources. ESA = Endangered Species Act. WOMT = Water Operations Management Team
Source: National Marine Fisheries Service 2009: 636–639.		

Action Suite IV.2 Delta Flow Management

Action Suite IV.2 describes a number of related actions aimed at maintaining adequate flows within the Delta in order to increase survival of outmigrating salmonids. These actions would occur from January 1 until June 15 each year (Table B-8).

Table B-8. Time Periods of Actions in Relation to Action Suite IV.2 (Delta Flow Management) of the Reasonable and Prudent Alternative from the National Marine Fisheries Service Operations Criteria and Plan Biological Opinion

Action	Period
IV.2.1 (San Joaquin River inflow to export ratio)	April 1–May 31
IV.2.2 (Acoustic tag studies)	March 1–March 31; April 1–May 31; June 1–15
IV.2.3 (OMR flow management)	January 1–June 15
Source: National Marine Fisheries Service 2009.	

For interim operations (2010–2012), Action IV.2.1 restricts exports and requires minimum flows at Vernalis on the San Joaquin River (Tables B-9 and B-10). Minimum long-term flows at Vernalis (Table B-11) would be achieved by Reclamation/DWR seeking supplemental agreement with the San Joaquin River Group Authority.

Table B-9. Minimum Flows Required at Vernalis during the Interim Operations of the SWP/CVP (2010–2011), as Stated in the Reasonable and Prudent Alternative from the National Marine Fisheries Service Operations Criteria and Plan Biological Opinion

New Melones Index (taf)[1]	Minimum flow required at Vernalis (cfs)
0–999	No new requirements
1,000–1,399	D-1641 requirements or 1,500, whichever is greater
1,400–1,999	D-1641 requirements or 3,000, whichever is greater
2,000–2,499	4,500
2,500 or greater	6,000

taf = thousand acre-feet.
Source: National Marine Fisheries Service 2009: 642.

Table B-10. Maximum Allowed Exports during the Interim Operations of the State Water Project/Central Valley Project (2010–2011), as Stated in the Reasonable and Prudent Alternative from the National Marine Fisheries Service Operations Criteria and Plan Biological Opinion

Flows at Vernalis (cfs)	Combined CVP and SWP Export
0–6,000	1,500 cfs
6,000–21,750	4:1 (Vernalis flow:export ratio)
21,750 or greater	Unrestricted until flood recedes below 21,750 cfs

cfs = cubic feet per second.
Source: National Marine Fisheries Service 2009: 642.

[1] The New Melones Index is a summation of end of February New Melones Reservoir storage and forecasted inflow using 50% exceedance from March through September.

Table B-11. Minimum Long-Term Flows at Vernalis during the Interim Operations of the SWP/CVP (2010–2011), as Stated in the Reasonable and Prudent Alternative from the National Marine Fisheries Service Operations Criteria and Plan Biological Opinion

San Joaquin River Index (60-20-20)[2]	Minimum Long-Term Flow at Vernalis (cfs)
Critically dry (≤2.1)	1,500
Dry (>2.1, ≤2.5)	3,000
Below normal (>2.5, ≤3.1)	4,500
Above normal (>3.1, <3.8)	6,000
Wet (≥3.8)	6,000

Source: National Marine Fisheries Service 2009: 643–644.

Beginning in 2012, exports would be restricted to a specified fraction of Vernalis flows (Table B-12). Exceptions would arise during multiple dry years (see NMFS 2009, 644, for definitions) or when exports of at least 1,500 cfs may not be achievable (the minimum requirement for human health and safety).

Table B-12. Flow: Export Ratio Limitations for the San Joaquin River, as Stated in the Reasonable and Prudent Alternative from the National Marine Fisheries Service (2009) Operations Criteria and Plan Biological Opinion

San Joaquin Valley Classification (San Joaquin River index)	Vernalis Flow (cfs):CVP/SWP Combined Export Ratio
Critically dry (≤ 2.1)	1:1
Dry (> 2.1, ≤ 2.5)	2:1
Below normal (> 2.5, ≤ 3.1)	3:1
Above normal (> 3.1, < 3.8)	4:1
Wet (≥ 3.8)	4:1
Vernalis flow equal to or greater than 21,750 cfs	Unrestricted exports until flood recedes below 21,750 cfs

cfs = cubic feet per second; CVP = Central Valley Project; SWP = State Water Project.
Source: National Marine Fisheries Service 2009.

Action IV.2.2 consists of a 6-year acoustic tag experiment to confirm proportional causes of salmonid mortality attributable to flows, exports, and other

[2] The San Joaquin River Index (aka the San Joaquin Valley index) is computed according to the following formula:

I_{SJ}=0.6X+0.2Y and 0.2Z

Where:

I_{SJ}=San Joaquin Valley Index

X=Current year's April–July San Joaquin Valley unimpaired runoff (maf)

Y=Current year's October–March San Joaquin Valley unimpaired runoff (maf)

Z=Previous year's index in maf, not to exceed 0.9 maf

San Joaquin Valley unimpaired runoff for the current water year is a forecast of the sum of the following locations: Stanislaus River, total flow to New Melones Reservoir; Tuolumne River, total inflow to Don Pedro Reservoir; Merced River, total flow to Exchequer Reservoir; San Joaquin River, total inflow to Millerton Lake.

SWP/CVP project or non-project adverse effects during outmigration through the Delta.

Whereas the USFWS (2008) delta smelt OCAP BO RPA focuses mostly on managing OMR flows, the NMFS (2009) OCAP BO RPA details measures specific not only to OMR flows but also to SWP/CVP exports themselves (see Action IV.3 below). Action IV.2.3 aims to manage OMR flows between January 1 and June 15 in order to reduce the vulnerability of emigrating listed salmonids within the lower Sacramento and San Joaquin Rivers to entrainment into the channels of the south Delta and at the export pumps. The action consists of three stages of increasingly restrictive measures (Table B-13).

Table B-13. Decision Tree Related to Management of Flows in the Old and Middle Rivers, as Stated in the Reasonable and Prudent Alternative from the National Marine Fisheries Service Operations Criteria and Plan Biological Opinion

Date	Triggers	Action
January 1–June 15	January 1–June 15	Exports are managed to a level that produces a 14-day running average of the tidally filtered flow of (minus) -5,000 cfs in Old and Middle River (OMR). A 5-day running average flow will be calculated from the daily tidally filtered values and be no more than 25% more negative than the targeted requirement flow for the 14-day average flow.
January 1–June 15 (first stage trigger)	Daily SWP/CVP older juvenile loss density (fish per taf): (1) is greater than incidental take limit divided by 2,000 (2% WR JPE[3] ÷ 2,000), with a minimum value of 2.5 fish per taf; or (2) daily loss is greater than daily measured fish density divided by 12 taf; or (3) CNFH CWT LFR[4] or LSNFH CWT WR[5] cumulative loss greater than 0.5%; or (4) daily loss of wild steelhead (intact adipose fin) is greater than the daily measured fish density divided by 12 taf	Reduce exports to achieve an average net OMR flow of (minus) -3,500 cfs for a minimum of 5 consecutive days. The 5-day running average OMR flows will be no more than 25% more negative than the targeted flow level at any time during the 5-day running average period (e.g., -4,375 cfs average over 5 days). Resumption of (minus) -5,000 cfs flows is allowed when average daily fish density is less than trigger density for 3 consecutive days following the 5 consecutive days of export reduction. Reductions are required when any one criterion is met.

[3] WR JPE is the winter-run Chinook salmon Juvenile Production Estimate, which is based on the number of spawning adult females (from carcass surveys), female fecundity, and egg-to-fry survival (Gaines and Poytress 2004).
[4] CNFH CWT LFR is coded wire–tagged late fall–run Chinook salmon from Coleman National Fish Hatchery on Battle Creek.
[5] LSNFH CWT WR is coded wire–tagged winter-run Chinook salmon from Livingston Stone National Fish Hatchery on the Sacramento River.

Date	Triggers	Action
January 1–June 15 (second stage trigger)	Daily SWP/CVP older juvenile loss density (fish per taf) is: (1) greater than incidental take limit (2% of WR JPE) divided by 1,000, with a minimum value of 2.5 fish per taf; or (2) daily loss is greater than daily fish density divided by 8 taf ; or (3) CNFH CWT LFR or LSNFH CWT WR cumulative loss greater than 0.5%, or (4) daily loss of wild steelhead (intact adipose fin) is greater than the daily measured fish density divided by 8 taf	Reduce exports to achieve an average net OMR flow of (minus) -2,500 cfs for a minimum of 5 consecutive days. Resumption of (minus) -5,000 cfs flows is allowed when average daily fish density is less than trigger density for 3 consecutive days following the 5 consecutive days of export reduction. Reductions are required when any one criterion is met.
End of triggers	Continue action until June 15 or until average daily water temperature at Mossdale is greater than 72ºF (22ºC) for 7 consecutive days (1 week), whichever is earlier	If trigger for end of OMR regulation is met, the restrictions on OMR are lifted.

Source: National Marine Fisheries Service 2009: 648–650.

Action IV.3 Reduce Likelihood of Entrainment or Salvage at the Export Facilities

In order to reduce entrainment from November 1 to December 31, exports may be reduced based on various triggers (Table B-14). Advance warning will be provided by the *Third Alert* (see Action IV.1.2 above for a description of the First and Second Alerts), consisting of catch indices of more than 10 fish captured per day (November 1–February 28) or more than 15 fish captured per day (March 1–April 30) from either the Knights Landing or Sacramento catch indices. Action IV.2.3 will be implemented from January 1 to April 30 to control export levels during this time.

Table B-14. Triggers and Actions Related to Management of SWP/CVP Exports, as Stated in the Reasonable and Prudent Alternative from the National Marine Fisheries Service Operations Criteria and Plan Biological Opinion

Date	Triggers	Action
January 1–June 15	Daily SWP/CVP older juvenile loss density greater than 8 fish/thousand acre feet (taf), or daily loss is more than 95 fish per day, or CNFH CWT LFR or LSNFH CWT WR cumulative loss is greater than 0.5%	Reduce exports to a combined 6,000 cfs for 3 days or until CVP/SWP daily density is less than 8 fish/taf. Export reductions are required when any one of the four criteria is met.
	Daily SWP/CVP older juvenile loss density greater than 15 fish/taf, or daily loss is more than 120 fish per day, or CNFH CWT LFR or LSNFH CWT WR cumulative loss greater than 0.5%	Reduce exports to a combined 4,000 cfs for 3 days or until CVP/SWP daily density is less than 8 fish/taf. Export reductions are required when any one of the four criteria is met.

SWP = State Water Project.
CVP = Central Valley Project.
CNFH CWT LFR = Coleman National Fish Hatchery, coded wire–tagged, late fall–run Chinook salmon.
LSNFH CWT WR = Livingston Stone National Fish Hatchery, coded wire–tagged, winter-run Chinook salmon.
Source: National Marine Fisheries Service 2009: 652–653.

Action Suite IV.4 Modifications of the Operations and Infrastructure of the CVP and SWP Fish Collection Facilities

A number of related actions are identified in Action Suite IV.4, each contributing to the overall objective of a 75% performance goal for whole-facility salvage at the SWP and CVP fish collection facilities (Table B-15).

Table B-15. Actions to Achieve a 75% Salvage Efficiency Performance Goal at the SWP/CVP Fish Collection Facilities, as Stated in the Reasonable and Prudent Alternative from the National Marine Fisheries Service Operations Criteria and Plan Biological Opinion

Action	Objective	Components
Action IV.4.1. Tracy Fish Collection Facility (TFCF) Improvements to Reduce Pre-Screen Loss and Improve Screening Efficiency	Implement specific measures to reduce pre-screen loss and improve screening efficiency at Federal facilities	1. Improvement of survival of listed fish to >75%; 2. Optimization of simultaneous salvage of juvenile salmonids and delta smelt; 3. Removal of predators in the secondary channel at least once per week, plus installation of equipment to detect predators; 4. Louver bypasses and channel flows operated at at least 75% efficiency; 5. Head differential between Old River and primary channel <1.5 ft at the trash rack; 6. Installation/maintenance of flow meters in the primary and secondary channels to ensure design flow conditions are met; and 7. Change of operations to meet salvage criteria. Detailed records of operating actions provided to NMFS upon request and following major/long-term deviations
Action IV.4.2. Skinner Fish Collection Facility Improvements to Reduce Pre-Screen Loss and Improve Screening Efficiency	Implement specific measures to reduce pre-screen loss and improve screening efficiency at state facilities	1. Improvement of salvage efficiency of listed anadromous fish to minimum 75% from the entrance to the primary channel; 2. Reduction of salmon/steelhead loss to no more than 40% in Clifton Court Forebay; and 3. Removal of secondary channel predators at least once per week.
Action IV.4.3. Tracy Fish Collection Facility and the Skinner Fish Collection Facility Actions to Improve Salvage Monitoring, Reporting, and Release Survival Rates	To improve overall survival of listed species at facilities through accurate, rapid salvage reporting and state-of-the-art salvage release procedures. This reporting is also necessary to provide information needed to trigger OMR Action IV.2.3.	1. Sampling rates no less than 25% of operational time; 2. Creation of websites to make salvage data available within 2 days of collection; 3. Release-site studies to develop methods to reduce losses of fish; 4. Reduction of predation following release by at least 50% from current rate; 5. Reduction of stress in transported fish by treating tanker water with salt and other products; 6. Training of personnel conducting fish counts; 7. Tanker truck runs to be scheduled at least every 12 hours; and 8. Maintenance of suitable environmental conditions during truck transport according to the Bates Table[6].

Source: National Marine Fisheries Service 2009: 653–658.

[6] The Bates Table was developed in the 1950s by D. Bates and gives information on maximum recommended fish loadings into tanker trucks of different volumes and water temperatures.

Action IV.5 Formation of Delta Operations for Salmon and Sturgeon (DOSS) Technical Working Group

Action IV.5 involves formation of a technical working group that will provide recommendations for real-time management of Delta division SWP/CVP operations; annually review project operations and associated monitoring data; track implementation of Delta Actions IV.1–IV.5 and evaluate their effectiveness; oversee implementation of the San Joaquin acoustic fish tag experiment (Action IV.2.2); coordinate with the Smelt Working Group (SWG) to benefit both USFWS- and NMFS-listed species; and coordinate with other technical teams to ensure consistent PRA implementation.

Action IV.6 South Delta Improvement Program—Phase I (Permanent Operable Gates)

Action IV.6 consists of DWR not implementing Phase I of the South Delta Improvements Program to replace temporary barriers with permanent operable gates. NMFS is of the opinion that installation of permanent operable gates will adversely modify critical habitat.

Delta Wetlands Fishery Resources Impact Assessment

The fishery resources impact assessment evaluates the Delta conditions that are important for relevant life stages of each fish species being evaluated. Where possible, impacts are evaluated as the estimates of the percentage of a whole population that is affected. The baseline conditions are compared with the flow and habitat conditions with the Project operating for a range of baseline Delta inflows. The periods used in each analysis differed according to input data and other considerations—these are detailed below. For most analyses, a 1980–2003 baseline period was adopted. This period was used because it is generally representative of the full range of Delta hydrology simulated with the IDSM model (1922–2003) and also corresponds to the period of most reliable fish salvage density data (fish/taf) collected at the SWP and CVP fish facilities (upon which several analyses are based). Potential effects of the Project operations on fish habitat and survival, as well as entrainment and predation losses are considered using appropriate fish surveys and export fish salvage data to characterize the existing conditions.

All simulated flows used in the analysis are described in Chapter 3and Section 4.1. The main considerations are that diversions to the Reservoir Islands were assumed to occur in December–March and discharges for export by SWP and CVP were assumed to occur in July–November. Only the Proposed Project (Alternative 2) was quantitatively modeled. A qualitative analysis was conducted for Alternative 1 and a mostly qualitative analysis was conducted for Alternative

3, with two quantitative analyses using the methods described in this Appendix and with the results described in Section 4.05, Fishery Resources. Alternative 3 is no longer considered to be a viable alternative (See Chapter 3).

Losses of Fish Eggs and Larvae by Entrainment

Fish larvae in the Delta are susceptible to entrainment at water diversions. Under the Project, direct losses to entrainment would occur at the new reservoir and habitat island diversions, but entrainment at agricultural diversions would cease. Indirect losses would occur when Project water is released and is exported by the SWP and CVP facilities. The 2001 FEIR and preceding draft documents used a fish transport model called DeltaMOVE to simulate an entrainment index for evaluating the effects of Project operations on fish distribution and entrainment loss in the Delta. Models such as DeltaMOVE essentially treat larvae as passive particles (albeit with occasional refinements such as avoidance of particular salinities) and assess their dispersal according to water movements and flow splits between the Delta channels. Kimmerer and Nobriga (2008) simulated movement of fish larvae in the Delta using a particle tracking model (PTM) to determine the fate of particles over a certain period of time. They examined a large number of different export and inflow scenarios and discovered that the proportion of particles lost to entrainment by the SWP and CVP pumps is well predicted by the export to inflow ratio (E/I), i.e., the quantity of water exported from the Delta by the CVP and SWP divided by water flowing in from the various tributaries (particularly the Sacramento River). High exports and low inflows give greater losses of particles (simulated eggs/larvae) over a given time period than lower exports and high inflows. Particles originating in a region quite susceptible to flow alteration by the SWP and CVP pumps (e.g., the Central Delta) will also be lost in greater numbers than particles originating in a region relatively unaffected by the pumps (e.g., the confluence of the Sacramento and San Joaquin rivers). As with the 2001 FEIR and preceding draft documents, an assessment was made of the potential impact of direct and indirect entrainment losses on striped bass eggs and larvae of Delta and longfin smelt.

Methods

For each species, one billion larvae were assumed to originate in fixed regions of the Delta during certain months of each year. The proportion of total eggs or larvae assigned to each region and month generally followed those used in the 2001 FEIR and preceding draft documents (Table B-16), with some slight modifications based on more recent information (Moyle 2002; California Department of Fish and Game 2009a). The E/I ratio was calculated for the baseline period with only simulated SWP and CVP exports for each month from WY 1980 to 2003. (This period was adopted for consistency with the entrainment analysis of juvenile and adult fish described below). The percentage of eggs or larvae that would be lost to entrainment from each region during a 30-day period was based on the sigmoidal relationships plotted by Kimmerer and Nobriga

(2008). An equation that appeared to produce similar curves to those plotted by Kimmerer and Nobriga (2008) differed only in a single exponent (A),

$$Loss = \frac{Maximum\ (100\%)}{1 + 100\ \times e^{\left(-A \times \frac{E}{I}\right)}}$$

The relationships between percentage of eggs or larvae lost had values of the A exponent ranging from 5 (Confluence of the Sacramento and San Joaquin rivers) to 15 (lower Mokelumne River) (Figure B-1). In the Confluence region, exports of 50% of the inflow (E/I = 0.5) were modeled as giving only 10% entrainment loss of particles (eggs or larvae) in that month, whereas the same E/I ratio gave 95% entrainment loss in the Mokelumne River.

For each species, the total number of particles (eggs or larvae) assumed for the whole year (i.e., one billion) was multiplied by the monthly weights to give the number of particles at the start of each month. The species-specific monthly numbers of particles were then multiplied by the weights for each region. The percentage of particles lost in each region was calculated based on the simulated E/I ratio, first for the baseline condition with SWP/CVP exports alone, then with exports plus Project reservoir island diversions and increased exports of reservoir island discharges, next with baseline exports and existing agricultural discharges, and finally with SWP/CVP exports and Project habitat island diversions. The overall impact of the Project diversions and discharges for export were characterized in terms of the percentage of the modeled SWP/CVP entrainment loss and also the percentage of the total number of particles per year (i.e., one billion).

The procedure for striped bass was not the same as for the other two species. The monthly weights used for striped bass spawning in the Sacramento River differed from those in the Delta and so, consistent with the 2001 FEIR and preceding draft documents, 55% of particles were assigned to the Sacramento River and 45% were assigned to the Delta (lower San Joaquin River). The monthly weightings were then applied to these two regions and the final results were combined.

As noted in the 2001 FEIR and preceding draft documents, the analysis is sensitive to the locations chosen for particles to originate in; in some years there may be more spawning occurring in the Delta than outside and so greater susceptibility to entrainment, whereas other years may have less spawning in the Delta and greater probability of safe passage downstream. A major assumption of the analysis was that entrainment at the Project facilities would be described by the same E/I-loss relationship as used for the SWP/CVP facilities.

Main Assumptions

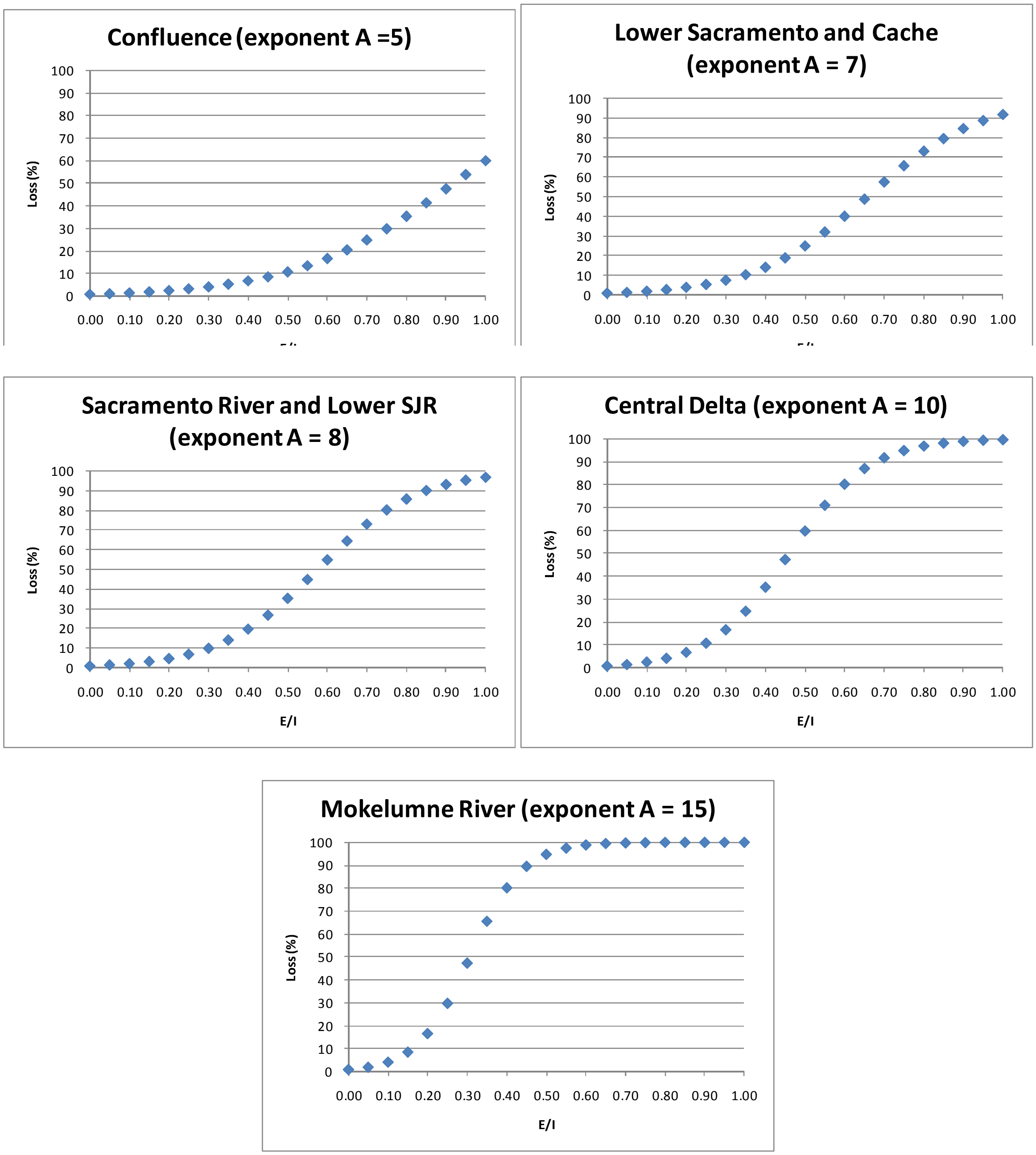
The assumptions of the egg and larval entrainment analysis were as follows:

- diversions to the Project Reservoir Islands occur in December–March;

- discharges for export occur in July–November;
- each species spawns according to a fixed pattern in each year, both spatially and seasonally, i.e., the species were assumed to spawn in the same places at the same times each year—the results of the analysis are dependent on this assumption;
- entrainment of eggs and larvae to the Project Islands can be estimated using relationships similar to the E/I curves developed for the SWP/CVP export facilities by Kimmer and Nobriga (2008);
- each month's losses will be completed before month's end (this was the case for most relationships reported by Kimmerer and Nobriga [2008]);
- intake screening offers no protection to eggs and larvae;
- eggs and larvae behave as passive particles and move with water flows;
- diversions to the agricultural and Habitat Islands are the same (quantity and timing) in all years.

Table B-16. Monthly and Location Weights Used in the Analysis of Fish Egg and Larval Entrainment for the Project

	Monthly weights						
	Dec	Jan	Feb	Mar	Apr	May	Jun
Delta smelt	0	0	0.1	0.25	0.35	0.25	0.05
Longfin smelt	0.1	0.25	0.35	0.2	0.1	0	0
Striped bass (Delta)	0	0	0	0	0.8	0.2	0
Striped bass (Sacramento River)	0	0	0	0	0	0.8	0.2
	Location weights						
	Confluence	Cache Slough	Lower Sacramento River	Sacramento River at Hood	Lower San Joaquin River	Mokelumne River	Central Delta
Delta smelt	0.167	0.167	0.167	0	0.167	0.167	0.167
Longfin smelt	0.333	0.333	0.333	0	0	0	0
Striped bass (Delta)	0	0	0	0	1	0	0
Striped bass (Sacramento River)	0	0	0	1	0	0	0



$$Loss = \frac{Maximum\ (100\%)}{1 + 100\ \times e^{(-A \times \frac{E}{I})}}$$

Figure B-1. Sigmoidal Relationships between Export:Inflow Ratio (E/I) and Monthly Percentage of Particles Lost to Entrainment for Various Regions in the Delta

Note: The exponent A of the exponential equation was varied to give the different sigmoidal curves.

Results

Delta Smelt

The baseline entrainment of Delta smelt by SWP and CVP in the simulation averaged over 76 million larvae per year from 1980 to 2003, or about 8% of the 1 billion larvae (particles) assumed to have been produced each year (Table B-17). The lowest entrainment of 2% occurred in 1983 and the maximum entrainment was 14% in 1981. Entrainment loss of delta smelt larvae estimated for the Project ranged from 0.0% in several years to 2.4% in 1987, and averaged about 0.3% (Table B-18). Loss of delta smelt larvae due to export of discharged Project water did not occur because discharges were limited to the July–September period (Table B-16).

Based on the assumed original locations of delta smelt larvae and the schedule of diversions for agriculture (under the existing/baseline conditions) and for the Habitat Islands (under the Project), it was estimated there would be a net benefit of the Project: approximately 830,000 less delta smelt larvae would be entrained annually (Tables B-19, B-20, and B-21). As a whole, the net impact of the Project was estimated to be an average of 0.2% loss of the total number of larvae per year (Table B-21).

Table B-17. Simulated entrainment losses of Delta smelt larvae under the baseline export pumping by SWP and CVP. The initial total number of larvae was 1,000,000,000.

Water Year	Feb	Mar	Apr	May	Jun	Total	Percent
1980	1,806,320	7,072,270	44,641,531	22,156,222	6,084,116	81,760,459	8%
1981	19,221,175	40,242,587	32,796,386	33,873,036	9,610,588	135,743,772	14%
1982	2,240,672	6,275,880	5,563,242	12,776,283	6,271,507	33,127,585	3%
1983	1,517,258	3,079,121	7,770,641	6,609,050	1,310,782	20,286,851	2%
1984	5,695,948	16,165,248	20,010,108	15,625,061	7,412,294	64,908,659	6%
1985	29,952,373	48,052,942	32,772,141	23,795,996	9,610,586	144,184,038	14%
1986	1,589,819	4,289,803	34,938,295	43,219,576	5,910,158	89,947,651	9%
1987	24,856,172	23,805,002	6,763,662	24,027,996	9,610,588	89,063,420	9%
1988	3,730,997	8,874,899	27,842,552	10,337,617	5,951,100	56,737,165	6%
1989	6,515,306	14,263,847	21,192,901	10,820,055	9,610,587	62,402,696	6%
1990	7,254,303	48,052,934	7,021,173	29,138,217	9,134,564	100,601,191	10%
1991	9,424,584	44,794,304	8,824,678	25,085,952	3,829,659	91,959,177	9%
1992	18,786,234	48,052,932	11,638,776	6,365,461	4,115,481	88,958,884	9%
1993	5,595,591	31,081,039	14,076,311	9,452,438	5,429,485	65,634,863	7%
1994	29,952,375	42,071,251	18,606,432	26,073,452	9,610,586	126,314,096	13%
1995	7,493,611	3,766,018	11,494,447	6,115,021	2,352,230	31,221,327	3%
1996	1,811,958	5,786,323	14,462,619	7,635,296	6,034,767	35,730,963	4%
1997	3,141,077	26,918,691	29,433,425	15,695,342	8,169,747	83,358,282	8%
1998	1,485,244	5,403,910	10,779,468	9,309,545	1,269,348	28,247,515	3%
1999	2,277,397	7,909,411	23,738,926	11,332,253	7,036,965	52,294,953	5%
2000	2,191,761	8,790,112	35,980,121	19,862,759	9,610,588	76,435,341	8%
2001	27,239,154	48,052,937	19,540,238	11,196,899	3,015,600	109,044,829	11%
2002	1,368,856	16,483,488	23,646,953	26,052,102	9,610,587	77,161,986	8%
2003	1,455,149	48,052,937	21,971,404	8,773,346	7,490,651	87,743,487	9%
					Average	**76,369,550**	**8%**

Table B-18. Simulated entrainment losses of Delta smelt larvae under the baseline export pumping by SWP and CVP plus Project diversions and discharges for export. Overall % is SWP/CVP loss plus Project loss; Project % is the loss attributable to the Project. (The initial total number of larvae was 1,000,000,000.

Water Year	Feb	Mar	Apr	May	Jun	Total	Overall %	Project %
1980	1,807,553	7,093,581	44,641,531	22,156,222	6,084,116	81,783,003	8%	0.0%
1981	19,221,175	48,052,939	32,796,386	33,873,036	9,610,588	143,554,124	14%	0.8%
1982	2,242,652	6,289,711	5,563,242	12,776,283	6,271,507	33,143,395	3%	0.0%
1983	1,518,056	3,081,256	7,770,641	6,609,050	1,310,782	20,289,784	2%	0.0%
1984	5,708,754	16,242,262	20,010,108	15,625,061	7,412,294	64,998,479	6%	0.0%
1985	29,952,373	48,052,942	32,772,141	23,795,996	9,610,586	144,184,038	14%	0.0%
1986	1,843,140	4,310,679	34,938,295	43,219,576	5,910,158	90,221,848	9%	0.0%
1987	24,856,172	48,052,939	6,763,662	24,027,996	9,610,588	113,311,356	11%	2.4%
1988	3,730,997	8,874,899	27,842,552	10,337,617	5,951,100	56,737,165	6%	0.0%
1989	6,515,306	25,715,475	21,192,901	10,820,055	9,610,587	73,854,323	7%	1.1%
1990	7,254,303	48,052,934	7,021,173	29,138,217	9,134,564	100,601,191	10%	0.0%
1991	9,424,584	48,052,939	8,824,678	25,085,952	3,829,659	95,217,812	10%	0.3%
1992	28,714,760	48,052,935	11,638,776	6,365,461	4,115,481	98,887,414	10%	1.0%
1993	5,605,251	31,218,811	14,076,311	9,452,438	5,429,485	65,782,296	7%	0.0%
1994	29,952,375	42,071,251	18,606,432	26,073,452	9,610,586	126,314,096	13%	0.0%
1995	7,507,855	3,769,222	11,494,447	6,115,021	2,352,230	31,238,776	3%	0.0%
1996	1,813,266	5,800,603	14,462,619	7,635,296	6,034,767	35,746,551	4%	0.0%
1997	3,144,968	27,072,881	29,433,425	15,695,342	8,169,747	83,516,363	8%	0.0%
1998	1,485,863	5,415,230	10,779,468	9,309,545	1,269,348	28,259,454	3%	0.0%
1999	2,279,655	7,933,181	23,738,926	11,332,253	7,036,965	52,320,980	5%	0.0%
2000	2,350,988	8,815,302	35,980,121	19,862,759	9,610,588	76,619,759	8%	0.0%
2001	29,952,374	48,052,937	19,540,238	11,196,899	3,015,600	111,758,048	11%	0.3%
2002	1,368,856	16,483,488	23,646,953	26,052,102	9,610,587	77,161,986	8%	0.0%
2003	1,455,149	48,052,937	21,971,404	8,773,346	7,490,651	87,743,487	9%	0.0%
					Average	**78,885,239**	**8%**	**0.3%**

Table B-19. Simulated entrainment losses of Delta smelt larvae under the baseline export pumping by SWP and CVP plus existing agricultural diversions. Overall % is SWP/CVP loss plus agricultural diversion loss; Ag. % is the loss attributable to the existing agricultural diversions. The initial total number of larvae was 1,000,000,000.

Water Year	Feb	Mar	Apr	May	Jun	Total	Overall %	Ag. %
1980	1,811,642	7,072,270	44,641,531	22,549,325	6,525,359	82,600,125	8%	0.08%
1981	19,386,600	40,242,587	32,796,386	34,646,716	10,271,817	137,344,107	14%	0.16%
1982	2,248,924	6,275,880	5,563,242	12,877,942	6,597,173	33,563,161	3%	0.04%
1983	1,520,583	3,079,121	7,770,641	6,639,922	1,342,918	20,353,185	2%	0.01%
1984	5,751,344	16,165,248	20,010,108	15,989,629	7,993,342	65,909,671	7%	0.10%
1985	30,226,435	48,052,942	32,772,141	24,319,698	10,307,237	145,678,454	15%	0.15%
1986	1,592,716	4,289,803	34,938,295	43,698,070	6,409,434	90,928,317	9%	0.10%
1987	25,093,961	23,805,002	6,763,662	24,623,849	10,325,335	90,611,809	9%	0.15%
1988	3,853,135	8,874,899	27,842,552	10,770,986	6,660,372	58,001,944	6%	0.13%
1989	6,798,488	14,263,847	21,192,901	11,111,379	10,352,457	63,719,072	6%	0.13%
1990	7,473,992	48,052,934	7,021,173	30,392,132	10,066,220	103,006,451	10%	0.24%
1991	9,830,059	44,794,304	8,824,678	26,087,856	4,685,680	94,222,576	9%	0.23%
1992	18,938,051	48,052,932	11,638,776	6,634,106	4,719,282	89,983,148	9%	0.10%
1993	5,635,900	31,081,039	14,076,311	9,575,196	5,730,173	66,098,619	7%	0.05%
1994	30,165,153	42,071,251	18,606,432	26,887,968	10,333,121	128,063,926	13%	0.17%
1995	7,553,043	3,766,018	11,494,447	6,140,937	2,445,295	31,399,741	3%	0.02%
1996	1,817,603	5,786,323	14,462,619	7,695,878	6,470,240	36,232,664	4%	0.05%
1997	3,157,307	26,918,691	29,433,425	16,062,354	8,823,601	84,395,378	8%	0.10%
1998	1,487,822	5,403,910	10,779,468	9,370,980	1,299,384	28,341,564	3%	0.01%
1999	2,286,811	7,909,411	23,738,926	11,525,057	7,584,971	53,045,176	5%	0.08%
2000	2,199,493	8,790,112	35,980,121	20,220,074	10,225,452	77,415,252	8%	0.10%
2001	27,421,519	48,052,937	19,540,238	11,572,282	3,520,507	110,107,484	11%	0.11%
2002	1,388,484	16,483,488	23,646,953	26,715,288	10,321,572	78,555,785	8%	0.14%
2003	1,476,432	48,052,937	21,971,404	8,859,960	8,026,124	88,386,857	9%	0.06%
					Average	**77,415,186**	**8%**	**0.10%**

Table B-20. Simulated entrainment losses of Delta smelt larvae under the baseline export pumping by SWP and CVP plus increased habitat island diversions. Overall % is SWP/CVP loss plus habitat island diversion loss; Habitat % is the loss attributable to the Project habitat island diversions. The initial total number of larvae was 1,000,000,000.

Water Year	Feb	Mar	Apr	May	Jun	total	Overall %	Habitat %
1980	1,808,384	7,072,270	44,641,531	22,214,319	6,181,180	81,917,684	8%	0.02%
1981	19,285,394	40,242,587	32,796,386	33,987,567	9,757,956	136,069,890	14%	0.03%
1982	2,243,872	6,275,880	5,563,242	12,791,341	6,343,440	33,217,775	3%	0.01%
1983	1,518,548	3,079,121	7,770,641	6,613,627	1,317,871	20,299,808	2%	0.00%
1984	5,717,395	16,165,248	20,010,108	15,678,760	7,540,735	65,112,246	7%	0.02%
1985	30,058,734	48,052,942	32,772,141	23,873,326	9,765,853	144,522,996	14%	0.03%
1986	1,590,943	4,289,803	34,938,295	43,290,636	6,019,681	90,129,358	9%	0.02%
1987	24,948,511	23,805,002	6,763,662	24,115,915	9,769,890	89,402,980	9%	0.03%
1988	3,777,926	8,874,899	27,842,552	10,400,870	6,105,833	57,002,080	6%	0.03%
1989	6,623,991	14,263,847	21,192,901	10,862,852	9,775,938	62,719,528	6%	0.03%
1990	7,338,945	48,052,934	7,021,173	29,322,781	9,341,888	101,077,720	10%	0.05%
1991	9,580,610	44,794,304	8,824,678	25,233,236	4,009,048	92,441,876	9%	0.05%
1992	18,845,167	48,052,932	11,638,776	6,404,606	4,244,759	89,186,240	9%	0.02%
1993	5,611,208	31,081,039	14,076,311	9,470,576	5,495,692	65,734,825	7%	0.01%
1994	30,034,959	42,071,251	18,606,432	26,193,508	9,771,625	126,677,775	13%	0.04%
1995	7,516,639	3,766,018	11,494,447	6,118,864	2,372,666	31,268,634	3%	0.00%
1996	1,814,147	5,786,323	14,462,619	7,644,266	6,130,549	35,837,904	4%	0.01%
1997	3,147,367	26,918,691	29,433,425	15,749,401	8,314,731	83,563,616	8%	0.02%
1998	1,486,244	5,403,910	10,779,468	9,318,648	1,275,976	28,264,246	3%	0.00%
1999	2,281,047	7,909,411	23,738,926	11,360,699	7,157,910	52,447,993	5%	0.02%
2000	2,194,759	8,790,112	35,980,121	19,915,539	9,747,618	76,628,150	8%	0.02%
2001	27,309,955	48,052,937	19,540,238	11,251,899	3,122,176	109,277,205	11%	0.02%
2002	1,376,438	16,483,488	23,646,953	26,149,998	9,769,050	77,425,926	8%	0.03%
2003	1,463,369	48,052,937	21,971,404	8,786,161	7,609,130	87,883,000	9%	0.01%
					Average	**76,587,894**	**8%**	**0.02%**

Table B-21. Summary of Delta Smelt Larval Entrainment Loss Impacts of the Project Compared to Existing/Baseline Conditions

	Simulated Baseline CVP/SWP Entrainment [(1)]		Project Diversion Entrainment Impact [(2)]			Project Export Entrainment Impact [(3)]		Baseline Project Agricultural Diversion	Project Habitat Diversion	Project Benefit from Reduced and Screened Agricultural Diversions [(6)]		Net Project Impact	Net Project Impact
Year	Loss	% of All Larvae	Loss	% of CVP/SWP	% of All Larvae	Loss	% of All Larvae	Loss [(4)]	Loss [(5)]	Reduced Loss	% of CVP/SWP Loss	% of CVP/SWP Loss	% of All Larvae
1980	81,760,459	8.2%	22,544	0.0%	0.0%	0	0	839,667	157,225	682,441	0.8%	-0.8%	-0.1%
1981	135,743,772	13.6%	7,810,352	5.8%	0.8%	0	0	1,600,334	326,118	1,274,217	0.9%	4.8%	0.7%
1982	33,127,585	3.3%	15,810	0.0%	0.0%	0	0	435,576	90,190	345,386	1.0%	-1.0%	0.0%
1983	20,286,851	2.0%	2,933	0.0%	0.0%	0	0	66,334	12,957	53,377	0.3%	-0.2%	0.0%
1984	64,908,659	6.5%	89,821	0.1%	0.0%	0	0	1,001,013	203,587	797,425	1.2%	-1.1%	-0.1%
1985	144,184,038	14.4%	0	0.0%	0.0%	0	0	1,494,416	338,958	1,155,459	0.8%	-0.8%	-0.1%
1986	89,947,651	9.0%	274,197	0.3%	0.0%	0	0	980,666	181,707	798,959	0.9%	-0.6%	-0.1%
1987	89,063,420	8.9%	24,247,936	27.2%	2.4%	0	0	1,548,389	339,560	1,208,829	1.4%	25.9%	2.3%
1988	56,737,165	5.7%	0	0.0%	0.0%	0	0	1,264,779	264,916	999,864	1.8%	-1.8%	-0.1%
1989	62,402,696	6.2%	11,451,628	18.4%	1.1%	0	0	1,316,376	316,833	999,544	1.6%	16.7%	1.0%
1990	100,601,191	10.1%	0	0.0%	0.0%	0	0	2,405,260	476,529	1,928,731	1.9%	-1.9%	-0.2%
1991	91,959,177	9.2%	3,258,635	3.5%	0.3%	0	0	2,263,399	482,699	1,780,700	1.9%	1.6%	0.1%
1992	88,958,884	8.9%	9,928,529	11.2%	1.0%	0	0	1,024,264	227,356	796,908	0.9%	10.3%	0.9%
1993	65,634,863	6.6%	147,432	0.2%	0.0%	0	0	463,755	99,962	363,794	0.6%	-0.3%	0.0%
1994	126,314,096	12.6%	0	0.0%	0.0%	0	0	1,749,830	363,680	1,386,151	1.1%	-1.1%	-0.1%
1995	31,221,327	3.1%	17,449	0.1%	0.0%	0	0	178,414	47,308	131,107	0.4%	-0.4%	0.0%
1996	35,730,963	3.6%	15,588	0.0%	0.0%	0	0	501,701	106,941	394,760	1.1%	-1.1%	0.0%
1997	83,358,282	8.3%	158,081	0.2%	0.0%	0	0	1,037,096	205,334	831,762	1.0%	-0.8%	-0.1%
1998	28,247,515	2.8%	11,939	0.0%	0.0%	0	0	94,049	16,731	77,318	0.3%	-0.2%	0.0%
1999	52,294,953	5.2%	26,027	0.0%	0.0%	0	0	750,223	153,040	597,183	1.1%	-1.1%	-0.1%
2000	76,435,341	7.6%	184,418	0.2%	0.0%	0	0	979,912	192,809	787,103	1.0%	-0.8%	-0.1%
2001	109,044,829	10.9%	2,713,220	2.5%	0.3%	0	0	1,062,655	232,376	830,279	0.8%	1.7%	0.2%
2002	77,161,986	7.7%	0	0.0%	0.0%	0	0	1,393,799	263,940	1,129,859	1.5%	-1.5%	-0.1%
2003	87,743,487	8.8%	0	0.0%	0.0%	0	0	643,370	139,513	503,857	0.6%	-0.6%	-0.1%
Avg	**76,369,550**	**7.6%**	**2,515,689**	**2.9%**	**0.3%**	**0**	**0.0%**	**1,045,637**	**218,344**	**827,292**	**1.0%**	**1.9%**	**0.2%**

Table B-21 Notes:
(1) Assumes 1,000,000,000 larvae were released annually at various locations.
(2) Assumes diversions from December to March.
(3) Assumes discharge for exports by SWP and CVP from July to November.
(4) Assumes similar pattern of agricultural diversions each year.
(5)Assumes similar pattern of habitat diversions each year.
(6) Benefit is calculated as reduction in agricultural diversion entrainment loss minus increase in habitat diversion entrainment loss.

Longfin Smelt

The baseline entrainment of longfin smelt by SWP and CVP in the simulation averaged over 60 million larvae per year from 1980 to 2003, or about 6% of the 1 billion larvae (particles) assumed to have been produced each year (Table B-22). The lowest entrainment of 2% occurred in 1983 and the maximum entrainment was 15% in 1994. Entrainment loss of longfin smelt larvae estimated for the Project ranged from 0.0% in several years to 2.4% in 1987, and averaged about 0.3% (Table B-23). Loss of longfin smelt larvae due to export of discharged Project water did not occur because discharges were limited to the July–September period (Table B-16).

Based on the assumed original locations of longfin smelt larvae and the schedule of diversions for agriculture (under the baseline/existing conditions) and for the Habitat Islands (under the Project), it was estimated there would be a net benefit of the Project: approximately 380,000 less longfin smelt larvae would be entrained annually (Tables B-24, B-25, and B-26). As a whole, the net impact of the Project was estimated to be an average of 0.4% loss of the total number of larvae per year (Table B-26).

Table B-22. Simulated entrainment losses of longfin smelt larvae under the baseline export pumping by SWP and CVP. The initial total number of larvae was 1,000,000,000.

Water Year	Dec	Jan	Feb	Mar	Apr	Total	Percent
1980	13,993,111	4,540,223	5,193,515	3,934,503	5,030,865	32,692,217	3%
1981	24,995,485	20,482,362	24,787,671	12,068,028	4,073,584	86,407,130	9%
1982	1,907,607	5,859,753	5,958,462	3,655,226	1,364,982	18,746,030	2%
1983	1,986,812	4,392,738	4,632,697	2,299,963	1,692,608	15,004,818	2%
1984	1,423,882	4,782,166	10,482,453	6,465,316	3,001,672	26,155,489	3%
1985	12,423,839	73,337,782	42,251,529	14,164,385	4,071,631	146,249,166	15%
1986	21,194,120	31,648,767	4,778,076	2,870,403	4,245,782	64,737,147	6%
1987	24,968,914	37,426,775	32,885,231	8,232,588	1,549,798	105,063,306	11%
1988	23,060,927	21,526,285	8,141,623	4,515,429	3,671,084	60,915,347	6%
1989	24,316,916	25,183,192	11,366,378	5,996,017	3,107,024	69,969,528	7%
1990	15,748,262	48,703,267	12,136,084	14,164,382	1,587,270	92,339,266	9%
1991	4,481,335	19,135,510	14,310,992	13,257,022	1,832,568	53,017,428	5%
1992	14,911,672	23,521,925	24,247,761	14,164,382	2,170,504	79,016,244	8%
1993	17,372,882	6,859,914	10,371,406	9,876,614	2,433,099	46,913,915	5%
1994	22,773,843	67,765,961	42,251,534	12,535,752	2,873,827	148,200,917	15%
1995	29,845,576	4,493,996	12,381,078	2,634,669	2,154,196	51,509,515	5%
1996	8,608,398	8,292,707	5,203,995	3,474,827	2,472,782	28,052,708	3%
1997	1,810,739	3,093,698	7,339,023	8,932,924	3,801,333	24,977,717	2%
1998	15,275,785	5,735,339	4,567,483	3,328,586	2,071,946	30,979,139	3%
1999	4,984,575	9,552,461	6,019,613	4,212,075	3,327,794	28,096,519	3%
2000	24,138,959	14,195,028	5,876,241	4,489,425	4,329,428	53,029,081	5%
2001	21,349,925	53,809,127	37,015,854	14,164,383	2,959,241	129,298,530	13%
2002	6,139,420	8,570,265	4,324,474	6,542,164	3,319,942	28,896,265	3%
2003	5,177,981	6,970,991	4,505,555	14,164,383	3,175,332	33,994,241	3%
					Average	**60,594,236**	**6%**

Table B-23. Simulated entrainment losses of longfin smelt larvae under the baseline export pumping by SWP and CVP plus Project diversions and discharges for export. Overall % is SWP/CVP loss plus Project loss; Project % is the loss attributable to the Project. The initial total number of larvae was 1,000,000,000.

Water Year	Dec	Jan	Feb	Mar	Apr	Total	Overall %	Project %
1980	13,993,111	5,368,930	5,195,808	3,941,760	5,030,865	33,530,474	3%	0.1%
1981	24,995,485	31,975,034	24,787,671	14,164,384	4,073,584	99,996,158	10%	1.4%
1982	2,339,194	5,863,475	5,961,770	3,660,220	1,364,982	19,189,641	2%	0.0%
1983	2,453,544	4,394,719	4,634,315	2,301,055	1,692,608	15,476,242	2%	0.0%
1984	1,605,743	4,785,450	10,496,575	6,483,953	3,001,672	26,373,393	3%	0.0%
1985	22,703,143	73,337,782	42,251,529	14,164,385	4,071,631	156,528,470	16%	1.0%
1986	21,194,120	31,648,767	5,261,672	2,879,497	4,245,782	65,229,838	7%	0.0%
1987	24,968,914	37,426,775	32,885,231	14,164,384	1,549,798	110,995,102	11%	0.6%
1988	23,060,927	36,399,834	8,141,623	4,515,429	3,671,084	75,788,896	8%	1.5%
1989	24,316,916	25,183,192	11,366,378	8,662,314	3,107,024	72,635,825	7%	0.3%
1990	15,748,262	48,703,267	12,136,084	14,164,382	1,587,270	92,339,266	9%	0.0%
1991	4,481,335	19,135,510	14,310,992	14,164,384	1,832,568	53,924,790	5%	0.1%
1992	14,911,672	23,521,925	39,794,549	14,164,383	2,170,504	94,563,033	9%	1.6%
1993	17,372,882	9,137,764	10,382,126	9,908,193	2,433,099	49,234,064	5%	0.2%
1994	22,773,843	67,765,961	42,251,534	12,535,752	2,873,827	148,200,917	15%	0.0%
1995	29,845,576	5,341,686	12,395,605	2,636,158	2,154,196	52,373,221	5%	0.1%
1996	8,608,398	12,162,735	5,206,424	3,480,194	2,472,782	31,930,532	3%	0.4%
1997	2,164,375	3,094,234	7,344,538	8,967,635	3,801,333	25,372,114	3%	0.0%
1998	15,275,785	7,465,411	4,568,751	3,332,987	2,071,946	32,714,880	3%	0.2%
1999	8,070,139	9,562,586	6,023,357	4,219,746	3,327,794	31,203,622	3%	0.3%
2000	24,138,959	20,967,781	6,140,697	4,497,163	4,329,428	60,074,028	6%	0.7%
2001	21,349,925	53,809,127	42,251,532	14,164,383	2,959,241	134,534,208	13%	0.5%
2002	8,472,069	9,997,513	4,324,474	6,542,164	3,319,942	32,656,161	3%	0.4%
2003	8,555,908	6,976,565	4,505,555	14,164,383	3,175,332	37,377,742	4%	0.3%
					Average	**64,676,776**	**6%**	**0.4%**

Table B-24. Simulated entrainment losses of longfin smelt larvae under the baseline export pumping by SWP and CVP plus existing agricultural diversions. Overall % is SWP/CVP loss plus agricultural diversion loss; Ag. % is the loss attributable to the existing agricultural diversions. The initial total number of larvae was 1,000,000,000.

Water Year	Dec	Jan	Feb	Mar	Apr	total	Overall %	Ag. %
1980	14,133,906	4,550,529	5,203,408	3,934,503	5,030,865	32,791,075	3%	0.02%
1981	25,283,420	20,651,748	24,995,796	12,068,028	4,073,584	86,692,550	9%	0.07%
1982	1,912,876	5,879,788	5,972,244	3,655,226	1,364,982	18,756,321	2%	0.00%
1983	1,992,491	4,403,399	4,639,433	2,299,963	1,692,608	15,011,990	2%	0.00%
1984	1,426,198	4,799,845	10,543,462	6,465,316	3,001,672	26,181,932	3%	0.01%
1985	12,545,888	74,103,826	42,810,738	14,164,385	4,071,631	146,601,252	15%	0.14%
1986	21,418,154	31,953,807	4,783,811	2,870,403	4,245,782	64,910,900	6%	0.05%
1987	25,323,052	37,967,948	33,277,537	8,232,588	1,549,798	105,490,324	11%	0.13%
1988	23,306,682	21,711,976	8,300,324	4,515,429	3,671,084	61,154,293	6%	0.06%
1989	24,748,141	25,614,045	11,663,934	5,996,017	3,107,024	70,403,076	7%	0.12%
1990	15,984,654	49,214,122	12,361,060	14,164,382	1,587,270	92,620,302	9%	0.10%
1991	4,626,658	19,810,237	14,710,382	13,257,022	1,832,568	53,315,102	5%	0.12%
1992	15,307,779	24,055,172	24,435,033	14,164,382	2,170,504	79,390,837	8%	0.11%
1993	17,651,584	6,886,616	10,416,091	9,876,614	2,433,099	47,119,669	5%	0.04%
1994	23,062,788	68,613,243	42,685,228	12,535,752	2,873,827	148,622,032	15%	0.16%
1995	30,165,502	4,504,510	12,441,650	2,634,669	2,154,196	51,748,126	5%	0.04%
1996	8,683,533	8,335,967	5,214,473	3,474,827	2,472,782	28,110,140	3%	0.01%
1997	1,815,114	3,096,580	7,362,005	8,932,924	3,801,333	24,989,766	2%	0.00%
1998	15,432,280	5,755,840	4,572,761	3,328,586	2,071,946	31,087,442	3%	0.02%
1999	5,017,617	9,607,016	6,035,209	4,212,075	3,327,794	28,128,545	3%	0.01%
2000	24,464,076	14,296,321	5,889,299	4,489,425	4,329,428	53,259,032	5%	0.04%
2001	21,575,256	54,358,378	37,350,195	14,164,383	2,959,241	129,617,628	13%	0.11%
2002	6,185,791	8,613,395	4,366,133	6,542,164	3,319,942	28,946,488	3%	0.01%
2003	5,213,825	7,001,005	4,549,414	14,164,383	3,175,332	34,037,343	3%	0.01%
					Average	**60,791,090**	**6%**	**0.06%**

Table B-25. Simulated entrainment losses of longfin smelt larvae under the baseline export pumping by SWP and CVP plus increased habitat island diversions. Overall % is SWP/CVP loss plus habitat island diversion loss; Habitat % is the loss attributable to the Project habitat island diversions. The initial total number of larvae was 1,000,000,000.

Water Year	Dec	Jan	Feb	Mar	Apr	Total	Overall %	Habitat %
1980	14,087,404	4,540,949	5,197,353	3,934,503	5,030,865	32,692,217	3%	0.01%
1981	25,188,380	20,494,277	24,868,282	12,068,028	4,073,584	86,407,130	9%	0.03%
1982	1,911,139	5,861,165	5,963,809	3,655,226	1,364,982	18,746,030	2%	0.00%
1983	1,990,618	4,393,490	4,635,311	2,299,963	1,692,608	15,004,818	2%	0.00%
1984	1,425,434	4,783,412	10,506,097	6,465,316	3,001,672	26,155,489	3%	0.00%
1985	12,505,576	73,391,747	42,467,913	14,164,385	4,071,631	146,249,166	15%	0.04%
1986	21,344,193	31,670,222	4,780,301	2,870,403	4,245,782	64,737,147	6%	0.02%
1987	25,206,105	37,464,781	33,037,052	8,232,588	1,549,798	105,063,306	11%	0.04%
1988	23,225,562	21,539,346	8,202,872	4,515,429	3,671,084	60,915,347	6%	0.02%
1989	24,605,637	25,213,398	11,481,000	5,996,017	3,107,024	69,969,528	7%	0.04%
1990	15,906,493	48,739,212	12,222,945	14,164,382	1,587,270	92,339,266	9%	0.03%
1991	4,578,291	19,182,442	14,464,779	13,257,022	1,832,568	53,017,428	5%	0.03%
1992	15,176,421	23,559,222	24,320,308	14,164,382	2,170,504	79,016,244	8%	0.04%
1993	17,559,429	6,861,795	10,388,732	9,876,614	2,433,099	46,913,915	5%	0.02%
1994	22,967,372	67,825,606	42,419,475	12,535,752	2,873,827	148,200,917	15%	0.04%
1995	30,059,964	4,494,737	12,404,560	2,634,669	2,154,196	51,509,515	5%	0.02%
1996	8,658,718	8,295,754	5,208,060	3,474,827	2,472,782	28,052,708	3%	0.01%
1997	1,813,671	3,093,901	7,347,936	8,932,924	3,801,333	24,977,717	2%	0.00%
1998	15,380,595	5,736,783	4,569,531	3,328,586	2,071,946	30,979,139	3%	0.01%
1999	5,006,709	9,556,302	6,025,663	4,212,075	3,327,794	28,096,519	3%	0.00%
2000	24,356,716	14,202,156	5,881,307	4,489,425	4,329,428	53,029,081	5%	0.02%
2001	21,500,868	53,847,785	37,145,351	14,164,383	2,959,241	129,298,530	13%	0.03%
2002	6,170,479	8,573,303	4,340,599	6,542,164	3,319,942	28,896,265	3%	0.01%
2003	5,201,991	6,973,106	4,522,531	14,164,383	3,175,332	33,994,241	3%	0.00%
					Average	**60,594,236**	**6%**	**0.02%**

Table B-26. Summary of Longfin Smelt Larval Entrainment Loss Impacts of the Project Compared to Existing/Baseline Conditions

	Simulated Baseline CVP/SWP Entrainment (1)		Project Diversion Entrainment Impact (2)			Project Export Entrainment Impact (3)		Baseline Project Agricultural Diversion	Project Habitat Diversion	Project Benefit from Reduced and Screened Agricultural Diversions (6)		Net Project Impact	Net Project Impact
Year	Loss	% of All Larvae	Loss	% of CVP/SWP	% of All Larvae	Loss	% of All Larvae	Loss (4)	Loss (5)	Reduced Loss	% of CVP/SWP Loss	% of CVP/SWP Loss	% of All Larvae
1980	32,692,217	3.3%	838,257	2.6%	0.1%	0	0	160,994	98,858	62,136	0.2%	2.4%	0.1%
1981	86,407,130	8.6%	13,589,028	15.7%	1.4%	0	0	665,446	285,420	380,026	0.4%	15.3%	1.3%
1982	18,746,030	1.9%	443,611	2.4%	0.0%	0	0	39,088	10,291	28,796	0.2%	2.2%	0.0%
1983	15,004,818	1.5%	471,424	3.1%	0.0%	0	0	23,075	7,172	15,903	0.1%	3.0%	0.0%
1984	26,155,489	2.6%	217,904	0.8%	0.0%	0	0	81,004	26,443	54,561	0.2%	0.6%	0.0%
1985	146,249,166	14.6%	10,279,304	7.0%	1.0%	0	0	1,447,302	352,086	1,095,216	0.7%	6.3%	0.9%
1986	64,737,147	6.5%	492,691	0.8%	0.0%	0	0	534,808	173,753	361,056	0.6%	0.2%	0.0%
1987	105,063,306	10.5%	5,931,796	5.6%	0.6%	0	0	1,287,617	427,018	860,599	0.8%	4.8%	0.5%
1988	60,915,347	6.1%	14,873,549	24.4%	1.5%	0	0	590,147	238,946	351,201	0.6%	23.8%	1.5%
1989	69,969,528	7.0%	2,666,297	3.8%	0.3%	0	0	1,159,633	433,548	726,085	1.0%	2.8%	0.2%
1990	92,339,266	9.2%	0	0.0%	0.0%	0	0	972,222	281,036	691,186	0.7%	-0.7%	-0.1%
1991	53,017,428	5.3%	907,362	1.7%	0.1%	0	0	1,219,439	297,674	921,765	1.7%	0.0%	0.0%
1992	79,016,244	7.9%	15,546,789	19.7%	1.6%	0	0	1,116,626	374,593	742,033	0.9%	18.7%	1.5%
1993	46,913,915	4.7%	2,320,149	4.9%	0.2%	0	0	350,089	205,754	144,335	0.3%	4.6%	0.2%
1994	148,200,917	14.8%	0	0.0%	0.0%	0	0	1,569,922	421,115	1,148,807	0.8%	-0.8%	-0.1%
1995	51,509,515	5.2%	863,707	1.7%	0.1%	0	0	391,012	238,611	152,401	0.3%	1.4%	0.1%
1996	28,052,708	2.8%	3,877,824	13.8%	0.4%	0	0	128,874	57,432	71,441	0.3%	13.6%	0.4%
1997	24,977,717	2.5%	394,397	1.6%	0.0%	0	0	30,238	12,049	18,189	0.1%	1.5%	0.0%
1998	30,979,139	3.1%	1,735,741	5.6%	0.2%	0	0	182,275	108,303	73,971	0.2%	5.4%	0.2%
1999	28,096,519	2.8%	3,107,103	11.1%	0.3%	0	0	103,193	32,025	71,167	0.3%	10.8%	0.3%
2000	53,029,081	5.3%	7,044,947	13.3%	0.7%	0	0	439,468	229,951	209,517	0.4%	12.9%	0.7%
2001	129,298,530	12.9%	5,235,678	4.0%	0.5%	0	0	1,108,923	319,098	789,825	0.6%	3.4%	0.4%
2002	28,896,265	2.9%	3,759,896	13.0%	0.4%	0	0	131,160	50,222	80,937	0.3%	12.7%	0.4%
2003	33,994,241	3.4%	3,383,501	10.0%	0.3%	0	0	109,717	43,102	66,616	0.2%	9.8%	0.3%
Avg	**60,594,236**	**6.1%**	**4,082,540**	**6.9%**	**0.4%**	**0**	**0.0%**	**576,761**	**196,854**	**379,907**	**0.5%**	**6.4%**	**0.4%**

Table B-26 Notes:
(1) Assumes 1,000,000,000 larvae were released annually at various locations.
(2) Assumes diversions from December to March.
(3) Assumes discharge for exports by SWP and CVP from July to September.
(4) Assumes similar pattern of agricultural diversions each year.
(5) Assumes similar pattern of habitat diversions each year.
(6) Benefit is calculated as reduction in agricultural diversion entrainment loss minus increase in habitat diversion entrainment loss.

Striped Bass

Limiting Project diversions to December–March and limiting discharge for export to July–September would avoid entrainment impacts on striped bass eggs, assuming eggs were vulnerable from April to June (Table B-16). Losses attributable to the baseline SWP/CVP exports ranged from 2% (1983) to 9% (1986) and averaged 5% per year (Table B-27).

Based on the assumed original locations of striped bass spawning and the schedule of diversions for agriculture (under the baseline/existing conditions) and for the Habitat Islands (under the Project), it was estimated there would be a net benefit of the Project: approximately 870,000 less striped bass eggs would be entrained annually (Tables B-28, B-29, B-30). As a whole, the net benefit of the Project was estimated to be an average of 0.1% less eggs lost per year (Table B-30).

Table B-27. Simulated entrainment losses of striped bass eggs under the baseline export pumping by SWP and CVP. The initial total number of eggs was 1,000,000,000.

Water Year	Apr	May	Jun	Total	Percent
1980	32,838,071	28,990,724	7,397,861	69,226,656	7%
1981	24,894,802	41,135,711	11,423,399	77,453,911	8%
1982	5,603,082	19,249,883	7,588,331	32,441,295	3%
1983	7,558,005	11,795,080	2,384,798	21,737,883	2%
1984	16,552,609	22,308,356	8,790,847	47,651,812	5%
1985	24,879,017	30,647,008	11,423,396	66,949,421	7%
1986	26,294,172	52,038,242	7,222,425	85,554,839	9%
1987	6,687,682	30,881,610	11,423,399	48,992,690	5%
1988	21,682,791	16,484,238	7,263,603	45,430,632	5%
1989	17,340,354	17,045,594	11,423,397	45,809,345	5%
1990	6,913,436	36,106,557	10,808,525	53,828,519	5%
1991	8,436,054	31,953,164	5,172,826	45,562,044	5%
1992	10,648,706	11,459,876	5,454,483	27,563,065	3%
1993	12,448,884	15,432,001	6,743,412	34,624,297	3%
1994	15,607,527	32,956,896	11,423,396	59,987,819	6%
1995	10,539,134	11,110,376	3,646,119	25,295,629	3%
1996	12,726,528	13,161,309	7,347,964	33,235,801	3%
1997	22,712,693	22,382,149	9,642,550	54,737,392	5%
1998	9,990,653	15,259,178	2,328,122	27,577,953	3%
1999	19,015,886	17,633,229	8,385,909	45,035,024	5%
2000	26,978,972	26,670,624	11,423,398	65,072,994	7%
2001	16,237,594	17,478,733	4,352,605	38,068,931	4%
2002	18,955,737	32,935,151	11,423,397	63,314,285	6%
2003	17,855,263	14,602,574	8,876,715	41,334,552	4%
			Average	**48,186,950**	**5%**

Table B-28. Simulated entrainment losses of striped bass eggs under the baseline export pumping by SWP and CVP plus existing agricultural diversions. Overall % is SWP/CVP loss plus agricultural diversion loss; Ag. % is the loss attributable to the existing agricultural diversions. The initial total number of larvae was 1,000,000,000.

Water Year	Apr	May	Jun	Total	Overall %	Ag %
1980	32,838,071	29,387,652	7,849,111	70,074,834	7%	0.08%
1981	24,894,802	41,982,807	12,327,143	79,204,753	8%	0.18%
1982	5,603,082	19,361,727	7,923,513	32,888,322	3%	0.04%
1983	7,558,005	11,837,243	2,428,286	21,823,534	2%	0.01%
1984	16,552,609	22,690,444	9,439,671	48,682,724	5%	0.10%
1985	24,879,017	31,176,753	12,377,291	68,433,061	7%	0.15%
1986	26,294,172	52,642,855	7,729,606	86,666,632	9%	0.11%
1987	6,687,682	31,484,723	12,402,985	50,575,389	5%	0.16%
1988	21,682,791	16,988,858	7,989,232	46,660,881	5%	0.12%
1989	17,340,354	17,380,831	12,441,581	47,162,766	5%	0.14%
1990	6,913,436	37,415,729	12,039,626	56,368,791	6%	0.25%
1991	8,436,054	32,971,569	6,012,809	47,420,431	5%	0.19%
1992	10,648,706	11,829,306	6,045,679	28,523,691	3%	0.10%
1993	12,448,884	15,579,783	7,042,161	35,070,829	4%	0.04%
1994	15,607,527	33,788,235	12,414,054	61,809,816	6%	0.18%
1995	10,539,134	11,146,780	3,748,322	25,434,236	3%	0.01%
1996	12,726,528	13,239,845	7,792,201	33,758,574	3%	0.05%
1997	22,712,693	22,766,463	10,421,633	55,900,788	6%	0.12%
1998	9,990,653	15,333,587	2,369,276	27,693,517	3%	0.01%
1999	19,015,886	17,852,356	8,980,722	45,848,964	5%	0.08%
2000	26,978,972	27,032,999	12,261,773	66,273,744	7%	0.12%
2001	16,237,594	17,905,864	4,865,293	39,008,751	4%	0.09%
2002	18,955,737	33,611,693	12,397,638	64,965,069	6%	0.17%
2003	17,855,263	14,709,536	9,477,153	42,041,951	4%	0.07%
			Average	**49,262,169**	**5%**	**0.11%**

Table B-29. Simulated entrainment losses of striped bass eggs under the baseline export pumping by SWP and CVP plus increased habitat island diversions. Overall % is SWP/CVP loss plus habitat island diversion loss; Habitat % is the loss attributable to the Project habitat island diversions. The initial total number of larvae was 1,000,000,000. The initial total number of larvae was 1,000,000,000.

Water Year	Apr	May	Jun	Total	Overall %	Habitat %
1980	32,838,071	29,049,389	7,496,316	69,383,777	7%	0.02%
1981	24,894,802	41,260,598	11,619,636	77,775,036	8%	0.03%
1982	5,603,082	19,266,464	7,661,890	32,531,436	3%	0.01%
1983	7,558,005	11,801,336	2,394,425	21,753,767	2%	0.00%
1984	16,552,609	22,364,745	8,931,853	47,849,207	5%	0.02%
1985	24,879,017	30,725,193	11,630,233	67,234,443	7%	0.03%
1986	26,294,172	52,127,699	7,332,731	85,754,602	9%	0.02%
1987	6,687,682	30,970,545	11,635,654	49,293,881	5%	0.03%
1988	21,682,791	16,558,297	7,419,852	45,660,941	5%	0.02%
1989	17,340,354	17,095,013	11,643,779	46,079,146	5%	0.03%
1990	6,913,436	36,298,387	11,072,845	54,284,669	5%	0.05%
1991	8,436,054	32,102,621	5,349,829	45,888,503	5%	0.03%
1992	10,648,706	11,514,051	5,581,328	27,744,085	3%	0.02%
1993	12,448,884	15,453,876	6,808,963	34,711,723	3%	0.01%
1994	15,607,527	33,079,218	11,637,985	60,324,730	6%	0.03%
1995	10,539,134	11,115,779	3,668,665	25,323,578	3%	0.00%
1996	12,726,528	13,172,951	7,444,906	33,344,385	3%	0.01%
1997	22,712,693	22,438,865	9,811,522	54,963,080	5%	0.02%
1998	9,990,653	15,270,213	2,337,235	27,598,102	3%	0.00%
1999	19,015,886	17,665,627	8,515,286	45,196,799	5%	0.02%
2000	26,978,972	26,724,182	11,605,777	65,308,931	7%	0.02%
2001	16,237,594	17,541,578	4,462,203	38,241,374	4%	0.02%
2002	18,955,737	33,034,879	11,634,526	63,625,142	6%	0.03%
2003	17,855,263	14,618,422	9,007,478	41,481,162	4%	0.01%
			Average	**48,389,687**	**5%**	**0.02%**

Table B-30. Summary of Striped Bass Entrainment Loss Impacts of the Project Compared to the Baseline Conditions

	Simulated Baseline CVP/SWP Entrainment (1)		Project Diversion Entrainment Impact (2)			Project Export Entrainment Impact (3)		Baseline Project Agricultural Diversion	Project Habitat Diversion	Project Benefit from Reduced and Screened Agricultural Diversions (6)		Net Project Impact	Net Project Impact
Year	Loss	% of All Eggs	Loss	% of CVP/SWP	% of All Eggs	Loss	% of All Eggs	Loss (4)	Loss (5)	Reduced Loss	% of CVP/SWP Loss	% of CVP/SWP Loss	% of All Eggs
1980	69,226,656	6.9%	0	0.0%	0.0%	0	0	848,178	157,120	691,058	1.0%	-1.0%	-0.1%
1981	77,453,911	7.7%	0	0.0%	0.0%	0	0	1,750,841	321,125	1,429,716	1.8%	-1.8%	-0.1%
1982	32,441,295	3.2%	0	0.0%	0.0%	0	0	447,027	90,141	356,886	1.1%	-1.1%	0.0%
1983	21,737,883	2.2%	0	0.0%	0.0%	0	0	85,651	15,884	69,767	0.3%	-0.3%	0.0%
1984	47,651,812	4.8%	0	0.0%	0.0%	0	0	1,030,912	197,395	833,517	1.7%	-1.7%	-0.1%
1985	66,949,421	6.7%	0	0.0%	0.0%	0	0	1,483,640	285,022	1,198,618	1.8%	-1.8%	-0.1%
1986	85,554,839	8.6%	0	0.0%	0.0%	0	0	1,111,793	199,763	912,031	1.1%	-1.1%	-0.1%
1987	48,992,690	4.9%	0	0.0%	0.0%	0	0	1,582,699	301,191	1,281,508	2.6%	-2.6%	-0.1%
1988	45,430,632	4.5%	0	0.0%	0.0%	0	0	1,230,250	230,309	999,941	2.2%	-2.2%	-0.1%
1989	45,809,345	4.6%	0	0.0%	0.0%	0	0	1,353,421	269,801	1,083,619	2.4%	-2.4%	-0.1%
1990	53,828,519	5.4%	0	0.0%	0.0%	0	0	2,540,272	456,150	2,084,122	3.9%	-3.9%	-0.2%
1991	45,562,044	4.6%	0	0.0%	0.0%	0	0	1,858,387	326,459	1,531,928	3.4%	-3.4%	-0.2%
1992	27,563,065	2.8%	0	0.0%	0.0%	0	0	960,626	181,020	779,606	2.8%	-2.8%	-0.1%
1993	34,624,297	3.5%	0	0.0%	0.0%	0	0	446,531	87,426	359,106	1.0%	-1.0%	0.0%
1994	59,987,819	6.0%	0	0.0%	0.0%	0	0	1,821,997	336,911	1,485,086	2.5%	-2.5%	-0.1%
1995	25,295,629	2.5%	0	0.0%	0.0%	0	0	138,607	27,949	110,658	0.4%	-0.4%	0.0%
1996	33,235,801	3.3%	0	0.0%	0.0%	0	0	522,773	108,584	414,189	1.2%	-1.2%	0.0%
1997	54,737,392	5.5%	0	0.0%	0.0%	0	0	1,163,396	225,688	937,708	1.7%	-1.7%	-0.1%
1998	27,577,953	2.8%	0	0.0%	0.0%	0	0	115,563	20,148	95,415	0.3%	-0.3%	0.0%
1999	45,035,024	4.5%	0	0.0%	0.0%	0	0	813,939	161,775	652,164	1.4%	-1.4%	-0.1%
2000	65,072,994	6.5%	0	0.0%	0.0%	0	0	1,200,750	235,937	964,814	1.5%	-1.5%	-0.1%
2001	38,068,931	3.8%	0	0.0%	0.0%	0	0	939,820	172,443	767,377	2.0%	-2.0%	-0.1%
2002	63,314,285	6.3%	0	0.0%	0.0%	0	0	1,650,783	310,857	1,339,927	2.1%	-2.1%	-0.1%
2003	41,334,552	4.1%	0	0.0%	0.0%	0	0	707,400	146,610	560,789	1.4%	-1.4%	-0.1%
Avg	**48,186,950**	**4.8%**	**0**	**0.0%**	**0.0%**	**0**	**0.0%**	**1,075,219**	**202,738**	**872,481**	**1.7%**	**-1.7%**	**-0.1%**

Table B-30 Notes
(1) Assumes 1,000,000,000 eggs were released annually at various locations
(2) Assumes diversions from December to March
(3) Assumes discharge for exports by SWP and CVP from July to September
(4) Assumes similar pattern of agricultural diversions each year
(5)Assumes similar pattern of habitat diversions each year
(6) Benefit is calculated as reduction in agricultural diversion entrainment loss minus increase in habitat diversion entrainment loss.

Entrainment Loss of Juvenile and Adult Fish

A potentially significant impact of the Project on fishery resources is through entrainment. Entrainment loss due to Project diversions is the total number of fish diverted onto the Project reservoir and Habitat Islands. The Project would greatly reduce entrainment of fish at the unscreened agricultural diversions. All Project facilities would be screened but some fish are still likely to be entrained (particularly smaller individuals) and some larger fish may be impinged on the screens. For juvenile and adult fish greater than 20 mm in length, the fish screens are assumed to considerably reduce direct entrainment losses. The screen structures would be in the water only during actual diversions (as assumed in the project description), and predator populations associated with the screens are not likely to increase during the 2- to 4-week diversion period. However, the presence of boat docks, pilings, and other structures associated with the intakes could provide habitat for predatory fish that may increase entrainment losses. Entrainment loss attributable to the Project also includes fish lost at the SWP fish facility as a result of discharges of water from the Project Reservoir Islands. The magnitude of this entrainment loss may be larger than that of entrainment loss caused by Project diversions (because of the Project screens) but will affect a different fish assemblage due to the marked seasonality of many species.

The assessment of Project entrainment impacts was made for several listed species and other species of conservation interest: Chinook salmon, steelhead, Delta smelt, longfin smelt, green sturgeon, and Sacramento splittail. Striped bass and American shad were included to document effects on species with economic (and ecological) importance. Threadfin shad and white catfish were also analyzed to demonstrate possible effects on species of high abundance and therefore ecological importance that occupy differing habitats (threadfin shad are pelagic schooling species whereas white catfish are demersal).

Methods

Historical CVP and SWP salvage records (California Department of Fish and Game 2009a) were used to estimate monthly densities of fish in the Delta that are large enough to be screened at the Project, i.e., longer than 20 mm. Only data from 1980 onwards were used because taxonomic identification for taxa such as the smelts became more consistent at this time. A summary of many of these historical CVP and SWP fish salvage data is provided in the Draft EIS for the Delta-Mendota Canal/California Aqueduct Intertie Project (US Bureau of Reclamation 2009). Fish density (fish salvaged/taf exported at SWP and CVP) in each month was examined for each species of interest. The monthly values of fish density in the Delta adopted for the analysis were fixed for each year and were based on monthly average estimated numbers of fish collected at the fish salvage facilities multiplied by factors to account for presalvage losses due to predation and passage through the screening louvers (Table B-31).

Presalvage losses were accounted for by multiplying the SWP salvage density by 5.3 (reflecting prescreen loss of around 80% due to louver efficiency and predation losses; National Marine Fisheries Service 2009, 352) and by multiplying the CVP salvage density by 2.5 (reflecting prescreen losses of approximately 60%). For green sturgeon, predation loss was assumed to be minimal (5% instead of 75% at SWP and 15% at CVP), with resulting multipliers of 1.4 for SWP data and 2.2 for CVP data based mostly on louver inefficiency.

Chinook salmon were divided into the four different runs found in the Central Valley using a simplified version of the Delta length-at-month key (Table B-32; Greene 2004) and assessing the proportions in each run by month for fish length data from the salvage facilities from 1993 to 2008. The proportions were then multiplied by the estimated density for all runs combined to give seasonal density patterns for each species.

Table B-31. Assumed survival proportions for fish during salvage at the State Water Project (SWP) and Central Valley Project (CVP) fish collection facilities. The data from both facilities were used to calculate density of fish in the Delta. The SWP loss multiplier was used to estimate losses during export from the equation: loss = fish density drawn to the export facilities (fish/taf) × water exported × loss multiplier. CHTR is collection, handling, trucking, and release.

	1. Most fish		2. Smelts		3. Green sturgeon	
	Proportion	Running Proportion	Proportion	Running Proportion	Proportion	Running Proportion
SWP						
Prescreen survival	0.25	0.25	0.25	0.25	0.95	0.95
Louver efficiency	0.75	0.19	0.75	0.19	0.75	0.71
CHTR survival	0.98	0.18	0.00	0.00	0.98	0.70
Postrelease survival	0.90	0.17	0.00	0.00	0.99	0.69
CVP						
Prescreen survival	0.85	0.85	0.85	0.85	0.95	0.95
Louver efficiency	0.47	0.40	0.47	0.40	0.47	0.44
CHTR survival	0.98	0.39	0.00	0.00	0.98	0.44
Postrelease survival	0.90	0.35	0.00	0.00	0.99	0.43
	Loss multiplier (For SWP Export) =	0.83	Loss multiplier (For SWP Export) =	1.00	Loss multiplier (For SWP Export) =	0.31

Table B-32. Length-at-month key used to assign Chinook salmon to different runs. Values are mm of fork length.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Winter-run	66-175	81-225	111-270	136-270	171-270	221-270	0-35	0-50, 246-270	0-60	31-80	41-105	51-135
Spring-run	46-65	56-80	71-110	81-135	101-170	121-220	151-270	181-245	221-270	0-30	0-40	36-50
Fall-run	0-45, 221-270	0-55	0-70	36-80	46-100	56-120	71-150	81-180	101-220	121-270	151-270	0-35, 181-270
Late fall–run	175-220	226-270	–	0-35	0-45	0-55	36-70	51-80	61-100	81-120	106-150	136-180

The entrainment analyses covered the period from 1980 to 2003. The baseline entrainment due to SWP and CVP operations was calculated by multiplying the assumed monthly density of each species by the quantity of water exported in that month and correcting for presalvage and postsalvage losses with a loss multiplier:

> Baseline entrainment loss by SWP and CVP (number of fish) = Fish density (fish/taf) × water exported (taf) × loss multiplier.

The loss multiplier accounted for all sources of losses, grouped by species (Table B-31). Presalvage loss is described above for the calculation of fish density in the Delta from salvage data. Postsalvage loss was assumed to be 2% during collection, holding, trucking and release and 10% by predation (NMFS 2009, 352); all smelt were assumed to die during salvage (Kimmerer 2008, 11) and pre-/post-salvage predation on green sturgeon was assumed to result in a 1% loss).

The entrainment impact of the Project's diversions onto the reservoir and Habitat Islands was calculated by multiplying the assumed density of fish by the simulated quantity of water diverted, incorporating a screen efficiency of 95% (as assumed in the NMFS 2009 OCAP BO) and a small-intake correction factor (see below):

> Project reservoir island entrainment loss (number of fish) = Fish density (fish/taf) × water exported (taf) × small-intake correction factor (0.50) × screen efficiency multiplier (0.05).

The small-intake correction factor was included to account for the general non-linear relationship between the size of a water intake (or amount of water withdrawn) and the number of fish (or proportion of a fish population) that is entrained (Kimmerer 2008). The SWP and CVP intakes are very large (several thousand cfs each), whereas the project reservoir-island intakes are smaller (each being 1,000-2000 cfs) and the agricultural/habit island intakes are each less than 100 cfs. Moyle and Israel (2005) noted that there is scant information on entrainment of fish in the Central Valley, but that one example from the Yuba River illustrates the concept (also recently highlighted by Kimmerer 2008) that the number of fish entrained increases in a non-linear manner (Figure B-2). An examination of various sources that included predictive entrainment-flow relationships at relatively large intakes was made to determine the ratio of the density of fish entrained at 2,000 cfs (i.e., a similar size to the Project reservoir island intakes) compared to the density of fish entrained at 4,000 cfs (i.e., a similar size to the SWP and CVP intakes). The first five examples presented in Table B-33 are from the NMFS OCAP BO (2009, 370-372) and the other two are examples from power plant cooling-water intakes. The average ratio from all studies combined is 0.49; that is, the average density of fish salvaged or entrained at a 2,000-cfs intake is approximately half that of a 4,000-cfs intake. It was therefore assumed that 0.5 was a reasonable small-intake correction factor for the reservoir-island intakes. The reasons for the nonlinear relationship may be the increase in 'draw' of fish from an adjacent water body with increasing diversion size, as would occur when the proportion of the water volume diverted increases.

In the case of the SWP/CVP export facilities, NMFS (2009, 369) suggested that relationship could be attributable to the faster transit time past predators, giving more fish at the salvage facilities and lower prescreen predation losses.

Table B-33. Ratio of Fish Density Salvaged or Entrained at Various Water Intakes of 2,000 cfs and 4,000 cfs

Study	Density (2,000-cfs intake)	Density (4,000-cfs intake)	Ratio
Chinook salmon salvage, older juveniles (SWP) (NMFS 2009)	0.063	0.092	0.251
Chinook salmon salvage, older juveniles (SWP) (NMFS 2009)	0.006	0.024	0.251
Steelhead salvage (unclipped; SWP) (NMFS 2009)	0.022	0.028	0.794
Steelhead salvage (clipped; SWP) (NMFS 2009)	0.007	0.0286	0.260
Steelhead salvage (unclipped; CVP) (NMFS 2009)	0.025	0.044	0.560
Great Lakes power plants (all fish) (Kelso and Milburn 1979)	601.1	1056.9	0.569
Northeast European coastal power plants (all fish) (Greenwood 2008)	1230.3	3580.2	0.344

For agricultural intakes of relatively small size (<100 cfs), the small-intake correction factor was 0.1, i.e., 10% of the density of fish drawn to the SWP/CVP intakes. This value was based on a comparison of the density (number of white catfish/taf) diverted at Bacon Island during sampling in the summers of 1993, 1994, and 1995 (Cooke and Buffaloe 1998) to the average density of fish entrained into the SWP and CVP intakes (after correcting for prescreen losses, see below). White catfish (greater than 30 mm long) were the main species for which adequate numbers of fish appeared to have been entrained. The density of white catfish entrained into the agricultural diversion ranged from 25 fish/taf in 1995 to almost 36 fish/taf in 1994. The estimated density of fish entrained into the SWP and CVP intakes ranged from almost 146 fish/taf in 1995 to nearly 1,250 fish in 1993. The average annual ratio of the densities (agricultural intake: SWP/CVP intake) was 0.083, i.e., the density of fish in the agricultural intake was 8.3% that of the density at the SWP/CVP intakes. This suggested that a ratio of 10% would be a reasonable small-intake correction factor for the agricultural and habitat-island intakes in the analysis of Project effects. The entrainment loss for the agricultural diversions under existing/baseline conditions was estimated as:

> Existing agricultural entrainment loss (number of fish) = Fish density (fish/taf) × water diverted (taf) × small-intake correction factor (0.1).

These assumptions regarding small-intake correction factors are based on limited existing information and so comparative analyses were also conducted using values for the reservoir intakes of 50% and 100% and for the agricultural/habitat island intakes of 10%, 50%, and 100%.

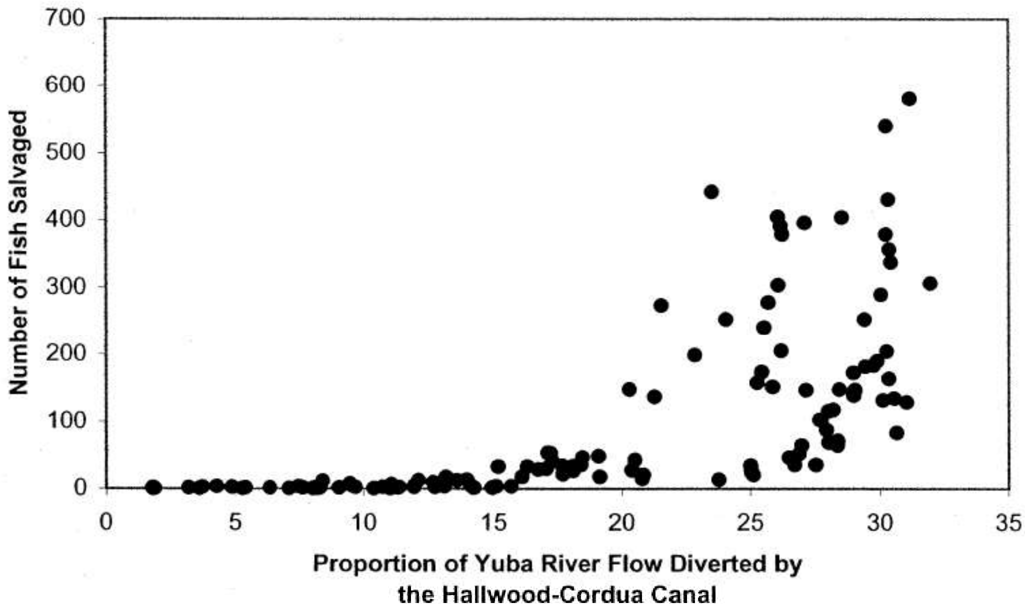


Figure B-2. Relation between the Number of Rainbow Trout Salvaged Daily by DFG at the Hallwood-Cordua Fish Screen between 13 April and 17 August, 2000, and the Proportion of Yuba River Flow Diverted by the Hallwood-Cordua Canal

Source: reproduced from Kozlowski (2004)

The increased entrainment at the SWP fish facility due to Project discharges of reservoir island water was estimated in the same manner as described above for the baseline entrainment:

> Entrainment loss through SWP export of Project water (number of fish) = Fish density (fish/taf) × water exported (taf) × loss multiplier.

The impact of the Project was compared to the baseline entrainment attributable to SWP and CVP water exports. The benefit of the Project (screening and reduction of agricultural diversions) was weighed against the impacts caused by diversions to the Project reservoir and Habitat Islands and export of Project water by the SWP facility.

Main Assumptions

To summarize, the entrainment analysis of juvenile and adult fish assumed:

- diversions to the Project Reservoir Islands occur in December–March;
- discharges for export occur in July–November;

- density of fish in the Delta can be estimated from historic SWP and CVP salvage data by applying appropriate corrections for presalvage losses (see above);
- the density of fish is the same in each year and differs by month according to seasonal patterns;
- the volume of water diverted or exported is directly related to the loss of fish, with corrections for pre-/post-salvage losses, screening effectiveness, and size of the intake;
- delta smelt adults occur from December to March and 25% of fish in April salvaged are adults—delta smelt in the remainder of the year are juveniles;
- chinook salmon race (run) can be determined from length in a given month using the key established for the Delta (Green 2004)
- diversions to the agricultural and Habitat Islands are the same (quantity and timing) in all years;
- baseline losses to Delta lowland agricultural diversions are 20 times greater than losses estimated for existing Project agricultural diversions—this assumption is based on the relative size of the irrigated acreages (the Project is 5% of the total lowland irrigated acreage) and that other irrigation in the Delta follows the same annual pattern of diversion as the existing Project agriculture.

Results

Fall-Run Chinook Salmon

The baseline entrainment loss of fall-run Chinook salmon by SWP and CVP averaged about 291,000 fish from 1980 to 2003 (Table B-34). The lowest entrainment loss of about 131,000 fish occurred in 1992 and the maximum entrainment was nearly 508,000 fish in 1995. Direct entrainment loss of fall-run Chinook salmon estimated for the Project ranged from 0 fish in 1990 and 1994 to 384 fish in 1986, and averaged 74 fish (Table B-35); this represented an average increased entrainment over baseline conditions of 0–0.2%. Loss of fall-run Chinook salmon due to export of discharged Project water averaged 311 fish, ranging from 0 (several years) to almost 1,200 in 1986; this was 0–0.5% of baseline losses (Table B-36).

Based on the assumed monthly density of fall-run Chinook salmon and the schedule of diversions for agriculture (under the existing/baseline conditions) and for the Habitat Islands (under the Project), it was estimated there would be a net benefit of the Project: 523 less fall-run Chinook salmon would be entrained annually (Table B-37). As a whole, the Project was estimated to result in a slight net benefit to fall-run Chinook salmon because the potential increase in entrainment caused by Project diversions (to the reservoir and Habitat Islands) from December to March and the export of Project water from July to November was offset by the decrease in entrainment attributable to the reduction and screening of the agricultural diversions. This net benefit averaged 138 fish per year, or 0.0% of the baseline entrainment by SWP and CVP (Table B-38).

Table B-34. Baseline Entrainment Loss of Fall-Run Chinook Salmon by SWP and CVP Export Facilities Assumed in the Analysis of Small Juvenile and Adult Fish

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Estimated Loss
	Assumed Density (Fish/taf)												
	9.5	11.8	3.6	9.6	66.7	31.9	126.4	611.2	246.5	4.5	0.4	0.5	
1980	3,449	5,750	1,801	5,419	29,986	11,678	40,750	149,160	76,429	1,881	165	245	326,712
1981	3,967	4,331	1,644	4,988	32,186	13,741	25,479	117,730	70,651	2,190	148	197	277,250
1982	4,141	5,751	1,800	5,110	33,084	14,073	47,791	269,785	106,004	2,266	221	249	490,275
1983	4,676	5,759	1,847	4,793	28,192	9,908	49,719	275,359	106,004	2,266	221	249	488,993
1984	4,676	5,759	1,693	3,614	26,832	12,841	25,235	102,047	68,526	2,069	219	228	253,740
1985	4,648	5,747	1,795	4,751	24,678	8,130	23,105	121,905	67,057	2,254	219	220	264,510
1986	3,650	4,734	1,799	4,918	37,776	14,353	45,235	227,631	65,906	1,608	193	249	408,052
1987	4,279	4,867	1,336	3,401	25,367	11,062	6,175	108,438	65,359	2,122	58	104	232,569
1988	2,556	3,002	1,784	4,875	6,236	2,223	17,214	45,787	47,054	1,747	29	97	132,604
1989	1,791	2,693	1,071	2,606	6,459	14,923	26,882	72,924	62,968	2,184	206	172	194,879
1990	3,292	3,878	1,235	4,833	9,579	6,838	6,175	63,555	48,843	1,506	76	116	149,925
1991	1,834	2,458	354	1,152	7,208	16,001	8,933	68,004	24,785	1,349	70	115	132,263
1992	2,144	1,513	695	1,927	34,636	10,627	10,957	29,868	37,448	766	121	119	130,821
1993	1,696	2,049	1,172	5,306	35,874	15,573	36,708	136,728	99,868	2,254	212	248	337,687
1994	4,568	4,162	1,500	4,019	31,781	8,471	14,867	87,002	64,654	2,261	203	135	223,623
1995	2,939	2,326	1,725	5,169	36,618	15,849	56,014	278,395	106,004	2,266	221	249	507,775
1996	4,676	5,759	1,801	4,688	28,512	11,422	44,116	187,212	76,849	1,581	199	249	367,064
1997	3,298	5,753	1,894	4,856	33,839	12,055	29,499	102,016	65,139	1,266	220	203	260,039
1998	3,355	5,204	1,798	4,767	33,740	12,320	49,769	265,157	106,004	2,266	221	249	484,851
1999	4,676	5,759	1,827	4,773	30,098	13,000	39,706	118,235	69,821	1,900	210	249	290,254
2000	4,330	5,750	1,410	4,883	33,553	14,892	37,653	143,427	75,980	1,537	220	238	323,871
2001	4,092	5,563	1,802	4,984	34,776	14,356	16,307	60,043	29,985	1,771	69	120	173,868
2002	2,403	4,066	1,795	4,989	3,261	6,519	23,400	106,575	65,705	2,220	196	149	221,279
2003	2,366	5,743	1,789	4,873	3,824	12,510	33,906	169,581	74,872	1,633	216	234	311,546
Avg	3,479	4,516	1,557	4,404	25,337	11,807	29,816	137,774	70,080	1,882	172	195	291,019

Table B-35. Entrainment Loss of Fall-Run Chinook Salmon during Diversions onto the Project Reservoir Islands

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Estimated Loss	% of Baseline
	Assumed Density (Fish/taf)													
	9.5	11.8	3.6	9.6	66.7	31.9	126.4	611.2	246.5	4.5	0.4	0.5		
1980	0	0	0	50	1	1	0	0	0	0	0	0	52	0.0%
1981	0	0	0	38	0	42	0	0	0	0	0	0	80	0.0%
1982	0	0	19	0	1	1	0	0	0	0	0	0	21	0.0%
1983	0	0	19	0	1	1	0	0	0	0	0	0	21	0.0%
1984	0	0	19	0	1	1	0	0	0	0	0	0	21	0.0%
1985	0	0	17	0	0	0	0	0	0	0	0	0	17	0.0%
1986	0	0	0	0	380	4	0	0	0	0	0	0	384	0.1%
1987	0	0	0	0	0	144	0	0	0	0	0	0	144	0.1%
1988	0	0	0	43	0	0	0	0	0	0	0	0	43	0.0%
1989	0	0	0	0	0	167	0	0	0	0	0	0	167	0.1%
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1991	0	0	0	0	0	19	0	0	0	0	0	0	19	0.0%
1992	0	0	0	0	312	0	0	0	0	0	0	0	312	0.2%
1993	0	0	0	50	1	1	0	0	0	0	0	0	52	0.0%
1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1995	0	0	0	50	1	1	0	0	0	0	0	0	52	0.0%
1996	0	0	0	50	1	1	0	0	0	0	0	0	52	0.0%
1997	0	0	19	0	1	1	0	0	0	0	0	0	21	0.0%
1998	0	0	0	50	1	1	0	0	0	0	0	0	52	0.0%
1999	0	0	19	0	1	1	0	0	0	0	0	0	21	0.0%
2000	0	0	0	38	94	1	0	0	0	0	0	0	133	0.0%
2001	0	0	0	0	70	0	0	0	0	0	0	0	70	0.0%
2002	0	0	11	21	0	0	0	0	0	0	0	0	32	0.0%
2003	0	0	19	0	0	0	0	0	0	0	0	0	19	0.0%
Average	0	0	6	16	36	16	0	0	0	0	0	0	74	0.0%

Table B-36. Entrainment Loss of Fall-Run Chinook Salmon during Export of Water Discharged from the Project Islands

Water year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Estimated loss	% of baseline
	Assumed density (Fish/taf)													
	9.5	11.8	3.6	9.6	66.7	31.9	126.4	611.2	246.5	4.5	0.4	0.5		
1980	0	0	0	0	0	0	0	0	0	0	46	4	50	0.0%
1981	563	0	0	0	0	0	0	0	0	41	51	22	677	0.2%
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1984	0	0	0	0	0	0	0	0	0	88	0	23	112	0.0%
1985	0	0	0	0	0	0	0	0	0	0	0	18	18	0.0%
1986	701	0	0	0	0	0	0	0	0	447	29	0	1,178	0.3%
1987	60	0	0	0	0	0	0	0	0	0	0	58	118	0.1%
1988	0	0	0	0	0	0	0	0	0	163	58	0	221	0.2%
1989	0	0	0	0	0	0	0	0	0	0	9	43	52	0.0%
1990	153	0	0	0	0	0	0	0	0	0	0	0	153	0.1%
1991	0	0	0	0	0	0	0	0	0	77	0	0	77	0.1%
1992	0	0	0	0	0	0	0	0	0	607	3	0	610	0.5%
1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1994	92	829	0	0	0	0	0	0	0	0	0	0	920	0.4%
1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1996	0	0	0	0	0	0	0	0	0	421	24	0	444	0.1%
1997	226	0	0	0	0	0	0	0	0	520	0	29	774	0.3%
1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1999	0	0	0	0	0	0	0	0	0	369	0	0	369	0.1%
2000	364	0	0	0	0	0	0	0	0	182	0	0	546	0.2%
2001	636	174	0	0	0	0	0	0	0	129	0	0	939	0.5%
2002	0	0	0	0	0	0	0	0	0	0	22	56	78	0.0%
2003	0	0	0	0	0	0	0	0	0	124	0	0	124	0.0%
Average	116	42	0	0	0	0	0	0	0	132	10	11	311	0.1%

Table B-37. Entrainment Loss of Fall-Run Chinook Salmon during Existing Agricultural Diversions Compared to Entrainment Loss during Diversions to the Habitat Islands under the Project

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Number of fish
	Assumed density (Fish/taf)												
	9.5	11.8	3.6	9.6	66.7	31.9	126.4	611.2	246.5	4.5	0.4	0.5	
Agricultural diversions	2	0	1	3	19	0	0	165	332	7	1	0	529
Habitat island diversions	0	0	0	0	0	0	0	1	4	0	0	0	6
Project Benefit	2	0	1	3	19	0	0	163	328	7	1	0	523

Table B-38. Summary of Fall-Run Chinook Salmon Entrainment Loss Impacts of the Project Compared to the Baseline Conditions

			Project Diversion Impact[3]		Project Export Impact[4]		Baseline Project Agricultural Diversion	Project Habitat Diversion	Project Benefit from Reduced and Screened Agricultural Diversions[7]		Net Project Impact	
	Baseline CVP/SWP Loss[1]	Baseline Delta Lowland Agriculture Loss[2]	Loss	% of Baseline SWP/CVP	Loss	% of Baseline SWP/CVP	Loss[5]	Loss[6]	Reduced Loss	% of SWP/CVP	Loss	% of SWP/CVP
1980	326,712	10,571	52	0.0%	50	0.0%	529	6	523	0.2%	-421	-0.1%
1981	277,250	10,571	80	0.0%	677	0.2%	529	6	523	0.2%	233	0.1%
1982	490,275	10,571	21	0.0%	0	0.0%	529	6	523	0.1%	-502	-0.1%
1983	488,993	10,571	21	0.0%	0	0.0%	529	6	523	0.1%	-502	-0.1%
1984	253,740	10,571	21	0.0%	112	0.0%	529	6	523	0.2%	-390	-0.2%
1985	264,510	10,571	17	0.0%	18	0.0%	529	6	523	0.2%	-488	-0.2%
1986	408,052	10,571	384	0.1%	1,178	0.3%	529	6	523	0.1%	1,039	0.3%
1987	232,569	10,571	144	0.1%	118	0.1%	529	6	523	0.2%	-261	-0.1%
1988	132,604	10,571	43	0.0%	221	0.2%	529	6	523	0.4%	-259	-0.2%
1989	194,879	10,571	167	0.1%	52	0.0%	529	6	523	0.3%	-304	-0.2%
1990	149,925	10,571	0	0.0%	153	0.1%	529	6	523	0.3%	-370	-0.2%
1991	132,263	10,571	19	0.0%	77	0.1%	529	6	523	0.4%	-427	-0.3%
1992	130,821	10,571	312	0.2%	610	0.5%	529	6	523	0.4%	399	0.3%
1993	337,687	10,571	52	0.0%	0	0.0%	529	6	523	0.2%	-471	-0.1%
1994	223,623	10,571	0	0.0%	920	0.4%	529	6	523	0.2%	397	0.2%
1995	507,775	10,571	52	0.0%	0	0.0%	529	6	523	0.1%	-471	-0.1%
1996	367,064	10,571	52	0.0%	444	0.1%	529	6	523	0.1%	-26	0.0%
1997	260,039	10,571	21	0.0%	774	0.3%	529	6	523	0.2%	273	0.1%
1998	484,851	10,571	52	0.0%	0	0.0%	529	6	523	0.1%	-471	-0.1%

	Baseline CVP/SWP Loss[1]	Baseline Delta Lowland Agriculture Loss[2]	Project Diversion Impact[3]		Project Export Impact[4]		Baseline Project Agricultural Diversion	Project Habitat Diversion	Project Benefit from Reduced and Screened Agricultural Diversions[7]		Net Project Impact	
			Loss	% of Baseline SWP/CVP	Loss	% of Baseline SWP/CVP	Loss[5]	Loss[6]	Reduced Loss	% of SWP/CVP	Loss	% of SWP/CVP
1999	290,254	10,571	21	0.0%	369	0.1%	529	6	523	0.2%	-133	0.0%
2000	323,871	10,571	133	0.0%	546	0.2%	529	6	523	0.2%	156	0.0%
2001	173,868	10,571	70	0.0%	939	0.5%	529	6	523	0.3%	486	0.3%
2002	221,279	10,571	32	0.0%	78	0.0%	529	6	523	0.2%	-413	-0.2%
2003	311,546	10,571	19	0.0%	124	0.0%	529	6	523	0.2%	-380	-0.1%
Avg.	291,019	10,571	74	0.0%	311	0.1%	529	6	523	0.2%	-138	0.0%

Notes.

1 Based on average of monthly fish densities at salvage (fish/taf) extrapolated to account for pre- and postsalvage losses and multiplied by export flows.

2 Assumes baseline loss is 20 times that of the Project agricultural diversion loss (based on the Project being 5% of irrigated Delta acreage).

3 Assumes diversions from December to March, 50% small-intake correction, and 95% screening efficiency.

4 Increased loss of fish assuming SWP export of discharged Project water from July to November.

5 Assumes similar pattern of agricultural diversions each year, and10% small-intake correction..

6 Assumes 95% screening efficiency, 10% small-intake correction, and similar pattern of habitat diversions each year.

7 Calculated as entrainment loss to existing Project agricultural diversions minus entrainment loss to Project wetland habitat diversions.

Late-Fall-Run Chinook Salmon

The baseline entrainment loss of late-fall-run Chinook salmon by SWP and CVP averaged just over 20,000 fish from 1980 to 2003 (Table B-39). The lowest entrainment loss of about 6,500 fish occurred in 1991 and the maximum entrainment was over 24,400 fish in 1997. Direct entrainment loss of late-fall-run Chinook salmon estimated for the Project ranged from 0 fish (several years) to 137 fish (several years), and averaged 52 fish (Table B-40); this represented an average increased entrainment over baseline conditions of 0–0.6%. Loss of late-fall-run Chinook salmon due to export of discharged Project water averaged 79 fish, ranging from 0 (several years) to over 900 in 1994; this amounted to 0–4.6% of baseline losses (Table B-41).

Based on the assumed monthly density of late-fall-run Chinook salmon and the schedule of diversions for agriculture (under the existing/baseline conditions) and for the Habitat Islands (under the Project), it was estimated there would be a net benefit of the Project: 10 less late-fall-run Chinook salmon would be entrained annually (Table B-42). As a whole, the Project was estimated to result in a net loss to late-fall-run Chinook salmon because the potential increase in entrainment caused by Project diversions (to the reservoir and Habitat Islands) from

December to March and the export of Project water from July to November was not offset by the decrease in entrainment attributable to the reduction and screening of the agricultural diversions. This net loss averaged 121 fish per year, or 0.6% of the baseline entrainment by SWP and CVP (Table B-43).

Table B-39. Baseline Entrainment Loss of Late Fall–Run Chinook Salmon by SWP and CVP Export Facilities Assumed in the Analysis of Small Juvenile and Adult Fish

Water year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Estimated loss
	Assumed density (Fish/taf)												
	2.7	12.6	26.1	4.7	2.1	0.0	0.0	0.0	0.2	0.0	0.0	0.1	
1980	973	6,094	13,130	2,679	946	0	7	0	58	0	8	34	23,929
1981	1,119	4,590	11,984	2,466	1,016	0	4	0	54	0	7	27	21,268
1982	1,168	6,095	13,122	2,526	1,044	0	8	0	81	0	11	35	24,090
1983	1,320	6,103	13,469	2,369	890	0	8	0	81	0	11	35	24,285
1984	1,320	6,103	12,342	1,787	847	0	4	0	52	0	11	32	22,497
1985	1,312	6,091	13,090	2,349	779	0	4	0	51	0	11	31	23,717
1986	1,030	5,017	13,115	2,431	1,192	0	8	0	50	0	9	35	22,887
1987	1,208	5,158	9,741	1,681	800	0	1	0	50	0	3	15	18,657
1988	721	3,182	13,005	2,410	197	0	3	0	36	0	1	14	19,568
1989	505	2,854	7,812	1,288	204	0	5	0	48	0	10	24	12,750
1990	929	4,110	9,007	2,389	302	0	1	0	37	0	4	16	16,795
1991	517	2,605	2,584	569	227	0	2	0	19	0	3	16	6,543
1992	605	1,604	5,066	953	1,093	0	2	0	29	0	6	17	9,373
1993	479	2,171	8,543	2,623	1,132	0	6	0	76	0	10	35	15,075
1994	1,289	4,411	10,933	1,987	1,003	0	3	0	49	0	10	19	19,702
1995	829	2,466	12,579	2,555	1,155	0	9	0	81	0	11	35	19,721
1996	1,320	6,103	13,131	2,318	900	0	7	0	59	0	10	35	23,881
1997	931	6,097	13,812	2,400	1,068	0	5	0	50	0	11	28	24,402
1998	947	5,516	13,109	2,356	1,065	0	8	0	81	0	11	35	23,128
1999	1,320	6,103	13,322	2,359	950	0	7	0	53	0	10	35	24,159
2000	1,222	6,094	10,279	2,414	1,059	0	6	0	58	0	11	33	21,174
2001	1,155	5,895	13,137	2,464	1,097	0	3	0	23	0	3	17	23,794
2002	678	4,309	13,089	2,466	103	0	4	0	50	0	10	21	20,730
2003	668	6,086	13,041	2,409	121	0	6	0	57	0	11	33	22,431
Average	982	4,786	11,352	2,177	799	0	5	0	54	0	8	27	20,190

Table B-40. Entrainment Loss of Late Fall–Run Chinook Salmon during Diversions onto the Project Reservoir Islands

Water year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Estimated loss	% of baseline
	Assumed density (Fish/taf)													
	2.7	12.6	26.1	4.7	2.1	0.0	0.0	0.0	0.2	0.0	0.0	0.1		
1980	0	0	0	25	0	0	0	0	0	0	0	0	25	0.1%
1981	0	0	0	19	0	0	0	0	0	0	0	0	19	0.1%
1982	0	0	137	0	0	0	0	0	0	0	0	0	137	0.6%
1983	0	0	137	0	0	0	0	0	0	0	0	0	137	0.6%
1984	0	0	137	0	0	0	0	0	0	0	0	0	137	0.6%
1985	0	0	123	0	0	0	0	0	0	0	0	0	123	0.5%
1986	0	0	0	0	12	0	0	0	0	0	0	0	12	0.1%
1987	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1988	0	0	0	21	0	0	0	0	0	0	0	0	21	0.1%
1989	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1992	0	0	0	0	10	0	0	0	0	0	0	0	10	0.1%
1993	0	0	0	25	0	0	0	0	0	0	0	0	25	0.2%
1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1995	0	0	0	25	0	0	0	0	0	0	0	0	25	0.1%
1996	0	0	0	25	0	0	0	0	0	0	0	0	25	0.1%
1997	0	0	137	0	0	0	0	0	0	0	0	0	137	0.6%
1998	0	0	0	25	0	0	0	0	0	0	0	0	25	0.1%
1999	0	0	137	0	0	0	0	0	0	0	0	0	137	0.6%
2000	0	0	0	19	3	0	0	0	0	0	0	0	22	0.1%
2001	0	0	0	0	2	0	0	0	0	0	0	0	2	0.0%
2002	0	0	80	10	0	0	0	0	0	0	0	0	90	0.4%
2003	0	0	137	0	0	0	0	0	0	0	0	0	137	0.6%
Average	0	0	43	8	1	0	0	0	0	0	0	0	52	0.3%

Table B-41. Entrainment Loss of Late Fall–Run Chinook Salmon during Export of Water Discharged from the Project Islands

Water year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Estimated loss	% of baseline
	Assumed density (Fish/taf)													
	2.7	12.6	26.1	4.7	2.1	0.0	0.0	0.0	0.2	0.0	0.0	0.1		
1980	0	0	0	0	0	0	0	0	0	0	2	1	3	0.0%
1981	159	0	0	0	0	0	0	0	0	0	2	3	164	0.8%
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1984	0	0	0	0	0	0	0	0	0	0	0	3	3	0.0%
1985	0	0	0	0	0	0	0	0	0	0	0	3	3	0.0%
1986	198	0	0	0	0	0	0	0	0	0	1	0	199	0.9%
1987	17	0	0	0	0	0	0	0	0	0	0	8	25	0.1%
1988	0	0	0	0	0	0	0	0	0	0	3	0	3	0.0%
1989	0	0	0	0	0	0	0	0	0	0	0	6	6	0.1%
1990	43	0	0	0	0	0	0	0	0	0	0	0	43	0.3%
1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1992	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1994	26	878	0	0	0	0	0	0	0	0	0	0	904	4.6%
1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1996	0	0	0	0	0	0	0	0	0	0	1	0	1	0.0%
1997	64	0	0	0	0	0	0	0	0	0	0	4	68	0.3%
1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
2000	103	0	0	0	0	0	0	0	0	0	0	0	103	0.5%
2001	179	184	0	0	0	0	0	0	0	0	0	0	364	1.5%
2002	0	0	0	0	0	0	0	0	0	0	1	8	9	0.0%
2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
Average	33	44	0	0	0	0	0	0	0	0	0	1	79	0.4%

Table B-42. Entrainment Loss of Late Fall–Run Chinook Salmon during Existing Agricultural Diversions Compared to Entrainment Loss during Diversions to the Habitat Islands under the Project

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Number of fish
	Assumed density (Fish/taf)												
	2.7	12.6	26.1	4.7	2.1	0.0	0.0	0.0	0.2	0.0	0.0	0.1	
Agricultural diversions	0	0	7	1	1	0	0	0	0	0	0	0	10
Habitat island diversions	0	0	0	0	0	0	0	0	0	0	0	0	0
Project Benefit	0	0	7	1	1	0	0	0	0	0	0	0	10

Table B-43. Summary of Late Fall–Run Chinook Salmon Entrainment Loss Impacts of the Project Compared to the Baseline Conditions

			Project Diversion Impact[3]		Project Export Impact[4]		Baseline Project Agricultural Diversion	Project Habitat Diversion	Project Benefit from Reduced and Screened Agricultural Diversions[7]		Net Project Impact	
	Baseline CVP/ SWP Loss[1]	Baseline Delta Lowland Agriculture Loss[2]	Loss	% of Baseline SWP/ CVP	Loss	% of Baseline SWP/ CVP	Loss[5]	Loss[6]	Reduced Loss	% of SWP/ CVP	Loss	% of SWP/ CVP
1980	23,929	202	25	0.1%	3	0.0%	10	0	10	0.0%	18	0.1%
1981	21,268	202	19	0.1%	164	0.8%	10	0	10	0.0%	173	0.8%
1982	24,090	202	137	0.6%	0	0.0%	10	0	10	0.0%	127	0.5%
1983	24,285	202	137	0.6%	0	0.0%	10	0	10	0.0%	127	0.5%
1984	22,497	202	137	0.6%	3	0.0%	10	0	10	0.0%	130	0.6%
1985	23,717	202	123	0.5%	3	0.0%	10	0	10	0.0%	116	0.5%
1986	22,887	202	12	0.1%	199	0.9%	10	0	10	0.0%	202	0.9%
1987	18,657	202	0	0.0%	25	0.1%	10	0	10	0.1%	15	0.1%
1988	19,568	202	21	0.1%	3	0.0%	10	0	10	0.0%	14	0.1%
1989	12,750	202	0	0.0%	6	0.1%	10	0	10	0.1%	-3	0.0%
1990	16,795	202	0	0.0%	43	0.3%	10	0	10	0.1%	34	0.2%
1991	6,543	202	0	0.0%	0	0.0%	10	0	10	0.1%	-10	-0.1%
1992	9,373	202	10	0.1%	0	0.0%	10	0	10	0.1%	0	0.0%
1993	15,075	202	25	0.2%	0	0.0%	10	0	10	0.1%	15	0.1%
1994	19,702	202	0	0.0%	904	4.6%	10	0	10	0.0%	894	4.5%
1995	19,721	202	25	0.1%	0	0.0%	10	0	10	0.0%	15	0.1%
1996	23,881	202	25	0.1%	1	0.0%	10	0	10	0.0%	16	0.1%
1997	24,402	202	137	0.6%	68	0.3%	10	0	10	0.0%	195	0.8%
1998	23,128	202	25	0.1%	0	0.0%	10	0	10	0.0%	15	0.1%

	Baseline CVP/ SWP Loss[1]	Baseline Delta Lowland Agriculture Loss[2]	Project Diversion Impact[3] Loss	Project Diversion Impact[3] % of Baseline SWP/ CVP	Project Export Impact[4] Loss	Project Export Impact[4] % of Baseline SWP/ CVP	Baseline Project Agricultural Diversion Loss[5]	Project Habitat Diversion Loss[6]	Project Benefit from Reduced and Screened Agricultural Diversions[7] Reduced Loss	Project Benefit from Reduced and Screened Agricultural Diversions[7] % of SWP/ CVP	Net Project Impact Loss	Net Project Impact % of SWP/ CVP
1999	24,159	202	137	0.6%	0	0.0%	10	0	10	0.0%	127	0.5%
2000	21,174	202	22	0.1%	103	0.5%	10	0	10	0.0%	115	0.5%
2001	23,794	202	2	0.0%	364	1.5%	10	0	10	0.0%	356	1.5%
2002	20,730	202	90	0.4%	9	0.0%	10	0	10	0.0%	90	0.4%
2003	22,431	202	137	0.6%	0	0.0%	10	0	10	0.0%	127	0.6%
Average	20,190	202	52	0.2%	79	0.4%	10	0	10	0.1%	121	0.6%

Notes. [1]Based on average of monthly fish densities at salvage (fish/taf) extrapolated to account for pre- and postsalvage losses and multiplied by export flows.
[2] Assumes baseline loss is 20 times that of the Project agricultural diversion loss (based on the Project being 5% of irrigated Delta acreage).
[3]Assumes diversions from December to March, 50% small-intake correction, and 95% screening efficiency.
[4]Increased loss of fish assuming SWP export of discharged Project water from July to November.
[5]Assumes similar pattern of agricultural diversions each year, and10% small-intake correction..
[6]Assumes 95% screening efficiency, 10% small-intake correction, and similar pattern of habitat diversions each year.
[7] Calculated as entrainment loss to existing Project agricultural diversions minus entrainment loss to Project wetland habitat diversions.

Winter-Run Chinook Salmon

The baseline entrainment loss of winter-run Chinook salmon by SWP and CVP averaged about 60,000 fish from 1980 to 2003 (Table B-44). The lowest entrainment loss of about 31,000 fish occurred in 1991and the maximum entrainment was just over 80,000 fish in 1995. Direct entrainment loss of winter-run Chinook salmon estimated for the Project ranged from 0 fish in 1990 and 1994 to 424 fish in 1986, and averaged 120 fish (Table B-45); this represented an average increased entrainment over baseline conditions of 0–0.2%. Loss of winter-run Chinook salmon due to export of discharged Project water did not occur because discharges were assumed to occur in July–November (Table B-46).

Based on the assumed monthly density of winter-run Chinook salmon and the schedule of diversions for agriculture (under the existing/baseline conditions) and for the Habitat Islands (under the Project), it was estimated there would be a net benefit of the Project: 31 less winter-run Chinook salmon would be entrained annually (Table B-47). As a whole, the Project was estimated to result in a net loss to winter-run Chinook salmon because the potential increase in entrainment caused by Project diversions (to the reservoir and Habitat Islands) from

December to March was not offset by the decrease in entrainment attributable to the reduction and screening of the agricultural diversions. This net loss averaged 85 fish per year, or 0.1% of the baseline entrainment by SWP and CVP (Table B-48).

Table B-44. Baseline Entrainment Loss of Winter-Run Chinook Salmon by SWP and CVP Export Facilities Assumed in the Analysis of Small Juvenile and Adult Fish

Water year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Estimated loss
	Assumed density (Fish/taf)												
	0.0	0.0	18.7	18.5	73.6	36.5	9.0	1.0	0.0	0.0	0.0	0.0	
1980	0	0	9,403	10,441	33,076	13,353	2,911	246	0	0	0	0	69,429
1981	0	0	8,582	9,611	35,502	15,711	1,820	194	0	0	0	0	71,421
1982	0	0	9,397	9,847	36,493	16,091	3,414	445	0	0	0	0	75,687
1983	0	0	9,645	9,235	31,097	11,328	3,552	455	0	0	0	0	65,312
1984	0	0	8,838	6,964	29,596	14,683	1,803	168	0	0	0	0	62,053
1985	0	0	9,374	9,155	27,220	9,295	1,650	201	0	0	0	0	56,897
1986	0	0	9,392	9,475	41,668	16,412	3,231	376	0	0	0	0	80,554
1987	0	0	6,976	6,554	27,981	12,648	441	179	0	0	0	0	54,779
1988	0	0	9,313	9,393	6,879	2,542	1,230	76	0	0	0	0	29,432
1989	0	0	5,594	5,021	7,124	17,063	1,920	120	0	0	0	0	36,843
1990	0	0	6,450	9,312	10,566	7,819	441	105	0	0	0	0	34,693
1991	0	0	1,850	2,220	7,950	18,295	638	112	0	0	0	0	31,066
1992	0	0	3,628	3,713	38,205	12,150	783	49	0	0	0	0	58,528
1993	0	0	6,118	10,223	39,571	17,806	2,622	226	0	0	0	0	76,565
1994	0	0	7,829	7,745	35,056	9,686	1,062	144	0	0	0	0	61,521
1995	0	0	9,008	9,959	40,391	18,122	4,001	460	0	0	0	0	81,942
1996	0	0	9,403	9,034	31,450	13,060	3,151	309	0	0	0	0	66,407
1997	0	0	9,891	9,356	37,326	13,784	2,107	168	0	0	0	0	72,632
1998	0	0	9,387	9,185	37,217	14,087	3,555	438	0	0	0	0	73,869
1999	0	0	9,540	9,196	33,199	14,864	2,836	195	0	0	0	0	69,831
2000	0	0	7,361	9,408	37,010	17,028	2,690	237	0	0	0	0	73,733
2001	0	0	9,408	9,603	38,360	16,415	1,165	99	0	0	0	0	75,049
2002	0	0	9,373	9,614	3,598	7,454	1,672	176	0	0	0	0	31,886
2003	0	0	9,339	9,388	4,218	14,303	2,422	280	0	0	0	0	39,951
Average	0	0	8,129	8,485	27,948	13,500	2,130	227	0	0	0	0	60,420

Table B-45. Entrainment Loss of Winter-Run Chinook Salmon during Diversions onto the Project Reservoir Islands

Water year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Estimated loss	% of baseline
	Assumed density (Fish/taf)													
	0.0	0.0	18.7	18.5	73.6	36.5	9.0	1.0	0.0	0.0	0.0	0.0		
1980	0	0	0	97	1	1	0	0	0	0	0	0	99	0.1%
1981	0	0	0	73	0	48	0	0	0	0	0	0	121	0.2%
1982	0	0	98	0	1	1	0	0	0	0	0	0	101	0.1%
1983	0	0	98	0	1	1	0	0	0	0	0	0	101	0.2%
1984	0	0	98	0	1	1	0	0	0	0	0	0	101	0.2%
1985	0	0	88	0	0	0	0	0	0	0	0	0	88	0.2%
1986	0	0	0	0	419	5	0	0	0	0	0	0	424	0.5%
1987	0	0	0	0	0	165	0	0	0	0	0	0	165	0.3%
1988	0	0	0	83	0	0	0	0	0	0	0	0	83	0.3%
1989	0	0	0	0	0	191	0	0	0	0	0	0	191	0.5%
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1991	0	0	0	0	0	22	0	0	0	0	0	0	22	0.1%
1992	0	0	0	0	344	0	0	0	0	0	0	0	344	0.6%
1993	0	0	0	97	1	1	0	0	0	0	0	0	99	0.1%
1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1995	0	0	0	97	1	1	0	0	0	0	0	0	99	0.1%
1996	0	0	0	97	1	1	0	0	0	0	0	0	99	0.1%
1997	0	0	98	0	1	1	0	0	0	0	0	0	101	0.1%
1998	0	0	0	97	1	1	0	0	0	0	0	0	99	0.1%
1999	0	0	98	0	1	1	0	0	0	0	0	0	101	0.1%
2000	0	0	0	73	103	1	0	0	0	0	0	0	177	0.2%
2001	0	0	0	0	77	0	0	0	0	0	0	0	77	0.1%
2002	0	0	57	40	0	0	0	0	0	0	0	0	98	0.3%
2003	0	0	98	0	0	0	0	0	0	0	0	0	98	0.2%
Average	0	0	31	31	40	18	0	0	0	0	0	0	120	0.2%

Table B-46. Entrainment Loss of Winter-Run Chinook Salmon during Export of Water Discharged from the Project Islands

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		
Water	**Assumed density (Fish/taf)**												Estimated	% of
year	0.0	0.0	18.7	18.5	73.6	36.5	9.0	1.0	0.0	0.0	0.0	0.0	loss	baseline
1980	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1981	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1984	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1985	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1986	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1987	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1988	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1989	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1992	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1997	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
2001	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
2002	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
Average	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%

Table B-47. Entrainment Loss of Winter-Run Chinook Salmon during Existing Agricultural Diversions Compared to Entrainment Loss During Diversions to the Habitat Islands under the Project

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
	Assumed density (Fish/taf)												Number
	0.0	0.0	18.7	18.5	73.6	36.5	9.0	1.0	0.0	0.0	0.0	0.0	of fish
Agricultural diversions	0	0	5	5	21	0	0	0	0	0	0	0	32
Habitat island diversions	0	0	2	0	3	0	0	0	0	0	0	0	1
Project Benefit	0	0	5	5	20	0	0	0	0	0	0	0	31

Table B-48. Summary of Winter-Run Chinook Salmon Entrainment Loss Impacts of the Project Compared to the Baseline Conditions

Water Year	Baseline CVP/ SWP Loss[1]	Baseline Delta Lowland Agriculture Loss[2]	Project Diversion Impact[3] Loss	Project Diversion Impact[3] % of Baseline SWP/ CVP	Project Export Impact[4] Loss	Project Export Impact[4] % of Baseline SWP/ CVP	Baseline Project Agricultural Diversion Loss[5]	Project Habitat Diversion Loss[6]	Project Benefit from Reduced and Screened Agricultural Diversions[7] Reduced Loss	Project Benefit from Reduced and Screened Agricultural Diversions[7] % of SWP/ CVP	Net Project Impact Loss	Net Project Impact % of SWP/ CVP
1980	69,429	633	99	0.1%	0	0.0%	32	1	31	0.0%	68	0.1%
1981	71,421	633	121	0.2%	0	0.0%	32	1	31	0.0%	90	0.1%
1982	75,687	633	101	0.1%	0	0.0%	32	1	31	0.0%	70	0.1%
1983	65,312	633	101	0.2%	0	0.0%	32	1	31	0.0%	70	0.1%
1984	62,053	633	101	0.2%	0	0.0%	32	1	31	0.1%	70	0.1%
1985	56,897	633	88	0.2%	0	0.0%	32	1	31	0.1%	57	0.1%
1986	80,554	633	424	0.5%	0	0.0%	32	1	31	0.0%	392	0.5%
1987	54,779	633	165	0.3%	0	0.0%	32	1	31	0.1%	133	0.2%
1988	29,432	633	83	0.3%	0	0.0%	32	1	31	0.1%	52	0.2%
1989	36,843	633	191	0.5%	0	0.0%	32	1	31	0.1%	160	0.4%
1990	34,693	633	0	0.0%	0	0.0%	32	1	31	0.1%	-31	-0.1%
1991	31,066	633	22	0.1%	0	0.0%	32	1	31	0.1%	-9	0.0%
1992	58,528	633	344	0.6%	0	0.0%	32	1	31	0.1%	313	0.5%
1993	76,565	633	99	0.1%	0	0.0%	32	1	31	0.0%	68	0.1%
1994	61,521	633	0	0.0%	0	0.0%	32	1	31	0.1%	-31	-0.1%
1995	81,942	633	99	0.1%	0	0.0%	32	1	31	0.0%	68	0.1%
1996	66,407	633	99	0.1%	0	0.0%	32	1	31	0.0%	68	0.1%
1997	72,632	633	101	0.1%	0	0.0%	32	1	31	0.0%	70	0.1%
1998	73,869	633	99	0.1%	0	0.0%	32	1	31	0.0%	68	0.1%
1999	69,831	633	101	0.1%	0	0.0%	32	1	31	0.0%	70	0.1%
2000	73,733	633	177	0.2%	0	0.0%	32	1	31	0.0%	146	0.2%
2001	75,049	633	77	0.1%	0	0.0%	32	1	31	0.0%	46	0.1%
2002	31,886	633	98	0.3%	0	0.0%	32	1	31	0.1%	67	0.2%
2003	39,951	633	98	0.2%	0	0.0%	32	1	31	0.1%	67	0.2%
Avg.	60,420	633	120	0.2%	0	0.0%	32	1	31	0.1%	89	0.1%

Notes.

1 Based on average of monthly fish densities at salvage (fish/taf) extrapolated to account for pre- and postsalvage losses and multiplied by export flows.

2 Assumes baseline loss is 20 times that of the Project agricultural diversion loss (based on the Project being 5% of irrigated Delta acreage).

3 Assumes diversions from December to March, 50% small-intake correction, and 95% screening efficiency.

4 Increased loss of fish assuming SWP export of discharged Project water from July to November.

5 Assumes similar pattern of agricultural diversions each year, and10% small-intake correction..

6 Assumes 95% screening efficiency, 10% small-intake correction, and similar pattern of habitat diversions each year.

7 Calculated as entrainment loss to existing Project agricultural diversions minus entrainment loss to Project wetland habitat diversions.

Spring-Run Chinook Salmon

The baseline entrainment loss of spring-run Chinook salmon by SWP and CVP averaged almost 131,000 fish from 1980 to 2003 (Table B-49). The lowest entrainment loss of just over 42,000 fish occurred in 1990 and the maximum entrainment was over 240,000 fish in 1995. Direct entrainment loss of spring-run Chinook salmon estimated for the Project ranged from 0 fish in several years to 245 fish in 1989, and averaged 26 fish (Table B-50); this represented an average increased entrainment over baseline conditions of 0–0.4%. Loss of spring-run Chinook salmon due to export of discharged Project water essentially did not occur, with values ranging from 0 (most years) to 1 fish in 1987 and 2002.

Based on the assumed monthly density of spring-run Chinook salmon and the schedule of diversions for agriculture (under the existing/baseline conditions) and for the Habitat Islands (under the Project), it was estimated there would be a net benefit of the Project: 42 less spring-run Chinook salmon would be entrained annually (Table B-51). As a whole, the Project was estimated to result in a slight net benefit to spring-run Chinook salmon because the potential increase in entrainment caused by Project diversions (to the reservoir and Habitat Islands) from December to March and the export of Project water from July to November was offset by the decrease in entrainment attributable to the reduction and screening of the agricultural diversions. This net benefit averaged 16 fish per year, or 0.0% of the baseline entrainment by SWP and CVP (Table B-52).

Table B-49. Baseline Entrainment Loss of Spring-Run Chinook Salmon by SWP and CVP Export Facilities Assumed in the Analysis of Small Juvenile and Adult Fish

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
	Assumed density (Fish/taf)												
Water year	0.0	0.0	0.1	0.0	3.3	46.9	337.5	141.1	2.7	0.0	0.0	0.0	Estimated loss
1980	0	0	55	25	1,501	17,164	108,844	34,434	833	0	0	2	162,859
1981	0	0	50	23	1,611	20,195	68,055	27,178	770	0	0	2	117,885
1982	0	0	55	24	1,656	20,684	127,653	62,281	1,155	0	0	2	213,509
1983	0	0	56	22	1,411	14,562	132,802	63,568	1,155	0	0	2	213,579
1984	0	0	52	17	1,343	18,873	67,404	23,558	747	0	0	2	111,996
1985	0	0	55	22	1,235	11,948	61,714	28,142	731	0	0	2	103,849
1986	0	0	55	23	1,891	21,096	120,825	52,550	718	0	0	2	197,159
1987	0	0	41	16	1,270	16,258	16,494	25,033	712	0	0	1	59,824
1988	0	0	54	23	312	3,267	45,978	10,570	513	0	0	1	60,718
1989	0	0	33	12	323	21,933	71,804	16,835	686	0	0	2	111,627
1990	0	0	38	22	479	10,050	16,494	14,672	532	0	0	1	42,289
1991	0	0	11	5	361	23,517	23,861	15,699	270	0	0	1	63,725
1992	0	0	21	9	1,734	15,618	29,267	6,895	408	0	0	1	53,954
1993	0	0	36	25	1,795	22,888	98,048	31,564	1,088	0	0	2	155,447
1994	0	0	46	19	1,591	12,451	39,711	20,085	705	0	0	1	74,607
1995	0	0	52	24	1,833	23,295	149,615	64,269	1,155	0	0	2	240,245
1996	0	0	55	22	1,427	16,788	117,836	43,219	837	0	0	2	180,186
1997	0	0	58	23	1,694	17,718	78,795	23,551	710	0	0	2	122,549
1998	0	0	55	22	1,689	18,107	132,936	61,213	1,155	0	0	2	215,178
1999	0	0	56	22	1,506	19,107	106,058	27,295	761	0	0	2	154,807
2000	0	0	43	23	1,679	21,888	100,572	33,111	828	0	0	2	158,146
2001	0	0	55	23	1,741	21,100	43,556	13,861	327	0	0	1	80,664
2002	0	0	55	23	163	9,581	62,503	24,603	716	0	0	1	97,646
2003	0	0	54	23	191	18,386	90,566	39,149	816	0	0	2	149,187
Average	0	0	47	20	1,268	17,353	79,641	31,806	764	0	0	2	130,901

Table B-50. Entrainment Loss of Spring-Run Chinook Salmon during Diversions onto the Project Reservoir Islands

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		
	Assumed density (Fish/taf)												Estimated	% of
Water year	0.0	0.0	0.1	0.0	3.3	46.9	337.5	141.1	2.7	0.0	0.0	0.0	loss	baseline
1980	0	0	0	0	0	2	0	0	0	0	0	0	2	0.0%
1981	0	0	0	0	0	62	0	0	0	0	0	0	62	0.1%
1982	0	0	1	0	0	2	0	0	0	0	0	0	2	0.0%
1983	0	0	1	0	0	2	0	0	0	0	0	0	2	0.0%
1984	0	0	1	0	0	2	0	0	0	0	0	0	2	0.0%
1985	0	0	1	0	0	0	0	0	0	0	0	0	1	0.0%
1986	0	0	0	0	19	6	0	0	0	0	0	0	25	0.0%
1987	0	0	0	0	0	211	0	0	0	0	0	0	211	0.4%
1988	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1989	0	0	0	0	0	245	0	0	0	0	0	0	245	0.2%
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1991	0	0	0	0	0	28	0	0	0	0	0	0	28	0.0%
1992	0	0	0	0	16	0	0	0	0	0	0	0	16	0.0%
1993	0	0	0	0	0	2	0	0	0	0	0	0	2	0.0%
1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1995	0	0	0	0	0	2	0	0	0	0	0	0	2	0.0%
1996	0	0	0	0	0	2	0	0	0	0	0	0	2	0.0%
1997	0	0	1	0	0	2	0	0	0	0	0	0	2	0.0%
1998	0	0	0	0	0	2	0	0	0	0	0	0	2	0.0%
1999	0	0	1	0	0	2	0	0	0	0	0	0	2	0.0%
2000	0	0	0	0	5	2	0	0	0	0	0	0	6	0.0%
2001	0	0	0	0	4	0	0	0	0	0	0	0	4	0.0%
2002	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
2003	0	0	1	0	0	0	0	0	0	0	0	0	1	0.0%
Average	0	0	0	0	2	24	0	0	0	0	0	0	26	0.0%

Table B-51. Entrainment Loss of Spring-Run Chinook Salmon during Export of Water Discharged from the Project Islands

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		
	Assumed density (Fish/taf)													
Water year	0.0	0.0	0.1	0.0	3.3	46.9	337.5	141.1	2.7	0.0	0.0	0.0	Estimated loss	% of baseline
1980	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1981	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1984	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1985	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1986	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1987	0	0	0	0	0	0	0	0	0	0	0	1	1	0.0%
1988	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1989	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1992	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1997	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
2001	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
2002	0	0	0	0	0	0	0	0	0	0	0	1	1	0.0%
2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
Average	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%

Table B-52. Entrainment Loss of Spring-Run Chinook Salmon during Existing Agricultural Diversions Compared to Entrainment Loss during Diversions to the Habitat Islands under the Project

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Number of fish
	Assumed density (Fish/taf)												
	0.0	0.0	0.1	0.0	3.3	46.9	337.5	141.1	2.7	0.0	0.0	0.0	
Agricultural diversions	0	0	0	0	1	0	0	38	4	0	0	0	43
Habitat island diversions	0	0	0	0	0	0	0	0	0	0	0	0	0
Project Benefit	0	0	0	0	1	0	0	38	4	0	0	0	43

Table B-53. Summary of Spring-Run Chinook Salmon Entrainment Loss Impacts of the Project Compared to the Baseline Conditions

			Project Diversion Impact[3]		Project Export Impact[4]		Baseline Project Agricultural Diversion	Project Habitat Diversion	Project Benefit from Reduced and Screened Agricultural Diversions[7]		Net Project Impact	
	Baseline CVP/SWP Loss[1]	Baseline Delta Lowland Agriculture Loss[2]	Loss	% of Baseline SWP/CVP	Loss	% of Baseline SWP/CVP	Loss[5]	Loss[6]	Reduced Loss	% of SWP/CVP	Loss	% of SWP/ CVP
1980	162,859	852	2	0.0%	0	0.0%	43	0	42	0.0%	-40	0.0%
1981	117,885	852	62	0.1%	0	0.0%	43	0	42	0.0%	20	0.0%
1982	213,509	852	2	0.0%	0	0.0%	43	0	42	0.0%	-40	0.0%
1983	213,579	852	2	0.0%	0	0.0%	43	0	42	0.0%	-40	0.0%
1984	111,996	852	2	0.0%	0	0.0%	43	0	42	0.0%	-40	0.0%
1985	103,849	852	1	0.0%	0	0.0%	43	0	42	0.0%	-42	0.0%
1986	197,159	852	25	0.0%	0	0.0%	43	0	42	0.0%	-17	0.0%
1987	59,824	852	211	0.4%	1	0.0%	43	0	42	0.1%	170	0.3%
1988	60,718	852	0	0.0%	0	0.0%	43	0	42	0.1%	-42	-0.1%
1989	111,627	852	245	0.2%	0	0.0%	43	0	42	0.0%	204	0.2%
1990	42,289	852	0	0.0%	0	0.0%	43	0	42	0.1%	-42	-0.1%

	Baseline CVP/SWP Loss[1]	Baseline Delta Lowland Agriculture Loss[2]	Project Diversion Impact[3]		Project Export Impact[4]		Baseline Project Agricultural Diversion	Project Habitat Diversion	Project Benefit from Reduced and Screened Agricultural Diversions[7]		Net Project Impact	
			Loss	% of Baseline SWP/CVP	Loss	% of Baseline SWP/CVP	Loss[5]	Loss[6]	Reduced Loss	% of SWP/CVP	Loss	% of SWP/ CVP
1991	63,725	852	28	0.0%	0	0.0%	43	0	42	0.1%	-14	0.0%
1992	53,954	852	16	0.0%	0	0.0%	43	0	42	0.1%	-27	0.0%
1993	155,447	852	2	0.0%	0	0.0%	43	0	42	0.0%	-40	0.0%
1994	74,607	852	0	0.0%	0	0.0%	43	0	42	0.1%	-42	-0.1%
1995	240,245	852	2	0.0%	0	0.0%	43	0	42	0.0%	-40	0.0%
1996	180,186	852	2	0.0%	0	0.0%	43	0	42	0.0%	-40	0.0%
1997	122,549	852	2	0.0%	0	0.0%	43	0	42	0.0%	-40	0.0%
1998	215,178	852	2	0.0%	0	0.0%	43	0	42	0.0%	-40	0.0%
1999	154,807	852	2	0.0%	0	0.0%	43	0	42	0.0%	-40	0.0%
2000	158,146	852	6	0.0%	0	0.0%	43	0	42	0.0%	-36	0.0%
2001	80,664	852	4	0.0%	0	0.0%	43	0	42	0.1%	-39	0.0%
2002	97,646	852	0	0.0%	1	0.0%	43	0	42	0.0%	-41	0.0%
2003	149,187	852	1	0.0%	0	0.0%	43	0	42	0.0%	-42	0.0%
Average	130,901	852	26	0.0%	0	0.0%	43	0	42	0.0%	-16	0.0%

Notes. [1]Based on average of monthly fish densities at salvage (fish/taf) extrapolated to account for pre- and postsalvage losses and multiplied by export flows.
[2] Assumes baseline loss is 20 times that of the Project agricultural diversion loss (based on the Project being 5% of irrigated Delta acreage).
[3]Assumes diversions from December to March, 50% small-intake correction, and 95% screening efficiency.
[4]Increased loss of fish assuming SWP export of discharged Project water from July to November.
[5]Assumes similar pattern of agricultural diversions each year, and10% small-intake correction..
[6]Assumes 95% screening efficiency, 10% small-intake correction, and similar pattern of habitat diversions each year.
[7] Calculated as entrainment loss to existing Project agricultural diversions minus entrainment loss to Project wetland habitat diversions.

Steelhead

The baseline entrainment loss of steelhead by SWP and CVP averaged over 23,000 fish from 1980 to 2003 (Table B-54). The lowest entrainment loss of nearly 10,000 fish occurred in 1988 and the maximum entrainment was almost 34,000 fish in 1995. Direct entrainment loss of steelhead estimated for the Project ranged from 0 fish in 1990 and 1994 to 105 fish in 1986, and averaged 26 fish (Table B-55); this represented an average increased entrainment over baseline conditions of 0–0.6%. Loss of steelhead due to export of discharged Project water averaged 6 fish per year, with values ranging from 0 (several years) to 56 fish in 1994. This was 0–0.3% of baseline SWP/CVP entrainment losses (Table B-56).

Based on the assumed monthly density of steelhead and the schedule of diversions for agriculture (under the existing/baseline conditions) and for the Habitat Islands (under the Project), it was estimated there would be a net benefit of the Project: 10 less steelhead would be entrained annually (Table B-57). As a whole, the Project was estimated to result in a net loss to steelhead because the potential increase in entrainment caused by Project diversions (to the reservoir and Habitat Islands) from December to March and the export of Project water from July to November was not offset by the decrease in entrainment attributable to the reduction and screening of the agricultural diversions. This net loss averaged 28 fish per year, or 0.1% of the baseline entrainment by SWP and CVP (Table B-58).

Table B-54. Baseline Entrainment Loss of Steelhead by SWP and CVP Export Facilities Assumed in the Analysis of Small Juvenile and Adult Fish

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
	Assumed density (Fish/taf)												Estimated
Water year	0.1	0.8	1.5	5.6	18.1	19.8	15.4	6.7	0.7	0.1	0.0	0.0	loss
1980	34	383	772	3,187	8,124	7,245	4,971	1,644	227	31	0	1	26,620
1981	39	289	705	2,934	8,720	8,524	3,108	1,298	210	36	0	1	25,863
1982	40	383	772	3,006	8,963	8,731	5,831	2,974	315	37	0	1	31,053
1983	45	384	792	2,819	7,638	6,146	6,066	3,035	315	37	0	1	27,279
1984	45	384	726	2,126	7,270	7,966	3,079	1,125	203	34	0	1	22,959
1985	45	383	770	2,795	6,686	5,043	2,819	1,344	199	37	0	1	20,122
1986	35	316	771	2,893	10,235	8,904	5,519	2,509	196	26	0	1	31,405
1987	42	325	573	2,001	6,873	6,862	753	1,195	194	35	0	0	18,853
1988	25	200	765	2,868	1,690	1,379	2,100	505	140	29	0	0	9,699
1989	17	180	459	1,533	1,750	9,258	3,280	804	187	36	0	0	17,504
1990	32	259	530	2,843	2,595	4,242	753	701	145	25	0	0	12,124
1991	18	164	152	678	1,953	9,926	1,090	750	74	22	0	0	14,826
1992	21	101	298	1,134	9,384	6,592	1,337	329	111	13	0	0	19,320
1993	16	137	502	3,121	9,720	9,661	4,478	1,507	296	37	0	1	29,477
1994	44	277	643	2,364	8,610	5,255	1,814	959	192	37	0	0	20,198
1995	29	155	740	3,040	9,921	9,832	6,834	3,069	315	37	0	1	33,973
1996	45	384	772	2,758	7,725	7,086	5,382	2,064	228	26	0	1	26,471
1997	32	384	812	2,856	9,168	7,479	3,599	1,125	193	21	0	1	25,669
1998	33	347	771	2,804	9,141	7,643	6,072	2,923	315	37	0	1	30,087
1999	45	384	783	2,808	8,154	8,065	4,844	1,303	207	31	0	1	26,627
2000	42	383	604	2,872	9,091	9,239	4,594	1,581	225	25	0	1	28,658
2001	40	371	772	2,932	9,422	8,906	1,989	662	89	29	0	0	25,213
2002	23	271	770	2,935	884	4,044	2,855	1,175	195	36	0	0	13,189
2003	23	383	767	2,866	1,036	7,761	4,137	1,869	222	27	0	1	19,092
Average	34	301	667	2,591	6,865	7,325	3,638	1,519	208	31	0	1	23,178

Table B-55. Entrainment Loss of Steelhead during Diversions onto the Project Reservoir Islands

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		
	Assumed density (Fish/taf)												Estimated	% of
Water year	0.1	0.8	1.5	5.6	18.1	19.8	15.4	6.7	0.7	0.1	0.0	0.0	loss	baseline
1980	0	0	0	30	0	1	0	0	0	0	0	0	30	0.1%
1981	0	0	0	22	0	26	0	0	0	0	0	0	48	0.2%
1982	0	0	8	0	0	1	0	0	0	0	0	0	9	0.0%
1983	0	0	8	0	0	1	0	0	0	0	0	0	9	0.0%
1984	0	0	8	0	0	1	0	0	0	0	0	0	9	0.0%
1985	0	0	7	0	0	0	0	0	0	0	0	0	7	0.0%
1986	0	0	0	0	103	3	0	0	0	0	0	0	105	0.3%
1987	0	0	0	0	0	89	0	0	0	0	0	0	89	0.5%
1988	0	0	0	25	0	0	0	0	0	0	0	0	25	0.3%
1989	0	0	0	0	0	104	0	0	0	0	0	0	104	0.6%
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1991	0	0	0	0	0	12	0	0	0	0	0	0	12	0.1%
1992	0	0	0	0	84	0	0	0	0	0	0	0	84	0.4%
1993	0	0	0	30	0	1	0	0	0	0	0	0	30	0.1%
1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1995	0	0	0	30	0	1	0	0	0	0	0	0	30	0.1%
1996	0	0	0	30	0	1	0	0	0	0	0	0	30	0.1%
1997	0	0	8	0	0	1	0	0	0	0	0	0	9	0.0%
1998	0	0	0	30	0	1	0	0	0	0	0	0	30	0.1%
1999	0	0	8	0	0	1	0	0	0	0	0	0	9	0.0%
2000	0	0	0	22	25	1	0	0	0	0	0	0	48	0.2%
2001	0	0	0	0	19	0	0	0	0	0	0	0	19	0.1%
2002	0	0	5	12	0	0	0	0	0	0	0	0	17	0.1%
2003	0	0	8	0	0	0	0	0	0	0	0	0	8	0.0%
Average	0	0	3	10	10	10	0	0	0	0	0	0	32	0.1%

Table B-56. Entrainment Loss of Steelhead during Export of Water Discharged from the Project Islands

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		
	Assumed density (Fish/taf)													
Water year	0.1	0.8	1.5	5.6	18.1	19.8	15.4	6.7	0.7	0.1	0.0	0.0	Estimated loss	% of baseline
1980	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1981	5	0	0	0	0	0	0	0	0	1	0	0	6	0.0%
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1984	0	0	0	0	0	0	0	0	0	1	0	0	2	0.0%
1985	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1986	7	0	0	0	0	0	0	0	0	7	0	0	14	0.0%
1987	1	0	0	0	0	0	0	0	0	0	0	0	1	0.0%
1988	0	0	0	0	0	0	0	0	0	3	0	0	3	0.0%
1989	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1990	1	0	0	0	0	0	0	0	0	0	0	0	1	0.0%
1991	0	0	0	0	0	0	0	0	0	1	0	0	1	0.0%
1992	0	0	0	0	0	0	0	0	0	10	0	0	10	0.1%
1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1994	1	55	0	0	0	0	0	0	0	0	0	0	56	0.3%
1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1996	0	0	0	0	0	0	0	0	0	7	0	0	7	0.0%
1997	2	0	0	0	0	0	0	0	0	9	0	0	11	0.0%
1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1999	0	0	0	0	0	0	0	0	0	6	0	0	6	0.0%
2000	4	0	0	0	0	0	0	0	0	3	0	0	7	0.0%
2001	6	12	0	0	0	0	0	0	0	2	0	0	20	0.1%
2002	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
2003	0	0	0	0	0	0	0	0	0	2	0	0	2	0.0%
Average	1	3	0	0	0	0	0	0	0	2	0	0	6	0.0%

Table B-57. Entrainment Loss of Steelhead during Existing Agricultural Diversions Compared to Entrainment Loss during Diversions to the Habitat Islands under the Project

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Number of fish
	Assumed density (Fish/taf)												
	0.1	0.8	1.5	5.6	18.1	19.8	15.4	6.7	0.7	0.1	0.0	0.0	
Agricultural diversions	0	0	0	2	5	0	0	2	1	0	0	0	10
Habitat island diversions	0	0	0	0	0	0	0	0	0	0	0	0	0
Project Benefit	0	0	0	2	5	0	0	2	1	0	0	0	10

Table B-58. Summary of Steelhead Entrainment Loss Impacts of the Project Compared to the Baseline Conditions

	Baseline CVP/SWP Loss[1]	Baseline Delta Lowland Agriculture Loss[2]	Project Diversion Impact[3]		Project Export Impact[4]		Baseline Project Agricultural Diversion	Project Habitat Diversion	Project Benefit from Reduced and Screened Agricultural Diversions[7]		Net Project Impact	
			Loss	% of Baseline SWP/CVP	Loss	% of Baseline SWP/CVP	Loss[5]	Loss[6]	Reduced Loss	% of SWP/CVP	Loss	% of SWP/CVP
1980	26,620	202	30	0.1%	0	0.0%	10	0	10	0.0%	21	0.1%
1981	25,863	202	48	0.2%	6	0.0%	10	0	10	0.0%	45	0.2%
1982	31,053	202	9	0.0%	0	0.0%	10	0	10	0.0%	-1	0.0%
1983	27,279	202	9	0.0%	0	0.0%	10	0	10	0.0%	-1	0.0%
1984	22,959	202	9	0.0%	2	0.0%	10	0	10	0.0%	1	0.0%
1985	20,122	202	7	0.0%	0	0.0%	10	0	10	0.0%	-3	0.0%
1986	31,405	202	105	0.3%	14	0.0%	10	0	10	0.0%	110	0.3%
1987	18,853	202	89	0.5%	1	0.0%	10	0	10	0.1%	80	0.4%
1988	9,699	202	25	0.3%	3	0.0%	10	0	10	0.1%	18	0.2%
1989	17,504	202	104	0.6%	0	0.0%	10	0	10	0.1%	94	0.5%

			Project Diversion Impact[3]		Project Export Impact[4]		Baseline Project Agricultural Diversion	Project Habitat Diversion	Project Benefit from Reduced and Screened Agricultural Diversions[7]		Net Project Impact	
	Baseline CVP/SWP Loss[1]	Baseline Delta Lowland Agriculture Loss[2]	Loss	% of Baseline SWP/CVP	Loss	% of Baseline SWP/CVP	Loss[5]	Loss[6]	Reduced Loss	% of SWP/CVP	Loss	% of SWP/CVP
1990	12,124	202	0	0.0%	1	0.0%	10	0	10	0.1%	-8	-0.1%
1991	14,826	202	12	0.1%	1	0.0%	10	0	10	0.1%	3	0.0%
1992	19,320	202	84	0.4%	10	0.1%	10	0	10	0.1%	85	0.4%
1993	29,477	202	30	0.1%	0	0.0%	10	0	10	0.0%	21	0.1%
1994	20,198	202	0	0.0%	56	0.3%	10	0	10	0.0%	46	0.2%
1995	33,973	202	30	0.1%	0	0.0%	10	0	10	0.0%	21	0.1%
1996	26,471	202	30	0.1%	7	0.0%	10	0	10	0.0%	27	0.1%
1997	25,669	202	9	0.0%	11	0.0%	10	0	10	0.0%	10	0.0%
1998	30,087	202	30	0.1%	0	0.0%	10	0	10	0.0%	21	0.1%
1999	26,627	202	9	0.0%	6	0.0%	10	0	10	0.0%	5	0.0%
2000	28,658	202	48	0.2%	7	0.0%	10	0	10	0.0%	45	0.2%
2001	25,213	202	19	0.1%	20	0.1%	10	0	10	0.0%	29	0.1%
2002	13,189	202	17	0.1%	0	0.0%	10	0	10	0.1%	7	0.1%
2003	19,092	202	8	0.0%	2	0.0%	10	0	10	0.1%	0	0.0%
Average	23,178	202	32	0.1%	6	0.0%	10	0	10	0.0%	28	0.1%

Notes.

1 Based on average of monthly fish densities at salvage (fish/taf) extrapolated to account for pre- and postsalvage losses and multiplied by export flows.

2 Assumes baseline loss is 20 times that of the Project agricultural diversion loss (based on the Project being 5% of irrigated Delta acreage).

3 Assumes diversions from December to March, 50% small-intake correction, and 95% screening efficiency.

4 Increased loss of fish assuming SWP export of discharged Project water from July to November.

5 Assumes similar pattern of agricultural diversions each year, and10% small-intake correction..

6 Assumes 95% screening efficiency, 10% small-intake correction, and similar pattern of habitat diversions each year.

7 Calculated as entrainment loss to existing Project agricultural diversions minus entrainment loss to Project wetland habitat diversions.

Striped Bass

The baseline entrainment loss of striped bass by SWP and CVP averaged over 20 million fish from 1980 to 2003 (Table B-59). The lowest entrainment loss of just over 9.7 million fish occurred in 1992 and the maximum entrainment was almost 30 million fish in 1983. Direct entrainment loss of striped bass estimated for the Project ranged from 0 fish in 1990 and 1994 to almost 4,300 fish in several years, and averaged 2,354 fish (Table B-60); this represented an average increased entrainment over baseline conditions of 0.0%. Loss of striped bass due to export of discharged Project water averaged almost 470,00 fish per year, with values ranging from 0 (several years) to over 1.9 million fish in 1992. This was 0–19.6% of baseline SWP/CVP entrainment losses (Table B-61).

Based on the assumed monthly density of striped bass and the schedule of diversions for agriculture (under the existing/baseline conditions) and for the Habitat Islands (under the Project), it was estimated there would be a net benefit of the Project: almost 77,000 less striped bass would be entrained annually (Table B-61). As a whole, the Project was estimated to result in a net loss to striped bass because the potential increase in entrainment caused by Project diversions (to the reservoir and Habitat Islands) from December to March and the export of Project water from July to November was not offset by the decrease in entrainment attributable to the reduction and screening of the agricultural diversions. This net loss averaged over 390,000 fish per year, or 2.5% of the baseline entrainment by SWP and CVP (Table B-63).

Table B-59. Baseline Entrainment Loss of Striped Bass by SWP and CVP Export Facilities Assumed in the Analysis of Small Juvenile and Adult Fish

Water year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Estimated loss
	Assumed density (Fish/taf)												
	427.1	934.1	818.0	434.6	389.2	138.5	66.0	9530.4	37123.7	14169.3	1628.0	315.2	
1980	154,874	453,440	411,105	245,669	174,842	50,711	21,294	2,325,756	11,510,154	5,895,029	608,800	154,042	22,005,718
1981	178,119	341,535	375,233	226,146	187,668	59,666	13,314	1,835,685	10,639,974	6,864,173	547,272	123,458	21,392,243
1982	185,938	453,538	410,853	231,693	192,903	61,109	24,974	4,206,600	15,964,153	7,100,296	813,733	156,432	29,802,223
1983	209,988	454,145	421,699	217,311	164,382	43,021	25,982	4,293,513	15,964,153	7,100,296	813,733	156,432	29,864,654
1984	209,988	454,145	386,419	163,874	156,449	55,759	13,187	1,591,162	10,319,973	6,485,617	808,973	142,934	20,788,481
1985	208,707	453,262	409,863	215,421	143,890	35,300	12,074	1,900,796	10,098,808	7,065,401	809,286	138,030	21,490,837
1986	163,894	373,342	410,628	222,956	220,263	62,326	23,638	3,549,315	9,925,490	5,038,194	713,400	156,013	20,859,457
1987	192,163	383,845	304,998	154,208	147,912	48,032	3,227	1,690,804	9,843,033	6,650,375	213,487	65,490	19,697,574
1988	114,766	236,776	407,174	221,023	36,362	9,652	8,995	713,937	7,086,245	5,474,543	108,486	61,196	14,479,155
1989	80,431	212,352	244,600	118,142	37,660	64,798	14,048	1,137,058	9,483,009	6,845,179	758,771	108,181	19,104,230
1990	147,829	305,797	282,006	219,114	55,852	29,692	3,227	990,975	7,355,684	4,719,312	279,071	72,988	14,461,547
1991	82,334	193,808	80,907	52,226	42,027	69,479	4,668	1,060,352	3,732,563	4,227,775	257,669	72,487	9,876,294
1992	96,266	119,356	158,602	87,366	201,954	46,143	5,726	465,717	5,639,588	2,401,137	445,547	74,937	9,742,339
1993	76,154	161,562	267,472	240,547	209,176	67,620	19,182	2,131,912	15,040,148	7,064,330	781,159	155,968	26,215,230
1994	205,111	328,190	342,303	182,235	185,307	36,785	7,769	1,356,575	9,736,887	7,085,654	748,248	84,690	20,299,755
1995	131,992	183,464	393,857	234,341	213,513	68,822	29,271	4,340,839	15,964,153	7,100,296	813,733	156,432	29,630,712
1996	209,988	454,145	411,129	212,564	166,246	49,598	23,054	2,919,087	11,573,434	4,954,473	733,072	156,182	21,862,972
1997	148,109	453,692	432,450	220,155	197,309	52,346	15,415	1,590,681	9,809,948	3,968,120	809,684	127,294	17,825,202
1998	150,672	410,441	410,437	216,133	196,734	53,496	26,008	4,134,436	15,964,153	7,100,296	813,733	156,432	29,632,969
1999	209,988	454,145	417,115	216,390	175,493	56,449	20,749	1,843,567	10,515,000	5,955,619	774,680	156,041	20,795,237
2000	194,417	453,435	321,821	221,370	195,641	64,666	19,676	2,236,363	11,442,495	4,817,224	810,535	149,160	20,926,803
2001	183,756	438,685	411,314	225,953	202,774	62,338	8,521	936,214	4,515,663	5,549,540	256,280	75,573	12,866,610
2002	107,908	320,657	409,824	226,210	19,017	28,307	12,228	1,661,753	9,895,137	6,958,620	721,423	93,609	20,454,691
2003	106,245	452,890	408,325	220,911	22,297	54,320	17,718	2,644,177	11,275,728	5,116,736	797,829	146,859	21,264,033
Avg.	156,235	356,110	355,422	199,665	147,736	51,268	15,581	2,148,220	10,553,982	5,897,426	634,942	122,536	20,639,124

Table B-60. Entrainment Loss of Striped Bass during Diversions onto the Project Reservoir Islands

Water year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Estimated loss	% of baseline
	Assumed density (Fish/taf)													
	427.1	934.1	818.0	434.6	389.2	138.5	66.0	9530.4	37123.7	14169.3	1628.0	315.2		
1980	0	0	0	2,275	6	5	0	0	0	0	0	0	2,286	0.0%
1981	0	0	0	1,710	0	182	0	0	0	0	0	0	1,892	0.0%
1982	0	0	4,282	6	7	5	0	0	0	0	0	0	4,299	0.0%
1983	0	0	4,282	6	7	5	0	0	0	0	0	0	4,299	0.0%
1984	0	0	4,282	6	6	5	0	0	0	0	0	0	4,298	0.0%
1985	0	0	3,846	0	0	0	0	0	0	0	0	0	3,846	0.0%
1986	0	0	0	0	2,214	18	0	0	0	0	0	0	2,232	0.0%
1987	0	0	0	0	0	625	0	0	0	0	0	0	625	0.0%
1988	0	0	0	1,952	0	0	0	0	0	0	0	0	1,952	0.0%
1989	0	0	0	0	0	725	0	0	0	0	0	0	725	0.0%
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1991	0	0	0	0	0	83	0	0	0	0	0	0	83	0.0%
1992	0	0	0	0	1,818	0	0	0	0	0	0	0	1,818	0.0%
1993	0	0	0	2,275	7	5	0	0	0	0	0	0	2,286	0.0%
1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1995	0	0	0	2,275	7	5	0	0	0	0	0	0	2,286	0.0%
1996	0	0	0	2,275	6	5	0	0	0	0	0	0	2,286	0.0%
1997	0	0	4,282	6	7	5	0	0	0	0	0	0	4,299	0.0%
1998	0	0	0	2,275	7	5	0	0	0	0	0	0	2,286	0.0%
1999	0	0	4,282	6	7	5	0	0	0	0	0	0	4,299	0.0%
2000	0	0	0	1,710	547	5	0	0	0	0	0	0	2,261	0.0%
2001	0	0	0	0	409	0	0	0	0	0	0	0	409	0.0%
2002	0	0	2,508	946	0	0	0	0	0	0	0	0	3,454	0.0%
2003	0	0	4,282	6	0	0	0	0	0	0	0	0	4,287	0.0%
Average	0	0	1,335	739	211	70	0	0	0	0	0	0	2,354	0.0%

Table B-61. Entrainment Loss of Striped Bass during Export of Water Discharged from the Project Islands

Water year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Estimated loss	% of baseline
	Assumed density (Fish/taf)													
	427.1	934.1	818.0	434.6	389.2	138.5	66.0	9530.4	37123.7	14169.3	1628.0	315.2		
1980	0	0	0	0	0	0	0	0	0	0	168,169	2,482	170,651	0.8%
1981	25,263	0	0	0	0	0	0	0	0	127,984	188,619	13,943	355,808	1.7%
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1984	0	0	0	0	0	0	0	0	0	277,308	0	14,638	291,947	1.4%
1985	0	0	0	0	0	0	0	0	0	0	0	11,514	11,514	0.1%
1986	31,485	0	0	0	0	0	0	0	0	1,402,297	108,262	0	1,542,044	7.4%
1987	2,709	0	0	0	0	0	0	0	0	0	0	36,350	39,059	0.2%
1988	0	0	0	0	0	0	0	0	0	510,986	213,161	0	724,148	5.0%
1989	0	0	0	0	0	0	0	0	0	0	34,207	27,102	61,309	0.3%
1990	6,889	0	0	0	0	0	0	0	0	0	0	0	6,889	0.0%
1991	0	0	0	0	0	0	0	0	0	240,690	0	0	240,690	2.4%
1992	0	0	0	0	0	0	0	0	0	1,902,666	9,477	0	1,912,143	19.6%
1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1994	4,112	65,360	0	0	0	0	0	0	0	0	0	0	69,471	0.3%
1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1996	0	0	0	0	0	0	0	0	0	1,318,042	87,996	0	1,406,038	6.4%
1997	10,146	0	0	0	0	0	0	0	0	1,629,534	0	17,902	1,657,582	9.3%
1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1999	0	0	0	0	0	0	0	0	0	1,156,050	0	0	1,156,050	5.6%
2000	16,360	0	0	0	0	0	0	0	0	570,125	0	0	586,485	2.8%
2001	28,543	13,702	0	0	0	0	0	0	0	404,990	0	0	447,236	3.5%
2002	0	0	0	0	0	0	0	0	0	0	80,999	35,225	116,225	0.6%
2003	0	0	0	0	0	0	0	0	0	389,629	0	0	389,629	1.8%
Average	5,229	3,294	0	0	0	0	0	0	0	413,763	37,120	6,632	466,038	2.3%

Table B-62. Entrainment Loss of Striped Bass during Existing Agricultural Diversions Compared to Entrainment Loss during Diversions to the Habitat Islands under the Project

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Number of fish
	Assumed density (Fish/taf)												
	427.1	934.1	818.0	434.6	389.2	138.5	66.0	9530.4	37123.7	14169.3	1628.0	315.2	
Agricultural diversions	73	0	232	123	110	0	0	2,565	49,962	22,683	1,914	174	77,837
Habitat island diversions	4	8	8	0	2	0	0	19	557	255	21	4	879
Project Benefit	69	-8	224	123	108	0	0	2,546	49,406	22,428	1,893	170	76,958

Table B-63. Summary of Striped Bass Entrainment Loss Impacts of the Project Compared to the Baseline Conditions

	Baseline CVP/SWP Loss[1]	Baseline Delta Lowland Agriculture Loss[2]	Project Diversion Impact[3]		Project Export Impact[4]		Baseline Project Agricultural Diversion	Project Habitat Diversion	Project Benefit from Reduced and Screened Agricultural Diversions[7]		Net Project Impact	
			Loss	% of Baseline SWP/CVP	Loss	% of Baseline SWP/CVP	Loss[5]	Loss[6]	Reduced Loss	% of SWP/ CVP	Loss	% of SWP/CVP
1980	22,005,718	1,556,731	2,286	0.0%	170,651	0.8%	77,837	879	76,958	0.3%	95,979	0.4%
1981	21,392,243	1,556,731	1,892	0.0%	355,808	1.7%	77,837	879	76,958	0.4%	280,743	1.3%
1982	29,802,223	1,556,731	4,299	0.0%	0	0.0%	77,837	879	76,958	0.3%	-72,659	-0.2%
1983	29,864,654	1,556,731	4,299	0.0%	0	0.0%	77,837	879	76,958	0.3%	-72,659	-0.2%
1984	20,788,481	1,556,731	4,298	0.0%	291,947	1.4%	77,837	879	76,958	0.4%	219,287	1.1%
1985	21,490,837	1,556,731	3,846	0.0%	11,514	0.1%	77,837	879	76,958	0.4%	-61,598	-0.3%
1986	20,859,457	1,556,731	2,232	0.0%	1,542,044	7.4%	77,837	879	76,958	0.4%	1,467,318	7.0%
1987	19,697,574	1,556,731	625	0.0%	39,059	0.2%	77,837	879	76,958	0.4%	-37,274	-0.2%
1988	14,479,155	1,556,731	1,952	0.0%	724,148	5.0%	77,837	879	76,958	0.5%	649,141	4.5%

	Baseline CVP/SWP Loss[1]	Baseline Delta Lowland Agriculture Loss[2]	Project Diversion Impact[3]		Project Export Impact[4]		Baseline Project Agricultural Diversion	Project Habitat Diversion	Project Benefit from Reduced and Screened Agricultural Diversions[7]		Net Project Impact	
			Loss	% of Baseline SWP/CVP	Loss	% of Baseline SWP/CVP	Loss[5]	Loss[6]	Reduced Loss	% of SWP/ CVP	Loss	% of SWP/CVP
1989	19,104,230	1,556,731	725	0.0%	61,309	0.3%	77,837	879	76,958	0.4%	-14,924	-0.1%
1990	14,461,547	1,556,731	0	0.0%	6,889	0.0%	77,837	879	76,958	0.5%	-70,069	-0.5%
1991	9,876,294	1,556,731	83	0.0%	240,690	2.4%	77,837	879	76,958	0.8%	163,816	1.7%
1992	9,742,339	1,556,731	1,818	0.0%	1,912,143	19.6%	77,837	879	76,958	0.8%	1,837,003	18.9%
1993	26,215,230	1,556,731	2,286	0.0%	0	0.0%	77,837	879	76,958	0.3%	-74,672	-0.3%
1994	20,299,755	1,556,731	0	0.0%	69,471	0.3%	77,837	879	76,958	0.4%	-7,486	0.0%
1995	29,630,712	1,556,731	2,286	0.0%	0	0.0%	77,837	879	76,958	0.3%	-74,672	-0.3%
1996	21,862,972	1,556,731	2,286	0.0%	1,406,038	6.4%	77,837	879	76,958	0.4%	1,331,366	6.1%
1997	17,825,202	1,556,731	4,299	0.0%	1,657,582	9.3%	77,837	879	76,958	0.4%	1,584,922	8.9%
1998	29,632,969	1,556,731	2,286	0.0%	0	0.0%	77,837	879	76,958	0.3%	-74,672	-0.3%
1999	20,795,237	1,556,731	4,299	0.0%	1,156,050	5.6%	77,837	879	76,958	0.4%	1,083,390	5.2%
2000	20,926,803	1,556,731	2,261	0.0%	586,485	2.8%	77,837	879	76,958	0.4%	511,789	2.4%
2001	12,866,610	1,556,731	409	0.0%	447,236	3.5%	77,837	879	76,958	0.6%	370,687	2.9%
2002	20,454,691	1,556,731	3,454	0.0%	116,225	0.6%	77,837	879	76,958	0.4%	42,721	0.2%
2003	21,264,033	1,556,731	4,287	0.0%	389,629	1.8%	77,837	879	76,958	0.4%	316,959	1.5%
Avg.	20,639,124	1,556,731	2,354	0.0%	466,038	2.9%	77,837	879	76,958	0.4%	391,435	2.5%

Notes.
1 Based on average of monthly fish densities at salvage (fish/taf) extrapolated to account for pre- and postsalvage losses and multiplied by export flows.
2 Assumes baseline loss is 20 times that of the Project agricultural diversion loss (based on the Project being 5% of irrigated Delta acreage).
3 Assumes diversions from December to March, 50% small-intake correction, and 95% screening efficiency.
4 Increased loss of fish assuming SWP export of discharged Project water from July to November.
5 Assumes similar pattern of agricultural diversions each year, and10% small-intake correction..
6 Assumes 95% screening efficiency, 10% small-intake correction, and similar pattern of habitat diversions each year.
7 Calculated as entrainment loss to existing Project agricultural diversions minus entrainment loss to Project wetland habitat diversions.

White Catfish

The baseline entrainment loss of white catfish by SWP and CVP averaged over 1.5 million fish from 1980 to 2003 (Table B-64). The lowest entrainment loss of just over 850,000 fish occurred in 1991 and the maximum entrainment was over 2 million fish in 1995. Direct entrainment loss of white catfish estimated for the Project ranged from 0 fish in 1990 and 1994 to over 1,000 fish in 1989, and averaged 585 fish (Table B-65); this represented an average increased entrainment over baseline conditions of 0–0.1%. Loss of white catfish due to export of discharged Project water averaged nearly 55,000 fish per year, with values ranging from 0 (several years) to over 160,000 fish in 1986. This was 0–17.2% of baseline SWP/CVP entrainment losses (Table B-66).

Based on the assumed monthly density of white catfish and the schedule of diversions for agriculture (under the existing/baseline conditions) and for the Habitat Islands (under the Project), it was estimated there would be a net benefit of the Project: over 3,800 less white catfish would be entrained annually (Table B-67). As a whole, the Project was estimated to result in a net loss to white catfish because the potential increase in entrainment caused by Project diversions (to the reservoir and Habitat Islands) from December to March and the export of Project water from July to November was not offset by the decrease in entrainment attributable to the reduction and screening of the agricultural diversions. This net loss averaged over 50,000 fish per year, or 3.7% of the baseline entrainment by SWP and CVP (Table B-68).

Table B-64. Baseline Entrainment Loss of White Catfish by SWP and CVP Export Facilities Assumed in the Analysis of Small Juvenile and Adult Fish

Water year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Estimated loss
	Assumed density (Fish/taf)												
	209.1	214.9	135.9	99.5	164.7	206.7	271.5	378.8	786.0	1065.2	614.2	289.0	
1980	75,812	104,334	68,324	56,240	73,979	75,664	87,552	92,446	243,711	443,186	229,688	141,226	1,692,164
1981	87,191	78,585	62,362	51,771	79,406	89,026	54,742	72,966	225,286	516,046	206,475	113,186	1,637,043
1982	91,019	104,356	68,282	53,041	81,622	91,179	102,681	167,208	338,018	533,797	307,005	143,417	2,081,625
1983	102,791	104,496	70,085	49,748	69,554	64,190	106,824	170,662	338,018	533,797	307,005	143,417	2,060,587
1984	102,791	104,496	64,221	37,515	66,197	83,197	54,219	63,247	218,511	487,586	305,209	131,042	1,718,231
1985	102,164	104,292	68,118	49,316	60,883	52,671	49,641	75,555	213,828	531,174	305,327	126,546	1,739,514
1986	80,227	85,904	68,245	51,040	93,198	92,994	97,189	141,081	210,158	378,769	269,151	143,033	1,710,991
1987	94,065	88,320	50,690	35,302	62,585	71,667	13,267	67,208	208,412	499,973	80,544	60,042	1,332,075
1988	56,179	54,481	67,671	50,598	15,386	14,401	36,984	28,378	150,041	411,574	40,930	56,104	982,727
1989	39,372	48,861	40,652	27,046	15,935	96,684	57,757	45,197	200,789	514,618	286,269	99,180	1,472,359
1990	72,363	70,362	46,868	50,161	23,632	44,303	13,267	39,390	155,746	354,796	105,288	66,915	1,043,093
1991	40,303	44,594	13,446	11,956	17,782	103,667	19,193	42,148	79,032	317,842	97,213	66,456	853,634
1992	47,123	27,463	26,359	20,000	85,451	68,849	23,542	18,512	119,410	180,517	168,096	68,702	854,024
1993	37,278	37,174	44,453	55,067	88,507	100,894	78,868	84,741	318,454	531,094	294,715	142,992	1,814,237
1994	100,404	75,514	56,890	41,718	78,407	54,886	31,943	53,922	206,165	532,697	282,299	77,644	1,592,489
1995	64,611	42,214	65,458	53,647	90,342	102,687	120,348	172,543	338,018	533,797	307,005	143,417	2,034,088
1996	102,791	104,496	68,328	48,661	70,342	74,004	94,785	116,030	245,051	372,475	276,573	143,188	1,716,726
1997	72,501	104,391	71,872	50,399	83,486	78,103	63,381	63,228	207,712	298,322	305,477	116,703	1,515,575
1998	73,755	94,440	68,213	49,478	83,242	79,820	106,931	164,339	338,018	533,797	307,005	143,417	2,042,456
1999	102,791	104,496	69,323	49,537	74,255	84,226	85,311	73,280	222,640	447,741	292,271	143,059	1,748,929
2000	95,169	104,332	53,486	50,677	82,780	96,487	80,899	88,893	242,279	362,157	305,798	136,750	1,699,706
2001	89,950	100,938	68,359	51,726	85,798	93,013	35,036	37,213	95,613	417,212	96,689	69,285	1,240,834
2002	52,822	73,781	68,111	51,785	8,046	42,237	50,276	66,053	209,516	523,146	272,178	85,820	1,503,772
2003	52,008	104,207	67,862	50,572	9,434	81,049	72,850	105,103	238,748	384,674	301,004	134,640	1,602,152
Average	76,478	81,939	59,070	45,709	62,510	76,496	64,062	85,389	223,466	443,366	239,551	112,341	1,570,376

Table B-65. Entrainment Loss of White Catfish during Diversions onto the Project Reservoir Islands

Water year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Estimated loss	% of baseline
	Assumed density (Fish/taf)													
	209.1	214.9	135.9	99.5	164.7	206.7	271.5	378.8	786.0	1065.2	614.2	289.0		
1980	0	0	0	521	3	7	0	0	0	0	0	0	530	0.0%
1981	0	0	0	392	0	272	0	0	0	0	0	0	663	0.0%
1982	0	0	712	1	3	7	0	0	0	0	0	0	723	0.0%
1983	0	0	712	1	3	7	0	0	0	0	0	0	723	0.0%
1984	0	0	712	1	3	7	0	0	0	0	0	0	722	0.0%
1985	0	0	639	0	0	0	0	0	0	0	0	0	639	0.0%
1986	0	0	0	0	937	27	0	0	0	0	0	0	963	0.1%
1987	0	0	0	0	0	932	0	0	0	0	0	0	932	0.1%
1988	0	0	0	447	0	0	0	0	0	0	0	0	447	0.0%
1989	0	0	0	0	0	1,082	0	0	0	0	0	0	1,082	0.1%
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1991	0	0	0	0	0	125	0	0	0	0	0	0	125	0.0%
1992	0	0	0	0	769	0	0	0	0	0	0	0	769	0.1%
1993	0	0	0	521	3	7	0	0	0	0	0	0	530	0.0%
1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1995	0	0	0	521	3	7	0	0	0	0	0	0	530	0.0%
1996	0	0	0	521	3	7	0	0	0	0	0	0	530	0.0%
1997	0	0	712	1	3	7	0	0	0	0	0	0	723	0.0%
1998	0	0	0	521	3	7	0	0	0	0	0	0	530	0.0%
1999	0	0	712	1	3	7	0	0	0	0	0	0	723	0.0%
2000	0	0	0	392	231	7	0	0	0	0	0	0	630	0.0%
2001	0	0	0	0	173	0	0	0	0	0	0	0	173	0.0%
2002	0	0	417	217	0	0	0	0	0	0	0	0	633	0.0%
2003	0	0	712	1	0	0	0	0	0	0	0	0	713	0.0%
Average	0	0	222	169	89	105	0	0	0	0	0	0	585	0.0%

Table B-66. Entrainment Loss of White Catfish during Export of Water Discharged from the Project Islands

Water year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Estimated loss	% of baseline
	Assumed density (Fish/taf)													
	209.1	214.9	135.9	99.5	164.7	206.7	271.5	378.8	786.0	1065.2	614.2	289.0		
1980	0	0	0	0	0	0	0	0	0	0	63,447	2,276	65,722	3.9%
1981	12,366	0	0	0	0	0	0	0	0	9,622	71,162	12,783	105,933	6.5%
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1984	0	0	0	0	0	0	0	0	0	20,848	0	13,421	34,268	2.0%
1985	0	0	0	0	0	0	0	0	0	0	0	10,556	10,556	0.6%
1986	15,412	0	0	0	0	0	0	0	0	105,424	40,845	0	161,682	9.4%
1987	1,326	0	0	0	0	0	0	0	0	0	0	33,326	34,652	2.6%
1988	0	0	0	0	0	0	0	0	0	38,416	80,421	0	118,837	12.1%
1989	0	0	0	0	0	0	0	0	0	0	12,906	24,847	37,753	2.6%
1990	3,372	0	0	0	0	0	0	0	0	0	0	0	3,372	0.3%
1991	0	0	0	0	0	0	0	0	0	18,095	0	0	18,095	2.1%
1992	0	0	0	0	0	0	0	0	0	143,042	3,575	0	146,617	17.2%
1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1994	2,013	15,039	0	0	0	0	0	0	0	0	0	0	17,052	1.1%
1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1996	0	0	0	0	0	0	0	0	0	99,090	33,199	0	132,289	7.7%
1997	4,966	0	0	0	0	0	0	0	0	122,508	0	16,413	143,887	9.5%
1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1999	0	0	0	0	0	0	0	0	0	86,911	0	0	86,911	5.0%
2000	8,008	0	0	0	0	0	0	0	0	42,862	0	0	50,870	3.0%
2001	13,972	3,153	0	0	0	0	0	0	0	30,447	0	0	47,572	3.8%
2002	0	0	0	0	0	0	0	0	0	0	30,559	32,295	62,854	4.2%
2003	0	0	0	0	0	0	0	0	0	29,292	0	0	29,292	1.8%
Average	2,560	758	0	0	0	0	0	0	0	31,107	14,005	6,080	54,509	3.5%

Table B-67. Entrainment Loss of White Catfish during Existing Agricultural Diversions Compared to Entrainment Loss during Diversions to the Habitat Islands under the Project

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Number of fish
	Assumed density (Fish/taf)												
	209.1	214.9	135.9	99.5	164.7	206.7	271.5	378.8	786.0	1065.2	614.2	289.0	
Agricultural diversions	36	0	39	28	47	0	0	102	1,058	1,705	722	160	3,896
Habitat island diversions	2	2	1	0	1	0	0	1	12	19	8	4	50
Project Benefit	34	-2	37	28	46	0	0	101	1,046	1,686	714	156	3,846

Table B-68. Summary of White Catfish Entrainment Loss Impacts of the Project Compared to the Baseline Conditions

			Project Diversion Impact[3]		Project Export Impact[4]		Baseline Project Agricultural Diversion	Project Habitat Diversion	Project Benefit from Reduced and Screened Agricultural Diversions[7]		Net Project Impact	
	Baseline CVP/SWP Loss[1]	Baseline Delta Lowland Agriculture Loss[2]	Loss	% of Baseline SWP/CVP	Loss	% of Baseline SWP/CVP	Loss[5]	Loss[6]	Reduced Loss	% of SWP/CVP	Loss	% of SWP/CVP
1980	1,692,164	77,919	530	0.0%	65,722	3.9%	3,896	50	3,846	0.2%	62,406	3.7%
1981	1,637,043	77,919	663	0.0%	105,933	6.5%	3,896	50	3,846	0.2%	102,750	6.3%
1982	2,081,625	77,919	723	0.0%	0	0.0%	3,896	50	3,846	0.2%	-3,124	-0.2%
1983	2,060,587	77,919	723	0.0%	0	0.0%	3,896	50	3,846	0.2%	-3,124	-0.2%
1984	1,718,231	77,919	722	0.0%	34,268	2.0%	3,896	50	3,846	0.2%	31,145	1.8%
1985	1,739,514	77,919	639	0.0%	10,556	0.6%	3,896	50	3,846	0.2%	7,349	0.4%
1986	1,710,991	77,919	963	0.1%	161,682	9.4%	3,896	50	3,846	0.2%	158,799	9.3%
1987	1,332,075	77,919	932	0.1%	34,652	2.6%	3,896	50	3,846	0.3%	31,738	2.4%
1988	982,727	77,919	447	0.0%	118,837	12.1%	3,896	50	3,846	0.4%	115,438	11.7%
1989	1,472,359	77,919	1,082	0.1%	37,753	2.6%	3,896	50	3,846	0.3%	34,988	2.4%
1990	1,043,093	77,919	0	0.0%	3,372	0.3%	3,896	50	3,846	0.4%	-474	0.0%

		Baseline Delta	Project Diversion Impact[3]		Project Export Impact[4]		Baseline Project Agricultural Diversion	Project Habitat Diversion	Project Benefit from Reduced and Screened Agricultural Diversions[7]		Net Project Impact	
	Baseline CVP/SWP Loss[1]	Lowland Agriculture Loss[2]	Loss	% of Baseline SWP/CVP	Loss	% of Baseline SWP/CVP	Loss[5]	Loss[6]	Reduced Loss	% of SWP/CVP	Loss	% of SWP/CVP
1991	853,634	77,919	125	0.0%	18,095	2.1%	3,896	50	3,846	0.5%	14,373	1.7%
1992	854,024	77,919	769	0.1%	146,617	17.2%	3,896	50	3,846	0.5%	143,540	16.8%
1993	1,814,237	77,919	530	0.0%	0	0.0%	3,896	50	3,846	0.2%	-3,316	-0.2%
1994	1,592,489	77,919	0	0.0%	17,052	1.1%	3,896	50	3,846	0.2%	13,205	0.8%
1995	2,034,088	77,919	530	0.0%	0	0.0%	3,896	50	3,846	0.2%	-3,316	-0.2%
1996	1,716,726	77,919	530	0.0%	132,289	7.7%	3,896	50	3,846	0.2%	128,973	7.5%
1997	1,515,575	77,919	723	0.0%	143,887	9.5%	3,896	50	3,846	0.3%	140,763	9.3%
1998	2,042,456	77,919	530	0.0%	0	0.0%	3,896	50	3,846	0.2%	-3,316	-0.2%
1999	1,748,929	77,919	723	0.0%	86,911	5.0%	3,896	50	3,846	0.2%	83,788	4.8%
2000	1,699,706	77,919	630	0.0%	50,870	3.0%	3,896	50	3,846	0.2%	47,653	2.8%
2001	1,240,834	77,919	173	0.0%	47,572	3.8%	3,896	50	3,846	0.3%	43,899	3.5%
2002	1,503,772	77,919	633	0.0%	62,854	4.2%	3,896	50	3,846	0.3%	59,641	4.0%
2003	1,602,152	77,919	713	0.0%	29,292	1.8%	3,896	50	3,846	0.2%	26,159	1.6%
Avg.	1,570,376	77,919	585	0.0%	54,509	4.0%	3,896	50	3,846	0.3%	51,247	3.7%

Notes. [1]Based on average of monthly fish densities at salvage (fish/taf) extrapolated to account for pre- and postsalvage losses and multiplied by export flows.
[2] Assumes baseline loss is 20 times that of the Project agricultural diversion loss (based on the Project being 5% of irrigated Delta acreage).
[3]Assumes diversions from December to March, 50% small-intake correction, and 95% screening efficiency.
[4]Increased loss of fish assuming SWP export of discharged Project water from July to November.
[5]Assumes similar pattern of agricultural diversions each year, and10% small-intake correction..
[6]Assumes 95% screening efficiency, 10% small-intake correction, and similar pattern of habitat diversions each year.
[7] Calculated as entrainment loss to existing Project agricultural diversions minus entrainment loss to Project wetland habitat diversions.

American Shad

The baseline entrainment loss of American shad by SWP and CVP averaged almost 3.8 million fish from 1980 to 2003 (Table B-69). The lowest entrainment loss of about 1.8 million fish occurred in 1992 and the maximum entrainment was over 4.7 million fish in 1983. Direct entrainment loss of American shad estimated for the Project ranged from 0 fish in 1990 and 1994 to over 5,100 fish in several years, and averaged over 2,700 fish (Table B-70); this represented an average increased entrainment over baseline conditions of 0–0.1%. Loss of American shad due to export of discharged Project water averaged almost 130,000 fish per year, with values ranging from 0 (several years) to almost 385,000 fish in 1986. This was 0–17.4% of baseline SWP/CVP entrainment losses (Table B-71).

Based on the assumed monthly density of American shad and the schedule of diversions for agriculture (under the existing/baseline conditions) and for the Habitat Islands (under the Project), it was estimated there would be a net benefit of the Project: 7,446 less American shad would be entrained annually (Table B-72). As a whole, the Project was estimated to result in a net loss to American shad because the potential increase in entrainment caused by Project diversions (to the reservoir and Habitat Islands) from December to March and the export of Project water from July to November was not offset by the decrease in entrainment attributable to the reduction and screening of the agricultural diversions. This net loss averaged almost 125,000 fish per year, or 3.7% of the baseline entrainment by SWP and CVP (Table B-73).

Table B-69. Baseline Entrainment Loss of American Shad by SWP and CVP Export Facilities Assumed in the Analysis of Small Juvenile and Adult Fish

Water year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Estimated loss
	Assumed density (Fish/taf)												
	712.2	1871.2	982.1	640.5	88.1	46.3	14.8	36.9	840.0	2330.8	1516.9	542.7	
1980	258,237	908,327	493,598	362,085	39,582	16,950	4,763	9,013	260,434	969,691	567,260	265,168	4,155,109
1981	296,994	684,159	450,529	333,310	42,486	19,944	2,978	7,114	240,745	1,129,109	509,930	212,519	3,929,816
1982	310,032	908,524	493,297	341,486	43,671	20,426	5,587	16,302	361,212	1,167,949	758,209	269,281	4,695,975
1983	350,132	909,740	506,318	320,289	37,214	14,380	5,812	16,639	361,212	1,167,949	758,209	269,281	4,717,175
1984	350,132	909,740	463,959	241,529	35,418	18,638	2,950	6,166	233,504	1,066,839	753,773	246,046	4,328,694
1985	347,996	907,969	492,108	317,503	32,575	11,799	2,701	7,366	228,500	1,162,209	754,065	237,604	4,502,395
1986	273,275	747,876	493,026	328,608	49,865	20,833	5,288	13,755	224,579	828,748	664,722	268,560	3,919,133
1987	320,410	768,914	366,200	227,283	33,485	16,055	722	6,553	222,713	1,093,940	198,920	112,735	3,367,930
1988	191,360	474,308	488,879	325,760	8,232	3,226	2,012	2,767	160,337	900,524	101,084	105,342	2,763,830
1989	134,111	425,382	293,682	174,127	8,526	21,659	3,142	4,407	214,567	1,125,984	706,997	186,222	3,298,806
1990	246,488	612,569	338,594	322,946	12,644	9,925	722	3,840	166,433	776,294	260,029	125,641	2,876,125
1991	137,282	388,235	97,142	76,974	9,514	23,224	1,044	4,109	84,455	695,440	240,087	124,779	1,882,284
1992	160,514	239,093	190,427	128,766	45,720	15,424	1,281	1,805	127,604	394,970	415,145	128,996	1,849,745
1993	126,978	323,640	321,144	354,535	47,355	22,602	4,291	8,262	340,305	1,162,033	727,858	268,483	3,707,486
1994	342,001	657,428	410,991	268,591	41,951	12,296	1,738	5,257	220,311	1,165,541	697,192	145,785	3,969,081
1995	220,082	367,514	472,890	345,389	48,336	23,004	6,548	16,823	361,212	1,167,949	758,209	269,281	4,057,237
1996	350,132	909,740	493,628	313,291	37,636	16,579	5,157	11,313	261,866	814,976	683,051	268,851	4,166,220
1997	246,956	908,831	519,227	324,479	44,668	17,497	3,448	6,165	221,964	652,728	754,436	219,123	3,919,523
1998	251,230	822,191	492,796	318,552	44,538	17,881	5,818	16,023	361,212	1,167,949	758,209	269,281	4,525,680
1999	350,132	909,740	500,815	318,930	39,729	18,868	4,641	7,145	237,917	979,658	721,820	268,608	4,358,005
2000	324,169	908,317	386,399	326,271	44,291	21,615	4,401	8,667	258,903	792,400	755,229	256,762	4,087,424
2001	306,393	878,769	493,850	333,025	45,905	20,837	1,906	3,628	102,173	912,861	238,793	130,091	3,468,231
2002	179,925	642,337	492,060	333,404	4,305	9,462	2,735	6,440	223,892	1,144,645	672,197	161,137	3,872,539
2003	177,152	907,225	490,261	325,594	5,048	18,157	3,963	10,247	255,130	841,667	743,390	252,802	4,030,636
Average	260,505	713,357	426,742	294,280	33,446	17,137	3,485	8,325	238,799	970,086	591,617	210,932	3,768,712

Table B-70. Entrainment Loss of American Shad during Diversions onto the Project Reservoir Islands

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		
	Assumed density (Fish/taf)												Estimated	% of
Water year	712.2	1871.2	982.1	640.5	88.1	46.3	14.8	36.9	840.0	2330.8	1516.9	542.7	loss	baseline
1980	0	0	0	3,353	1	2	0	0	0	0	0	0	3,356	0.1%
1981	0	0	0	2,521	0	61	0	0	0	0	0	0	2,582	0.1%
1982	0	0	5,141	8	1	2	0	0	0	0	0	0	5,152	0.1%
1983	0	0	5,141	8	1	2	0	0	0	0	0	0	5,152	0.1%
1984	0	0	5,141	8	1	2	0	0	0	0	0	0	5,152	0.1%
1985	0	0	4,617	0	0	0	0	0	0	0	0	0	4,617	0.1%
1986	0	0	0	0	501	6	0	0	0	0	0	0	507	0.0%
1987	0	0	0	0	0	209	0	0	0	0	0	0	209	0.0%
1988	0	0	0	2,877	0	0	0	0	0	0	0	0	2,877	0.1%
1989	0	0	0	0	0	242	0	0	0	0	0	0	242	0.0%
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1991	0	0	0	0	0	28	0	0	0	0	0	0	28	0.0%
1992	0	0	0	0	412	0	0	0	0	0	0	0	412	0.0%
1993	0	0	0	3,353	1	2	0	0	0	0	0	0	3,356	0.1%
1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1995	0	0	0	3,353	1	2	0	0	0	0	0	0	3,356	0.1%
1996	0	0	0	3,353	1	2	0	0	0	0	0	0	3,356	0.1%
1997	0	0	5,141	8	1	2	0	0	0	0	0	0	5,152	0.1%
1998	0	0	0	3,353	1	2	0	0	0	0	0	0	3,356	0.1%
1999	0	0	5,141	8	1	2	0	0	0	0	0	0	5,152	0.1%
2000	0	0	0	2,521	124	2	0	0	0	0	0	0	2,646	0.1%
2001	0	0	0	0	93	0	0	0	0	0	0	0	93	0.0%
2002	0	0	3,012	1,394	0	0	0	0	0	0	0	0	4,406	0.1%
2003	0	0	5,141	8	0	0	0	0	0	0	0	0	5,149	0.1%
Average	0	0	1,603	1,089	48	23	0	0	0	0	0	0	2,763	0.1%

Table B-71. Entrainment Loss of American Shad during Export of Water Discharged from the Project Islands

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		
	Assumed density (Fish/taf)													
Water year	712.2	1871.2	982.1	640.5	88.1	46.3	14.8	36.9	840.0	2330.8	1516.9	542.7	Estimated loss	% of baseline
1980	0	0	0	0	0	0	0	0	0	0	156,694	4,273	160,967	3.9%
1981	42,123	0	0	0	0	0	0	0	0	21,052	175,748	24,001	262,925	6.7%
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1984	0	0	0	0	0	0	0	0	0	45,615	0	25,198	70,814	1.6%
1985	0	0	0	0	0	0	0	0	0	0	0	19,820	19,820	0.4%
1986	52,499	0	0	0	0	0	0	0	0	230,668	100,875	0	384,041	9.8%
1987	4,517	0	0	0	0	0	0	0	0	0	0	62,573	67,089	2.0%
1988	0	0	0	0	0	0	0	0	0	84,054	198,616	0	282,670	10.2%
1989	0	0	0	0	0	0	0	0	0	0	31,873	46,653	78,526	2.4%
1990	11,487	0	0	0	0	0	0	0	0	0	0	0	11,487	0.4%
1991	0	0	0	0	0	0	0	0	0	39,592	0	0	39,592	2.1%
1992	0	0	0	0	0	0	0	0	0	312,975	8,830	0	321,805	17.4%
1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1994	6,856	130,928	0	0	0	0	0	0	0	0	0	0	137,784	3.5%
1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1996	0	0	0	0	0	0	0	0	0	216,809	81,992	0	298,801	7.2%
1997	16,917	0	0	0	0	0	0	0	0	268,047	0	30,817	315,781	8.1%
1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1999	0	0	0	0	0	0	0	0	0	190,162	0	0	190,162	4.4%
2000	27,278	0	0	0	0	0	0	0	0	93,782	0	0	121,060	3.0%
2001	47,593	27,448	0	0	0	0	0	0	0	66,618	0	0	141,659	4.1%
2002	0	0	0	0	0	0	0	0	0	0	75,472	60,637	136,109	3.5%
2003	0	0	0	0	0	0	0	0	0	64,091	0	0	64,091	1.6%
Average	8,720	6,599	0	0	0	0	0	0	0	68,061	34,588	11,416	129,383	3.4%

Table B-72. Entrainment Loss of American Shad during Existing Agricultural Diversions Compared to Entrainment Loss during Diversions to the Habitat Islands under the Project

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Number of fish
	Assumed density (Fish/taf)												
	712.2	1871.2	982.1	640.5	88.1	46.3	14.8	36.9	840.0	2330.8	1516.9	542.7	
Agricultural diversions	121	0	278	181	25	0	0	10	1,130	3,731	1,784	300	7,561
Habitat island diversions	7	16	9	1	0	0	0	0	13	42	20	7	115
Project Benefit	114	-16	269	181	24	0	0	10	1,118	3,689	1,764	292	7,446

Table B-73. Summary of American Shad Entrainment Loss Impacts of the Project Compared to the Baseline Conditions

	Baseline CVP/SWP Loss[1]	Baseline Delta Lowland Agriculture Loss[2]	Project Diversion Impact[3]		Project Export Impact[4]		Baseline Project Agricultural Diversion	Project Habitat Diversion	Project Benefit from Reduced and Screened Agricultural Diversions[7]		Net Project Impact	
			Loss	% of Baseline SWP/CVP	Loss	% of Baseline SWP/CVP	Loss[5]	Loss[6]	Reduced Loss	% of SWP/ CVP	Loss	% of SWP/CVP
1980	4,155,109	151,216	3,356	0.1%	160,967	3.9%	7,561	115	7,446	0.2%	156,876	3.8%
1981	3,929,816	151,216	2,582	0.1%	262,925	6.7%	7,561	115	7,446	0.2%	258,061	6.6%
1982	4,695,975	151,216	5,152	0.1%	0	0.0%	7,561	115	7,446	0.2%	-2,294	0.0%
1983	4,717,175	151,216	5,152	0.1%	0	0.0%	7,561	115	7,446	0.2%	-2,294	0.0%
1984	4,328,694	151,216	5,152	0.1%	70,814	1.6%	7,561	115	7,446	0.2%	68,520	1.6%
1985	4,502,395	151,216	4,617	0.1%	19,820	0.4%	7,561	115	7,446	0.2%	16,991	0.4%
1986	3,919,133	151,216	507	0.0%	384,041	9.8%	7,561	115	7,446	0.2%	377,103	9.6%
1987	3,367,930	151,216	209	0.0%	67,089	2.0%	7,561	115	7,446	0.2%	59,852	1.8%
1988	2,763,830	151,216	2,877	0.1%	282,670	10.2%	7,561	115	7,446	0.3%	278,101	10.1%
1989	3,298,806	151,216	242	0.0%	78,526	2.4%	7,561	115	7,446	0.2%	71,323	2.2%

	Baseline CVP/SWP Loss[1]	Baseline Delta Lowland Agriculture Loss[2]	Project Diversion Impact[3]		Project Export Impact[4]		Baseline Project Agricultural Diversion	Project Habitat Diversion	Project Benefit from Reduced and Screened Agricultural Diversions[7]		Net Project Impact	
			Loss	% of Baseline SWP/CVP	Loss	% of Baseline SWP/CVP	Loss[5]	Loss[6]	Reduced Loss	% of SWP/ CVP	Loss	% of SWP/CVP
1990	2,876,125	151,216	0	0.0%	11,487	0.4%	7,561	115	7,446	0.3%	4,041	0.1%
1991	1,882,284	151,216	28	0.0%	39,592	2.1%	7,561	115	7,446	0.4%	32,174	1.7%
1992	1,849,745	151,216	412	0.0%	321,805	17.4%	7,561	115	7,446	0.4%	314,771	17.0%
1993	3,707,486	151,216	3,356	0.1%	0	0.0%	7,561	115	7,446	0.2%	-4,090	-0.1%
1994	3,969,081	151,216	0	0.0%	137,784	3.5%	7,561	115	7,446	0.2%	130,338	3.3%
1995	4,057,237	151,216	3,356	0.1%	0	0.0%	7,561	115	7,446	0.2%	-4,090	-0.1%
1996	4,166,220	151,216	3,356	0.1%	298,801	7.2%	7,561	115	7,446	0.2%	294,710	7.1%
1997	3,919,523	151,216	5,152	0.1%	315,781	8.1%	7,561	115	7,446	0.2%	313,487	8.0%
1998	4,525,680	151,216	3,356	0.1%	0	0.0%	7,561	115	7,446	0.2%	-4,090	-0.1%
1999	4,358,005	151,216	5,152	0.1%	190,162	4.4%	7,561	115	7,446	0.2%	187,868	4.3%
2000	4,087,424	151,216	2,646	0.1%	121,060	3.0%	7,561	115	7,446	0.2%	116,260	2.8%
2001	3,468,231	151,216	93	0.0%	141,659	4.1%	7,561	115	7,446	0.2%	134,305	3.9%
2002	3,872,539	151,216	4,406	0.1%	136,109	3.5%	7,561	115	7,446	0.2%	133,069	3.4%
2003	4,030,636	151,216	5,149	0.1%	64,091	1.6%	7,561	115	7,446	0.2%	61,794	1.5%
Average	3,768,712	151,216	2,763	0.1%	129,383	3.8%	7,561	115	7,446	0.2%	124,699	3.7%

Notes.
[1]Based on average of monthly fish densities at salvage (fish/taf) extrapolated to account for pre- and postsalvage losses and multiplied by export flows.
[2] Assumes baseline loss is 20 times that of the Project agricultural diversion loss (based on the Project being 5% of irrigated Delta acreage).
[3]Assumes diversions from December to March, 50% small-intake correction, and 95% screening efficiency.
[4]Increased loss of fish assuming SWP export of discharged Project water from July to November.
[5]Assumes similar pattern of agricultural diversions each year, and10% small-intake correction..
[6]Assumes 95% screening efficiency, 10% small-intake correction, and similar pattern of habitat diversions each year.
[7] Calculated as entrainment loss to existing Project agricultural diversions minus entrainment loss to Project wetland habitat diversions.

Threadfin Shad

The baseline entrainment loss of threadfin shad by SWP and CVP averaged over 9.7 million fish from 1980 to 2003 (Table B-74). The lowest entrainment loss of around 5.1 million fish occurred in 1991 and the maximum entrainment was over 12.2 million fish in 1983. Direct entrainment loss of threadfin shad estimated for the Project ranged from 0 fish in 1990 and 1994 to almost 7,400 fish in several years, and averaged almost 4,800 fish (Table B-75); this represented an average increased entrainment over baseline conditions of 0–0.1%. Loss of threadfin shad due to export of discharged Project water averaged over 400,000 fish per year, with values ranging from 0 (several years) to 1.2 million fish in 1986. This was 0–19.3% of baseline SWP/CVP entrainment losses (Table B-76).

Based on the assumed monthly density of threadfin shad and the schedule of diversions for agriculture (under the existing/baseline conditions) and for the Habitat Islands (under the Project), it was estimated there would be a net benefit of the Project: over 22,000 less threadfin shad would be entrained annually (Table B-77). As a whole, the Project was estimated to result in a net loss to threadfin shad because the potential increase in entrainment caused by Project diversions (to the reservoir and Habitat Islands) from December to March and the export of Project water from July to November was not offset by the decrease in entrainment attributable to the reduction and screening of the agricultural diversions. This net loss averaged over 385,000 fish per year, or 4.4% of the baseline entrainment by SWP and CVP (Table B-78).

Table B-74. Baseline Entrainment Loss of Threadfin Shad by SWP and CVP Export Facilities Assumed in the Analysis of Small Juvenile and Adult Fish

Water year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Estimated loss
	Assumed density (Fish/taf)												
	2289.6	2516.7	1404.1	1167.0	764.5	215.4	335.4	277.0	1949.2	7250.7	4747.1	2188.5	
1980	830,231	1,221,658	705,714	659,716	343,493	78,846	108,173	67,606	604,336	3,016,602	1,775,173	1,069,390	10,480,938
1981	954,838	920,162	644,136	607,288	368,691	92,770	67,636	53,360	558,647	3,512,531	1,595,765	857,065	10,232,889
1982	996,755	1,221,922	705,282	622,184	378,976	95,014	126,866	122,279	838,191	3,633,360	2,372,726	1,085,978	12,199,533
1983	1,125,677	1,223,557	723,900	583,564	322,943	66,890	131,984	124,805	838,191	3,633,360	2,372,726	1,085,978	12,233,575
1984	1,125,677	1,223,557	663,337	440,063	307,359	86,696	66,989	46,252	541,846	3,318,817	2,358,846	992,273	11,171,712
1985	1,118,808	1,221,177	703,582	578,487	282,684	54,886	61,333	55,253	530,233	3,615,504	2,359,759	958,228	11,539,934
1986	878,580	1,005,858	704,895	598,722	432,725	96,905	120,080	103,173	521,133	2,578,142	2,080,170	1,083,071	10,203,455
1987	1,030,121	1,034,154	523,568	414,108	290,586	74,681	16,392	49,149	516,804	3,403,127	622,497	454,647	8,429,833
1988	615,222	637,922	698,966	593,532	71,437	15,007	45,695	20,753	372,060	2,801,431	316,329	424,832	6,613,186
1989	431,167	572,119	419,887	317,257	73,987	100,750	71,361	33,052	497,901	3,502,812	2,212,465	751,013	8,983,770
1990	792,460	823,877	484,099	588,405	109,727	46,166	16,392	28,806	386,207	2,414,964	813,730	506,694	7,011,528
1991	441,363	522,158	138,886	140,245	82,565	108,027	23,714	30,823	195,977	2,163,435	751,325	503,218	5,101,737
1992	516,052	321,569	272,260	234,610	396,757	71,744	29,087	13,538	296,104	1,228,709	1,299,149	520,227	5,199,807
1993	408,235	435,281	459,150	645,959	410,944	105,137	97,444	61,971	789,676	3,614,956	2,277,745	1,082,759	10,389,258
1994	1,099,534	884,210	587,607	489,371	364,052	57,194	39,466	39,433	511,231	3,625,868	2,181,781	587,936	10,467,682
1995	707,564	494,290	676,106	629,296	419,464	107,006	148,693	126,181	838,191	3,633,360	2,372,726	1,085,978	11,238,855
1996	1,125,677	1,223,557	705,756	570,814	326,605	77,117	117,110	84,853	607,658	2,535,301	2,137,529	1,084,246	10,596,223
1997	793,964	1,222,335	742,356	591,199	387,631	81,388	78,309	46,238	515,067	2,030,565	2,360,919	883,699	9,733,670
1998	807,705	1,105,809	704,567	580,399	386,501	83,177	132,116	120,181	838,191	3,633,360	2,372,726	1,085,978	11,850,710
1999	1,125,677	1,223,557	716,032	581,088	344,772	87,768	105,404	53,589	552,085	3,047,606	2,258,853	1,083,266	11,179,698
2000	1,042,203	1,221,644	552,448	594,463	384,354	100,545	99,953	65,007	600,783	2,465,068	2,363,401	1,035,493	10,525,362
2001	985,054	1,181,904	706,073	606,769	398,367	96,925	43,288	27,214	237,093	2,839,808	747,273	524,641	8,394,409
2002	578,458	863,914	703,515	607,459	37,361	44,013	62,117	48,304	519,540	3,560,862	2,103,562	649,848	9,778,953
2003	569,543	1,220,176	700,942	593,229	43,804	84,457	90,008	76,862	592,027	2,618,333	2,326,351	1,019,522	9,935,255
Average	837,524	959,432	610,128	536,176	290,241	79,713	79,150	62,445	554,132	3,017,828	1,851,397	850,666	9,728,832

Table B-75. Entrainment Loss of Threadfin Shad during Diversions onto the Project Reservoir Islands

Water year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Estimated loss	% of baseline
	Assumed density (Fish/taf)													
	2289.6	2516.7	1404.1	1167.0	764.5	215.4	335.4	277.0	1949.2	7250.7	4747.1	2188.5		
1980	0	0	0	6,109	13	7	0	0	0	0	0	0	6,128	0.1%
1981	0	0	0	4,593	0	283	0	0	0	0	0	0	4,876	0.0%
1982	0	0	7,350	15	13	7	0	0	0	0	0	0	7,385	0.1%
1983	0	0	7,350	15	13	7	0	0	0	0	0	0	7,385	0.1%
1984	0	0	7,350	15	13	7	0	0	0	0	0	0	7,385	0.1%
1985	0	0	6,602	0	0	0	0	0	0	0	0	0	6,602	0.1%
1986	0	0	0	0	4,350	28	0	0	0	0	0	0	4,378	0.0%
1987	0	0	0	0	0	971	0	0	0	0	0	0	971	0.0%
1988	0	0	0	5,241	0	0	0	0	0	0	0	0	5,241	0.1%
1989	0	0	0	0	0	1,127	0	0	0	0	0	0	1,127	0.0%
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1991	0	0	0	0	0	130	0	0	0	0	0	0	130	0.0%
1992	0	0	0	0	3,572	0	0	0	0	0	0	0	3,572	0.1%
1993	0	0	0	6,109	13	7	0	0	0	0	0	0	6,129	0.1%
1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1995	0	0	0	6,109	13	7	0	0	0	0	0	0	6,129	0.1%
1996	0	0	0	6,109	13	7	0	0	0	0	0	0	6,128	0.1%
1997	0	0	7,350	15	13	7	0	0	0	0	0	0	7,385	0.1%
1998	0	0	0	6,109	13	7	0	0	0	0	0	0	6,129	0.1%
1999	0	0	7,350	15	13	7	0	0	0	0	0	0	7,385	0.1%
2000	0	0	0	4,593	1,074	7	0	0	0	0	0	0	5,674	0.1%
2001	0	0	0	0	804	0	0	0	0	0	0	0	804	0.0%
2002	0	0	4,306	2,540	0	0	0	0	0	0	0	0	6,846	0.1%
2003	0	0	7,350	15	0	0	0	0	0	0	0	0	7,365	0.1%
Average	0	0	2,292	1,983	414	109	0	0	0	0	0	0	4,798	0.0%

Table B-76. Entrainment Loss of Threadfin Shad during Export of Water Discharged from the Project Islands

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		
	Assumed density (Fish/taf)													
Water year	2289.6	2516.7	1404.1	1167.0	764.5	215.4	335.4	277.0	1949.2	7250.7	4747.1	2188.5	Estimated loss	% of baseline
1980	0	0	0	0	0	0	0	0	0	0	490,356	17,231	507,587	4.8%
1981	135,425	0	0	0	0	0	0	0	0	65,492	549,984	96,794	847,696	8.3%
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1984	0	0	0	0	0	0	0	0	0	141,904	0	101,623	243,527	2.2%
1985	0	0	0	0	0	0	0	0	0	0	0	79,932	79,932	0.7%
1986	168,783	0	0	0	0	0	0	0	0	717,583	315,676	0	1,202,042	11.8%
1987	14,521	0	0	0	0	0	0	0	0	0	0	252,349	266,870	3.2%
1988	0	0	0	0	0	0	0	0	0	261,482	621,547	0	883,029	13.4%
1989	0	0	0	0	0	0	0	0	0	0	99,743	188,147	287,890	3.2%
1990	36,930	0	0	0	0	0	0	0	0	0	0	0	36,930	0.5%
1991	0	0	0	0	0	0	0	0	0	123,166	0	0	123,166	2.4%
1992	0	0	0	0	0	0	0	0	0	973,631	27,633	0	1,001,264	19.3%
1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1994	22,041	176,093	0	0	0	0	0	0	0	0	0	0	198,133	1.9%
1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1996	0	0	0	0	0	0	0	0	0	674,468	256,584	0	931,052	8.8%
1997	54,388	0	0	0	0	0	0	0	0	833,864	0	124,281	1,012,534	10.4%
1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1999	0	0	0	0	0	0	0	0	0	591,573	0	0	591,573	5.3%
2000	87,699	0	0	0	0	0	0	0	0	291,744	0	0	379,443	3.6%
2001	153,011	36,916	0	0	0	0	0	0	0	207,241	0	0	397,168	4.7%
2002	0	0	0	0	0	0	0	0	0	0	236,182	244,542	480,723	4.9%
2003	0	0	0	0	0	0	0	0	0	199,381	0	0	199,381	2.0%
Average	28,033	8,875	0	0	0	0	0	0	0	211,730	108,238	46,037	402,914	4.1%

Table B-77. Entrainment Loss of Threadfin Shad during Existing Agricultural Diversions Compared to Entrainment Loss during Diversions to the Habitat Islands under the Project

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Number of fish
	Assumed density (Fish/taf)												
	2289.6	2516.7	1404.1	1167.0	764.5	215.4	335.4	277.0	1949.2	7250.7	4747.1	2188.5	
Agricultural diversions	389	0	398	331	217	0	0	75	2,623	11,607	5,582	1,209	22,430
Habitat island diversions	22	21	13	1	4	0	0	1	29	131	62	30	313
Project Benefit	367	-21	384	329	212	0	0	74	2,594	11,477	5,520	1,180	22,117

Table B-78. Summary of threadfin shad entrainment loss impacts of the Project compared to the baseline conditions

	Baseline CVP/SWP Loss[1]	Baseline Delta Lowland Agriculture Loss[2]	Project Diversion Impact[3]		Project Export Impact[4]		Baseline Project Agricultural Diversion	Project Habitat Diversion	Project Benefit from Reduced and Screened Agricultural Diversions[7]		Net Project Impact	
			Loss	% of Baseline SWP/CVP	Loss	% of Baseline SWP/CVP	Loss[5]	Loss[6]	Reduced Loss	% of SWP/CVP	Loss	% of SWP/CVP
1980	10,480,938	448,606	6,128	0.1%	507,587	4.8%	22,430	313	22,117	0.2%	491,598	4.7%
1981	10,232,889	448,606	4,876	0.0%	847,696	8.3%	22,430	313	22,117	0.2%	830,455	8.1%
1982	12,199,533	448,606	7,385	0.1%	0	0.0%	22,430	313	22,117	0.2%	-14,731	-0.1%
1983	12,233,575	448,606	7,385	0.1%	0	0.0%	22,430	313	22,117	0.2%	-14,731	-0.1%
1984	11,171,712	448,606	7,385	0.1%	243,527	2.2%	22,430	313	22,117	0.2%	228,795	2.0%
1985	11,539,934	448,606	6,602	0.1%	79,932	0.7%	22,430	313	22,117	0.2%	64,417	0.6%
1986	10,203,455	448,606	4,378	0.0%	1,202,042	11.8%	22,430	313	22,117	0.2%	1,184,302	11.6%
1987	8,429,833	448,606	971	0.0%	266,870	3.2%	22,430	313	22,117	0.3%	245,724	2.9%
1988	6,613,186	448,606	5,241	0.1%	883,029	13.4%	22,430	313	22,117	0.3%	866,153	13.1%
1989	8,983,770	448,606	1,127	0.0%	287,890	3.2%	22,430	313	22,117	0.2%	266,901	3.0%
1990	7,011,528	448,606	0	0.0%	36,930	0.5%	22,430	313	22,117	0.3%	14,813	0.2%

			Project Diversion Impact[3]		Project Export Impact[4]		Baseline Project Agricultural Diversion	Project Habitat Diversion	Project Benefit from Reduced and Screened Agricultural Diversions[7]		Net Project Impact	
	Baseline CVP/SWP Loss[1]	Baseline Delta Lowland Agriculture Loss[2]	Loss	% of Baseline SWP/CVP	Loss	% of Baseline SWP/CVP	Loss[5]	Loss[6]	Reduced Loss	% of SWP/CVP	Loss	% of SWP/CVP
1991	5,101,737	448,606	130	0.0%	123,166	2.4%	22,430	313	22,117	0.4%	101,179	2.0%
1992	5,199,807	448,606	3,572	0.1%	1,001,264	19.3%	22,430	313	22,117	0.4%	982,719	18.9%
1993	10,389,258	448,606	6,129	0.1%	0	0.0%	22,430	313	22,117	0.2%	-15,988	-0.2%
1994	10,467,682	448,606	0	0.0%	198,133	1.9%	22,430	313	22,117	0.2%	176,016	1.7%
1995	11,238,855	448,606	6,129	0.1%	0	0.0%	22,430	313	22,117	0.2%	-15,988	-0.1%
1996	10,596,223	448,606	6,128	0.1%	931,052	8.8%	22,430	313	22,117	0.2%	915,063	8.6%
1997	9,733,670	448,606	7,385	0.1%	1,012,534	10.4%	22,430	313	22,117	0.2%	997,802	10.3%
1998	11,850,710	448,606	6,129	0.1%	0	0.0%	22,430	313	22,117	0.2%	-15,988	-0.1%
1999	11,179,698	448,606	7,385	0.1%	591,573	5.3%	22,430	313	22,117	0.2%	576,842	5.2%
2000	10,525,362	448,606	5,674	0.1%	379,443	3.6%	22,430	313	22,117	0.2%	363,000	3.4%
2001	8,394,409	448,606	804	0.0%	397,168	4.7%	22,430	313	22,117	0.3%	375,856	4.5%
2002	9,778,953	448,606	6,846	0.1%	480,723	4.9%	22,430	313	22,117	0.2%	465,452	4.8%
2003	9,935,255	448,606	7,365	0.1%	199,381	2.0%	22,430	313	22,117	0.2%	184,629	1.9%
Average	9,728,832	448,606	4,798	0.0%	402,914	4.6%	22,430	313	22,117	0.2%	385,595	4.4%

Notes. [1]Based on average of monthly fish densities at salvage (fish/taf) extrapolated to account for pre- and postsalvage losses and multiplied by export flows.
[2] Assumes baseline loss is 20 times that of the Project agricultural diversion loss (based on the Project being 5% of irrigated Delta acreage).
[3]Assumes diversions from December to March, 50% small-intake correction, and 95% screening efficiency.
[4]Increased loss of fish assuming SWP export of discharged Project water from July to November.
[5]Assumes similar pattern of agricultural diversions each year, and10% small-intake correction..
[6]Assumes 95% screening efficiency, 10% small-intake correction, and similar pattern of habitat diversions each year.
[7] Calculated as entrainment loss to existing Project agricultural diversions minus entrainment loss to Project wetland habitat diversions.

Sacramento Splittail

The baseline entrainment loss of Sacramento splittail by SWP and CVP averaged almost 1.7 million fish from 1980 to 2003 (Table B-79). The lowest entrainment loss of around 740,000 fish occurred in 1991 and the maximum entrainment was over 2.6 million fish in 1995. Direct entrainment loss of Sacramento splittail estimated for the Project ranged from 0 fish in 1990 and 1994 to 375 fish in 1986, and averaged 114 fish (Table B-80); this represented an average increased entrainment over baseline conditions of 0.0%. Loss of Sacramento splittail due to export of discharged Project water averaged almost 20,000 fish per year, with values ranging from 0 (several years) to almost 85,000 fish in 1992. This was 0–10.4% of baseline SWP/CVP entrainment losses (Table B-81).

Based on the assumed monthly density of Sacramento splittail and the schedule of diversions for agriculture (under the existing/baseline conditions) and for the Habitat Islands (under the Project), it was estimated there would be a net benefit of the Project: nearly 6,500 less Sacramento splittail would be entrained annually (Table B-82). As a whole, the Project was estimated to result in a net loss to Sacramento splittail because the potential increase in entrainment caused by Project diversions (to the reservoir and Habitat Islands) from December to March and the export of Project water from July to November was not offset by the decrease in entrainment attributable to the reduction and screening of the agricultural diversions. This net loss averaged almost 13,500 fish per year, or 1.1% of the baseline entrainment by SWP and CVP (Table B-83).

Table B-79. Baseline Entrainment Loss of Sacramento Splittail by SWP and CVP Export Facilities Assumed in the Analysis of Small Juvenile and Adult Fish

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
	Assumed density (Fish/taf)												Estimated loss
Water year	1.8	1.0	4.2	32.4	65.1	33.2	69.1	1131.7	3820.3	628.3	58.1	6.1	
1980	644	502	2,108	18,344	29,240	12,162	22,284	276,164	1,184,490	261,405	21,734	2,978	1,832,054
1981	740	378	1,924	16,886	31,385	14,310	13,933	217,972	1,094,941	304,381	19,538	2,387	1,718,774
1982	773	502	2,107	17,300	32,260	14,656	26,135	499,498	1,642,843	314,851	29,050	3,024	2,582,999
1983	873	502	2,163	16,226	27,490	10,318	27,189	509,818	1,642,843	314,851	29,050	3,024	2,584,348
1984	873	502	1,982	12,236	26,164	13,373	13,800	188,937	1,062,010	287,594	28,880	2,763	1,639,115
1985	868	501	2,102	16,085	24,063	8,466	12,635	225,703	1,039,251	313,304	28,892	2,668	1,674,538
1986	681	413	2,106	16,648	36,835	14,948	24,737	421,451	1,021,415	223,411	25,468	3,016	1,791,129
1987	799	425	1,564	11,514	24,736	11,520	3,377	200,769	1,012,929	294,900	7,622	1,266	1,571,420
1988	477	262	2,088	16,503	6,081	2,315	9,413	84,774	729,233	242,760	3,873	1,183	1,098,962
1989	334	235	1,254	8,822	6,298	15,541	14,700	135,016	975,880	303,538	27,088	2,091	1,490,798
1990	615	338	1,446	16,361	9,340	7,121	3,377	117,670	756,961	209,270	9,963	1,411	1,133,873
1991	342	214	415	3,900	7,028	16,664	4,885	125,908	384,112	187,474	9,199	1,401	741,541
1992	400	132	813	6,523	33,774	11,067	5,992	55,300	580,360	106,475	15,906	1,449	818,191
1993	317	179	1,372	17,961	34,981	16,218	20,074	253,146	1,547,755	313,256	27,887	3,015	2,236,161
1994	853	363	1,755	13,607	30,990	8,822	8,130	161,082	1,002,006	314,202	26,713	1,637	1,570,160
1995	549	203	2,020	17,498	35,707	16,506	30,631	515,438	1,642,843	314,851	29,050	3,024	2,608,319
1996	873	502	2,108	15,872	27,802	11,896	24,125	346,617	1,191,002	219,698	26,171	3,019	1,869,684
1997	616	502	2,218	16,439	32,997	12,554	16,132	188,880	1,009,524	175,960	28,906	2,461	1,487,188
1998	626	454	2,105	16,138	32,901	12,830	27,216	490,929	1,642,843	314,851	29,050	3,024	2,572,968
1999	873	502	2,139	16,157	29,349	13,539	21,713	218,908	1,082,080	264,092	27,656	3,017	1,680,025
2000	808	502	1,650	16,529	32,718	15,509	20,590	265,549	1,177,527	213,612	28,936	2,883	1,776,815
2001	764	485	2,109	16,872	33,911	14,951	8,917	111,167	464,699	246,085	9,149	1,461	910,571
2002	449	355	2,102	16,891	3,180	6,789	12,796	197,319	1,018,291	308,569	25,755	1,810	1,594,305
2003	442	501	2,094	16,495	3,729	13,028	18,542	313,973	1,160,365	226,893	28,483	2,839	1,787,384
Average	650	394	1,823	14,909	24,707	12,296	16,305	255,083	1,086,092	261,512	22,667	2,369	1,698,805

Table B-80. Entrainment Loss of Sacramento Splittail during Diversions onto the Project Reservoir Islands

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		
	Assumed density (Fish/taf)													
Water year	1.8	1.0	4.2	32.4	65.1	33.2	69.1	1131.7	3820.3	628.3	58.1	6.1	Estimated loss	% of baseline
1980	0	0	0	170	1	1	0	0	0	0	0	0	172	0.0%
1981	0	0	0	128	0	44	0	0	0	0	0	0	171	0.0%
1982	0	0	22	0	1	1	0	0	0	0	0	0	25	0.0%
1983	0	0	22	0	1	1	0	0	0	0	0	0	25	0.0%
1984	0	0	22	0	1	1	0	0	0	0	0	0	25	0.0%
1985	0	0	20	0	0	0	0	0	0	0	0	0	20	0.0%
1986	0	0	0	0	370	4	0	0	0	0	0	0	375	0.0%
1987	0	0	0	0	0	150	0	0	0	0	0	0	150	0.0%
1988	0	0	0	146	0	0	0	0	0	0	0	0	146	0.0%
1989	0	0	0	0	0	174	0	0	0	0	0	0	174	0.0%
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1991	0	0	0	0	0	20	0	0	0	0	0	0	20	0.0%
1992	0	0	0	0	304	0	0	0	0	0	0	0	304	0.0%
1993	0	0	0	170	1	1	0	0	0	0	0	0	172	0.0%
1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1995	0	0	0	170	1	1	0	0	0	0	0	0	172	0.0%
1996	0	0	0	170	1	1	0	0	0	0	0	0	172	0.0%
1997	0	0	22	0	1	1	0	0	0	0	0	0	25	0.0%
1998	0	0	0	170	1	1	0	0	0	0	0	0	172	0.0%
1999	0	0	22	0	1	1	0	0	0	0	0	0	25	0.0%
2000	0	0	0	128	91	1	0	0	0	0	0	0	220	0.0%
2001	0	0	0	0	68	0	0	0	0	0	0	0	68	0.0%
2002	0	0	13	71	0	0	0	0	0	0	0	0	83	0.0%
2003	0	0	22	0	0	0	0	0	0	0	0	0	22	0.0%
Average	0	0	7	55	35	17	0	0	0	0	0	0	114	0.0%

Table B-81. Entrainment Loss of Sacramento Splittail during Export of Water Discharged from the Project Island

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		
	Assumed density (Fish/taf)													
Water year	1.8	1.0	4.2	32.4	65.1	33.2	69.1	1131.7	3820.3	628.3	58.1	6.1	Estimated loss	% of baseline
1980	0	0	0	0	0	0	0	0	0	0	6,004	48	6,052	0.3%
1981	105	0	0	0	0	0	0	0	0	5,675	6,734	270	12,784	0.7%
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1984	0	0	0	0	0	0	0	0	0	12,297	0	283	12,580	0.8%
1985	0	0	0	0	0	0	0	0	0	0	0	223	223	0.0%
1986	131	0	0	0	0	0	0	0	0	62,183	3,865	0	66,178	3.7%
1987	11	0	0	0	0	0	0	0	0	0	0	703	714	0.0%
1988	0	0	0	0	0	0	0	0	0	22,659	7,610	0	30,269	2.8%
1989	0	0	0	0	0	0	0	0	0	0	1,221	524	1,745	0.1%
1990	29	0	0	0	0	0	0	0	0	0	0	0	29	0.0%
1991	0	0	0	0	0	0	0	0	0	10,673	0	0	10,673	1.4%
1992	0	0	0	0	0	0	0	0	0	84,371	338	0	84,709	10.4%
1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1994	17	72	0	0	0	0	0	0	0	0	0	0	89	0.0%
1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1996	0	0	0	0	0	0	0	0	0	58,446	3,141	0	61,588	3.3%
1997	42	0	0	0	0	0	0	0	0	72,259	0	346	72,647	4.9%
1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1999	0	0	0	0	0	0	0	0	0	51,263	0	0	51,263	3.1%
2000	68	0	0	0	0	0	0	0	0	25,281	0	0	25,349	1.4%
2001	119	15	0	0	0	0	0	0	0	17,959	0	0	18,092	2.0%
2002	0	0	0	0	0	0	0	0	0	0	2,892	681	3,573	0.2%
2003	0	0	0	0	0	0	0	0	0	17,277	0	0	17,277	1.0%
Average	22	4	0	0	0	0	0	0	0	18,348	1,325	128	19,826	1.2%

Table B-82. Entrainment loss of Sacramento splittail during existing agricultural diversions compared to entrainment loss during diversions to the Habitat Islands under the Project.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
	Assumed density (Fish/taf)												
	1.8	1.0	4.2	32.4	65.1	33.2	69.1	1131.7	3820.3	628.3	58.1	6.1	Number of fish
Agricultural diversions	0	0	1	9	18	0	0	305	5,142	1,006	68	3	6,553
Habitat island diversions	0	0	0	0	0	0	0	2	57	11	1	0	72
Project Benefit	0	0	1	9	18	0	0	302	5,084	995	68	3	6,481

Table B-83. Summary of Sacramento Splittail Entrainment Loss Impacts of the Project Compared to the Baseline Conditions

			Project Diversion Impact[3]		Project Export Impact[4]		Baseline Project Agricultural Diversion	Project Habitat Diversion	Project Benefit from Reduced and Screened Agricultural Diversions[7]		Net Project Impact	
	Baseline CVP/SWP Loss[1]	Baseline Delta Lowland Agriculture Loss[2]	Loss	% of Baseline SWP/CVP	Loss	% of Baseline SWP/CVP	Loss5	Loss6	Reduced Loss	% of SWP/CVP	Loss	% of SWP/CVP
1980	1,832,054	131,056	172	0.0%	6,052	0.3%	6,553	72	6,481	0.4%	-257	0.0%
1981	1,718,774	131,056	171	0.0%	12,784	0.7%	6,553	72	6,481	0.4%	6,474	0.4%
1982	2,582,999	131,056	25	0.0%	0	0.0%	6,553	72	6,481	0.3%	-6,456	-0.2%
1983	2,584,348	131,056	25	0.0%	0	0.0%	6,553	72	6,481	0.3%	-6,456	-0.2%
1984	1,639,115	131,056	25	0.0%	12,580	0.8%	6,553	72	6,481	0.4%	6,124	0.4%
1985	1,674,538	131,056	20	0.0%	223	0.0%	6,553	72	6,481	0.4%	-6,238	-0.4%
1986	1,791,129	131,056	375	0.0%	66,178	3.7%	6,553	72	6,481	0.4%	60,072	3.4%
1987	1,571,420	131,056	150	0.0%	714	0.0%	6,553	72	6,481	0.4%	-5,617	-0.4%
1988	1,098,962	131,056	146	0.0%	30,269	2.8%	6,553	72	6,481	0.6%	23,934	2.2%
1989	1,490,798	131,056	174	0.0%	1,745	0.1%	6,553	72	6,481	0.4%	-4,562	-0.3%

	Baseline CVP/SWP Loss[1]	Baseline Delta Lowland Agriculture Loss[2]	Project Diversion Impact[3]		Project Export Impact[4]		Baseline Project Agricultural Diversion	Project Habitat Diversion	Project Benefit from Reduced and Screened Agricultural Diversions[7]		Net Project Impact	
			Loss	% of Baseline SWP/CVP	Loss	% of Baseline SWP/CVP	Loss5	Loss6	Reduced Loss	% of SWP/ CVP	Loss	% of SWP/ CVP
1990	1,133,873	131,056	0	0.0%	29	0.0%	6,553	72	6,481	0.6%	-6,452	-0.6%
1991	741,541	131,056	20	0.0%	10,673	1.4%	6,553	72	6,481	0.9%	4,212	0.6%
1992	818,191	131,056	304	0.0%	84,709	10.4%	6,553	72	6,481	0.8%	78,532	9.6%
1993	2,236,161	131,056	172	0.0%	0	0.0%	6,553	72	6,481	0.3%	-6,309	-0.3%
1994	1,570,160	131,056	0	0.0%	89	0.0%	6,553	72	6,481	0.4%	-6,391	-0.4%
1995	2,608,319	131,056	172	0.0%	0	0.0%	6,553	72	6,481	0.2%	-6,309	-0.2%
1996	1,869,684	131,056	172	0.0%	61,588	3.3%	6,553	72	6,481	0.3%	55,279	3.0%
1997	1,487,188	131,056	25	0.0%	72,647	4.9%	6,553	72	6,481	0.4%	66,191	4.5%
1998	2,572,968	131,056	172	0.0%	0	0.0%	6,553	72	6,481	0.3%	-6,309	-0.2%
1999	1,680,025	131,056	25	0.0%	51,263	3.1%	6,553	72	6,481	0.4%	44,807	2.7%
2000	1,776,815	131,056	220	0.0%	25,349	1.4%	6,553	72	6,481	0.4%	19,089	1.1%
2001	910,571	131,056	68	0.0%	18,092	2.0%	6,553	72	6,481	0.7%	11,680	1.3%
2002	1,594,305	131,056	83	0.0%	3,573	0.2%	6,553	72	6,481	0.4%	-2,825	-0.2%
2003	1,787,384	131,056	22	0.0%	17,277	1.0%	6,553	72	6,481	0.4%	10,819	0.6%
Average	1,698,805	131,056	114	0.0%	19,826	1.5%	6,553	72	6,481	0.4%	13,460	1.1%

Notes.

1Based on average of monthly fish densities at salvage (fish/taf) extrapolated to account for pre- and postsalvage losses and multiplied by export flows.

2 Assumes baseline loss is 20 times that of the Project agricultural diversion loss (based on the Project being 5% of irrigated Delta acreage).

3Assumes diversions from December to March, 50% small-intake correction, and 95% screening efficiency.

4Increased loss of fish assuming SWP export of discharged Project water from July to November.

5Assumes similar pattern of agricultural diversions each year, and10% small-intake correction..

6Assumes 95% screening efficiency, 10% small-intake correction, and similar pattern of habitat diversions each year.

7 Calculated as entrainment loss to existing Project agricultural diversions minus entrainment loss to Project wetland habitat diversions.

Longfin Smelt

The baseline entrainment loss of longfin smelt by SWP and CVP averaged over 130,000 fish from 1980 to 2003 (Table B-84). The lowest entrainment loss of over 43,000 fish occurred in 1992 and the maximum entrainment was over 250,000 fish in 1995. Direct entrainment loss of longfin smelt estimated for the Project ranged from 0 fish in 1990 and 1994 to 17 fish in 1989, and averaged 10 fish (Table B-85); this represented an average increased entrainment over baseline conditions of 0.0%. Loss of longfin smelt due to export of discharged Project water averaged 195 fish per year, with values ranging from 0 (several years) to almost 550 fish in 1986. This was 0–1.0% of baseline SWP/CVP entrainment losses (Table B-86).

Based on the assumed monthly density of longfin smelt and the schedule of diversions for agriculture (under the existing/baseline conditions) and for the Habitat Islands (under the Project), it was estimated there would be a net benefit of the Project: 113 less longfin smelt would be entrained annually (Table B-87). As a whole, the Project was estimated to result in a net loss to longfin smelt because the potential increase in entrainment caused by Project diversions (to the reservoir and Habitat Islands) from December to March and the export of Project water from July to November was not offset by the decrease in entrainment attributable to the reduction and screening of the agricultural diversions. This net loss averaged 92 fish per year, or 0.1% of the baseline entrainment by SWP and CVP (Table B-88).

Table B-84. Baseline entrainment loss of longfin smelt by SWP and CVP export facilities assumed in the analysis of small juvenile and adult fish.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
	Assumed density (Fish/taf)												Estimated
Water year	0.4	0.2	2.3	2.3	0.6	3.3	141.4	224.0	32.9	2.5	2.7	1.0	loss
1980	187	101	1,536	1,758	346	1,629	61,484	73,674	13,767	1,402	1,385	684	157,954
1981	216	76	1,402	1,618	372	1,916	38,443	58,150	12,726	1,633	1,245	548	118,345
1982	225	101	1,535	1,658	382	1,963	72,108	133,254	19,094	1,689	1,851	695	234,556
1983	254	101	1,576	1,555	325	1,382	75,017	136,007	19,094	1,689	1,851	695	239,547
1984	254	101	1,444	1,173	310	1,791	38,075	50,404	12,343	1,543	1,840	635	109,913
1985	253	101	1,532	1,542	285	1,134	34,861	60,212	12,079	1,681	1,841	613	116,132
1986	198	83	1,534	1,596	436	2,002	68,251	112,433	11,871	1,199	1,623	693	201,920
1987	233	86	1,140	1,104	293	1,543	9,317	53,560	11,773	1,582	486	291	81,406
1988	139	53	1,522	1,582	72	310	25,972	22,616	8,476	1,302	247	272	62,561
1989	97	47	914	845	75	2,081	40,560	36,019	11,342	1,628	1,726	480	95,816
1990	179	68	1,054	1,568	111	954	9,317	31,391	8,798	1,123	635	324	55,521
1991	100	43	302	374	83	2,231	13,479	33,589	4,464	1,006	586	322	56,580
1992	116	27	593	625	400	1,482	16,532	14,753	6,745	571	1,014	333	43,191
1993	92	36	1,000	1,721	414	2,172	55,385	67,533	17,989	1,681	1,777	692	150,493
1994	248	73	1,279	1,304	367	1,181	22,432	42,973	11,646	1,686	1,702	376	85,267
1995	160	41	1,472	1,677	423	2,210	84,515	137,506	19,094	1,689	1,851	695	251,333
1996	254	101	1,536	1,521	329	1,593	66,563	92,469	13,843	1,179	1,668	693	181,750
1997	179	101	1,616	1,576	391	1,681	44,509	50,389	11,733	944	1,842	565	115,526
1998	182	92	1,534	1,547	390	1,718	75,093	130,968	19,094	1,689	1,851	695	234,852
1999	254	101	1,559	1,549	347	1,813	59,910	58,399	12,577	1,417	1,762	693	140,381
2000	235	101	1,203	1,584	387	2,077	56,811	70,842	13,686	1,146	1,844	662	150,579
2001	222	98	1,537	1,617	402	2,002	24,604	29,657	5,401	1,320	583	336	67,779
2002	131	72	1,531	1,619	38	909	35,306	52,640	11,835	1,655	1,641	416	107,793
2003	129	101	1,526	1,581	44	1,744	51,159	83,761	13,486	1,217	1,815	652	157,215
Average	189	80	1,328	1,429	293	1,646	44,988	68,050	12,623	1,403	1,444	544	134,017

Table B-85. Longfin smelt2. Entrainment loss of longfin smelt during diversions onto the Project Reservoir Islands.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		
	Assumed density (Fish/taf)													
Water year	0.4	0.2	2.3	2.3	0.6	3.3	141.4	224.0	32.9	2.5	2.7	1.0	Estimated loss	% of baseline
1980	0	0	0	12	0	0	0	0	0	0	0	0	12	0.0%
1981	0	0	0	9	0	4	0	0	0	0	0	0	13	0.0%
1982	0	0	12	0	0	0	0	0	0	0	0	0	12	0.0%
1983	0	0	12	0	0	0	0	0	0	0	0	0	12	0.0%
1984	0	0	12	0	0	0	0	0	0	0	0	0	12	0.0%
1985	0	0	11	0	0	0	0	0	0	0	0	0	11	0.0%
1986	0	0	0	0	3	0	0	0	0	0	0	0	4	0.0%
1987	0	0	0	0	0	15	0	0	0	0	0	0	15	0.0%
1988	0	0	0	10	0	0	0	0	0	0	0	0	10	0.0%
1989	0	0	0	0	0	17	0	0	0	0	0	0	17	0.0%
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1991	0	0	0	0	0	2	0	0	0	0	0	0	2	0.0%
1992	0	0	0	0	3	0	0	0	0	0	0	0	3	0.0%
1993	0	0	0	12	0	0	0	0	0	0	0	0	12	0.0%
1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1995	0	0	0	12	0	0	0	0	0	0	0	0	12	0.0%
1996	0	0	0	12	0	0	0	0	0	0	0	0	12	0.0%
1997	0	0	12	0	0	0	0	0	0	0	0	0	12	0.0%
1998	0	0	0	12	0	0	0	0	0	0	0	0	12	0.0%
1999	0	0	12	0	0	0	0	0	0	0	0	0	12	0.0%
2000	0	0	0	9	1	0	0	0	0	0	0	0	10	0.0%
2001	0	0	0	0	1	0	0	0	0	0	0	0	1	0.0%
2002	0	0	7	5	0	0	0	0	0	0	0	0	12	0.0%
2003	0	0	12	0	0	0	0	0	0	0	0	0	12	0.0%
Average	0	0	4	4	0	2	0	0	0	0	0	0	10	0.0%

Table B-86. Entrainment loss of longfin smelt during export of water discharged from the Project Islands

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		
	Assumed density (Fish/taf)													
Water year	0.4	0.2	2.3	2.3	0.6	3.3	141.4	224.0	32.9	2.5	2.7	1.0	Estimated loss	% of baseline
1980	0	0	0	0	0	0	0	0	0	0	340	10	350	0.2%
1981	27	0	0	0	0	0	0	0	0	27	381	55	491	0.4%
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1984	0	0	0	0	0	0	0	0	0	59	0	58	116	0.1%
1985	0	0	0	0	0	0	0	0	0	0	0	45	45	0.0%
1986	34	0	0	0	0	0	0	0	0	297	219	0	549	0.3%
1987	3	0	0	0	0	0	0	0	0	0	0	143	146	0.2%
1988	0	0	0	0	0	0	0	0	0	108	431	0	539	0.9%
1989	0	0	0	0	0	0	0	0	0	0	69	107	176	0.2%
1990	7	0	0	0	0	0	0	0	0	0	0	0	7	0.0%
1991	0	0	0	0	0	0	0	0	0	51	0	0	51	0.1%
1992	0	0	0	0	0	0	0	0	0	402	19	0	422	1.0%
1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1994	4	13	0	0	0	0	0	0	0	0	0	0	17	0.0%
1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1996	0	0	0	0	0	0	0	0	0	279	178	0	457	0.3%
1997	11	0	0	0	0	0	0	0	0	345	0	71	426	0.4%
1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1999	0	0	0	0	0	0	0	0	0	244	0	0	244	0.2%
2000	18	0	0	0	0	0	0	0	0	121	0	0	138	0.1%
2001	31	3	0	0	0	0	0	0	0	86	0	0	119	0.2%
2002	0	0	0	0	0	0	0	0	0	0	164	139	303	0.3%
2003	0	0	0	0	0	0	0	0	0	82	0	0	82	0.1%
Average	6	1	0	0	0	0	0	0	0	87	75	26	195	0.1%

Table B-87. Entrainment loss of longfin smelt during existing agricultural diversions compared to entrainment loss during diversions to the Habitat Islands under the Project.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Number of fish
	Assumed density (Fish/taf)												
	0.4	0.2	2.3	2.3	0.6	3.3	141.4	224.0	32.9	2.5	2.7	1.0	
Agricultural diversions	0	0	1	1	0	0	0	60	44	4	3	1	114
Habitat island diversions	0	0	0	0	0	0	0	0	0	0	0	0	1
Project Benefit	0	0	1	1	0	0	0	60	44	4	3	1	113

Table B-88. Summary of longfin smelt entrainment loss impacts of the Project compared to the baseline conditions.

	Baseline CVP/SWP Loss[1]	Baseline Delta Lowland Agriculture Loss[2]	Project Diversion Impact[3]		Project Export Impact[4]		Baseline Project Agricultural Diversion	Project Habitat Diversion	Project Benefit from Reduced and Screened Agricultural Diversions[7]		Net Project Impact	
			Loss	% of Baseline SWP/CVP	Loss	% of Baseline SWP/CVP	Loss[5]	Loss[6]	Reduced Loss	% of SWP/CVP	Loss	% of SWP/CVP
1980	157,954	2,279	12	0.0%	350	0.2%	114	1	113	0.1%	249	0.2%
1981	118,345	2,279	13	0.0%	491	0.4%	114	1	113	0.1%	391	0.3%
1982	234,556	2,279	12	0.0%	0	0.0%	114	1	113	0.0%	-101	0.0%
1983	239,547	2,279	12	0.0%	0	0.0%	114	1	113	0.0%	-101	0.0%
1984	109,913	2,279	12	0.0%	116	0.1%	114	1	113	0.1%	16	0.0%
1985	116,132	2,279	11	0.0%	45	0.0%	114	1	113	0.1%	-57	0.0%
1986	201,920	2,279	4	0.0%	549	0.3%	114	1	113	0.1%	440	0.2%
1987	81,406	2,279	15	0.0%	146	0.2%	114	1	113	0.1%	48	0.1%
1988	62,561	2,279	10	0.0%	539	0.9%	114	1	113	0.2%	437	0.7%
1989	95,816	2,279	17	0.0%	176	0.2%	114	1	113	0.1%	81	0.1%
1990	55,521	2,279	0	0.0%	7	0.0%	114	1	113	0.2%	-105	-0.2%
1991	56,580	2,279	2	0.0%	51	0.1%	114	1	113	0.2%	-60	-0.1%
1992	43,191	2,279	3	0.0%	422	1.0%	114	1	113	0.3%	311	0.7%

	Baseline CVP/SWP Loss[1]	Baseline Delta Lowland Agriculture Loss[2]	Project Diversion Impact[3]		Project Export Impact[4]		Baseline Project Agricultural Diversion	Project Habitat Diversion	Project Benefit from Reduced and Screened Agricultural Diversions[7]		Net Project Impact	
			Loss	% of Baseline SWP/CVP	Loss	% of Baseline SWP/CVP	Loss[5]	Loss[6]	Reduced Loss	% of SWP/CVP	Loss	% of SWP/CVP
1993	150,493	2,279	12	0.0%	0	0.0%	114	1	113	0.1%	-101	-0.1%
1994	85,267	2,279	0	0.0%	17	0.0%	114	1	113	0.1%	-95	-0.1%
1995	251,333	2,279	12	0.0%	0	0.0%	114	1	113	0.0%	-101	0.0%
1996	181,750	2,279	12	0.0%	457	0.3%	114	1	113	0.1%	356	0.2%
1997	115,526	2,279	12	0.0%	426	0.4%	114	1	113	0.1%	325	0.3%
1998	234,852	2,279	12	0.0%	0	0.0%	114	1	113	0.0%	-101	0.0%
1999	140,381	2,279	12	0.0%	244	0.2%	114	1	113	0.1%	144	0.1%
2000	150,579	2,279	10	0.0%	138	0.1%	114	1	113	0.1%	35	0.0%
2001	67,779	2,279	1	0.0%	119	0.2%	114	1	113	0.2%	7	0.0%
2002	107,793	2,279	12	0.0%	303	0.3%	114	1	113	0.1%	202	0.2%
2003	157,215	2,279	12	0.0%	82	0.1%	114	1	113	0.1%	-19	0.0%
Average	134,017	2,279	10	0.0%	195	0.2%	114	1	113	0.1%	92	0.1%

Notes.

[1]Based on average of monthly fish densities at salvage (fish/taf) extrapolated to account for pre- and postsalvage losses and multiplied by export flows.

[2] Assumes baseline loss is 20 times that of the Project agricultural diversion loss (based on the Project being 5% of irrigated Delta acreage).

[3]Assumes diversions from December to March, 50% small-intake correction, and 95% screening efficiency.

[4]Increased loss of fish assuming SWP export of discharged Project water from July to November.

[5]Assumes similar pattern of agricultural diversions each year, and10% small-intake correction..

[6]Assumes 95% screening efficiency, 10% small-intake correction, and similar pattern of habitat diversions each year.

[7] Calculated as entrainment loss to existing Project agricultural diversions minus entrainment loss to Project wetland habitat diversions.

Delta Smelt

Adults

The baseline entrainment loss of adult delta smelt by SWP and CVP averaged over 33,500 fish from 1980 to 2003 (Table B-89). The lowest entrainment loss of over 16,000 fish occurred in 1991 and the maximum entrainment was almost 44,000 fish in 1995. Direct entrainment loss of adult delta smelt estimated for the Project ranged from 0 fish in 1990 and 1994 to 105 fish in 1986, and averaged 62 fish (Table B-90); this represented an average increased entrainment over baseline conditions of 0–0.4%. Loss of adult delta smelt due to export of discharged Project water did not occur because the assumed export period did not coincide with the period of susceptibility to export entrainment.

Based on the assumed monthly density of delta smelt adults and the schedule of diversions for agriculture (under the existing/baseline conditions) and for the Habitat Islands (under the Project), it was estimated there would be a net benefit of the Project: 13 less delta smelt adults would be entrained annually (Table B-92). As a whole, the Project was estimated to result in a net loss to delta smelt adults because the potential increase in entrainment caused by Project diversions (to the reservoir and Habitat Islands) from December to March was not offset by the decrease in entrainment attributable to the reduction and screening of the agricultural diversions. This net loss averaged 50 fish per year, or 0.1% of the baseline entrainment by SWP and CVP (Table B-93).

Juveniles

The baseline entrainment loss of juvenile delta smelt by SWP and CVP averaged over 260,000 fish from 1980 to 2003 (Table B-89). The lowest entrainment loss of over 100,000 fish occurred in 1992 and the maximum entrainment was almost 444,000 fish in 1983. Direct entrainment loss of juvenile delta smelt estimated for the Project did not occur because the diversion period did not coincide with the assumed period of susceptibility to entrainment (Table B-90). Loss of juvenile delta smelt due to export of discharged Project water averaged over 2,500 fish per year and ranged from 0 fish (several years) to over 9,000 fish (1992) (Table B-91).

Based on the assumed monthly density of delta smelt juveniles and the schedule of diversions for agriculture (under the existing/baseline conditions) and for the Habitat Islands (under the Project), it was estimated there would be a net benefit of the Project: 562 less delta smelt juveniles would be entrained annually (Table B-92). As a whole, the Project was estimated to result in a net loss to delta smelt juveniles because the potential increase in entrainment caused by Project diversions (to the reservoir and Habitat Islands) from December to March and discharge for export (July–November) was not offset by the decrease in entrainment attributable to the reduction and screening of the agricultural diversions. This net loss averaged 1,971 fish per year, or 1.1% of the baseline entrainment by SWP and CVP (Table B-93).

Table B-89. Baseline entrainment loss of delta smelt by SWP and CVP export facilities assumed in the analysis of small juvenile and adult fish.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		
	Assumed density (Fish/taf)													
Water year	7.9	4.6	7.3	19.8	18.1	13.5	12.9	363.6	265.9	55.4	14.2	2.6	Estimated adult loss	Estimated juvenile loss
1980	3,856	3,012	4,917	15,107	10,970	6,675	5,608	119,606	111,132	31,095	7,140	1,734	39,070	281,781
1981	4,435	2,269	4,488	13,906	11,774	7,853	3,507	94,403	102,731	36,207	6,418	1,390	38,898	250,482
1982	4,629	3,013	4,914	14,247	12,103	8,043	6,578	216,331	154,137	37,453	9,543	1,761	40,951	431,800
1983	5,228	3,017	5,044	13,363	10,313	5,662	6,843	220,801	154,137	37,453	9,543	1,761	36,093	437,071
1984	5,228	3,017	4,622	10,077	9,816	7,339	3,473	81,828	99,641	34,211	9,487	1,609	32,721	237,625
1985	5,196	3,011	4,902	13,247	9,028	4,646	3,180	97,752	97,506	37,269	9,491	1,554	32,617	254,162
1986	4,080	2,480	4,911	13,710	13,819	8,203	6,226	182,529	95,832	26,576	8,366	1,756	42,200	326,289
1987	4,784	2,550	3,648	9,482	9,280	6,322	850	86,952	95,036	35,080	2,504	737	28,945	228,280
1988	2,857	1,573	4,870	13,591	2,281	1,270	2,369	36,715	68,419	28,877	1,272	689	22,605	142,180
1989	2,003	1,411	2,925	7,265	2,363	8,529	3,700	58,475	91,560	36,107	8,898	1,218	22,007	202,446
1990	3,680	2,031	3,373	13,474	3,504	3,908	850	50,962	71,020	24,894	3,273	822	24,471	157,320
1991	2,050	1,287	968	3,211	2,637	9,145	1,229	54,530	36,039	22,301	3,022	816	16,268	120,967
1992	2,397	793	1,897	5,372	12,671	6,073	1,508	23,950	54,451	12,666	5,225	843	26,390	101,456
1993	1,896	1,073	3,199	14,792	13,124	8,900	5,052	109,637	145,215	37,263	9,161	1,756	41,277	309,790
1994	5,107	2,180	4,094	11,206	11,626	4,842	2,046	69,764	94,011	37,376	8,775	953	32,279	219,701
1995	3,286	1,219	4,711	14,410	13,396	9,058	7,709	223,235	154,137	37,453	9,543	1,761	43,502	436,415
1996	5,228	3,017	4,917	13,071	10,430	6,528	6,072	150,119	111,743	26,134	8,597	1,758	36,464	311,150
1997	3,687	3,014	5,172	13,538	12,379	6,890	4,060	81,803	94,717	20,931	9,495	1,433	38,994	218,126
1998	3,751	2,726	4,909	13,290	12,343	7,041	6,850	212,620	154,137	37,453	9,543	1,761	39,296	427,128
1999	5,228	3,017	4,989	13,306	11,010	7,430	5,465	94,808	101,524	31,415	9,085	1,756	38,101	250,932
2000	4,840	3,012	3,849	13,612	12,274	8,511	5,182	115,009	110,479	25,410	9,505	1,679	39,543	273,821
2001	4,575	2,914	4,919	13,894	12,722	8,205	2,244	48,146	43,599	29,273	3,005	851	40,302	134,047
2002	2,687	2,130	4,902	13,910	1,193	3,726	3,221	85,458	95,539	36,706	8,460	1,054	24,536	234,449
2003	2,645	3,008	4,884	13,584	1,399	7,150	4,667	135,981	108,869	26,990	9,356	1,653	28,183	292,003
Average	3,890	2,365	4,251	12,278	9,269	6,748	4,104	110,476	101,900	31,108	7,446	1,379	33,571	261,643

Table B-90. Entrainment loss of delta smelt during diversions onto the Project Reservoir Islands.

Water year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Estimated adult loss	% of baseline	Estimated juvenile loss	% of baseline
	Assumed density (Fish/taf)															
	7.9	4.6	7.3	19.8	18.1	13.5	12.9	363.6	265.9	55.4	14.2	2.6				
1980	0	0	0	104	0	0	0	0	0	0	0	0	105	0.3%	0	0.0%
1981	0	0	0	78	0	18	0	0	0	0	0	0	96	0.2%	0	0.0%
1982	0	0	38	0	0	0	0	0	0	0	0	0	39	0.1%	0	0.0%
1983	0	0	38	0	0	0	0	0	0	0	0	0	39	0.1%	0	0.0%
1984	0	0	38	0	0	0	0	0	0	0	0	0	39	0.1%	0	0.0%
1985	0	0	34	0	0	0	0	0	0	0	0	0	34	0.1%	0	0.0%
1986	0	0	0	0	103	2	0	0	0	0	0	0	105	0.2%	0	0.0%
1987	0	0	0	0	0	61	0	0	0	0	0	0	61	0.2%	0	0.0%
1988	0	0	0	89	0	0	0	0	0	0	0	0	89	0.4%	0	0.0%
1989	0	0	0	0	0	71	0	0	0	0	0	0	71	0.3%	0	0.0%
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%	0	0.0%
1991	0	0	0	0	0	8	0	0	0	0	0	0	8	0.1%	0	0.0%
1992	0	0	0	0	85	0	0	0	0	0	0	0	85	0.3%	0	0.0%
1993	0	0	0	104	0	0	0	0	0	0	0	0	105	0.3%	0	0.0%
1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%	0	0.0%
1995	0	0	0	104	0	0	0	0	0	0	0	0	105	0.2%	0	0.0%
1996	0	0	0	104	0	0	0	0	0	0	0	0	105	0.3%	0	0.0%
1997	0	0	38	0	0	0	0	0	0	0	0	0	39	0.1%	0	0.0%
1998	0	0	0	104	0	0	0	0	0	0	0	0	105	0.3%	0	0.0%
1999	0	0	38	0	0	0	0	0	0	0	0	0	39	0.1%	0	0.0%
2000	0	0	0	78	25	0	0	0	0	0	0	0	104	0.3%	0	0.0%
2001	0	0	0	0	19	0	0	0	0	0	0	0	19	0.0%	0	0.0%
2002	0	0	22	43	0	0	0	0	0	0	0	0	65	0.3%	0	0.0%
2003	0	0	38	0	0	0	0	0	0	0	0	0	38	0.1%	0	0.0%
Average	0	0	12	34	10	7	0	0	0	0	0	0	62	0.2%	0	0.0%

Table B-91. Entrainment loss of delta smelt during export of water discharged from the Project Islands.

Water year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Estimated loss	% of baseline	Estimated loss	% of baseline
	Assumed density (Fish/taf)															
	7.9	4.6	7.3	19.8	18.1	13.5	12.9	363.6	265.9	55.4	14.2	2.6				
1980	0	0	0	0	0	0	0	0	0	0	1,753	25	0	0.0%	1,778	0.6%
1981	559	0	0	0	0	0	0	0	0	600	1,966	139	0	0.0%	3,265	1.3%
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%	0	0.0%
1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%	0	0.0%
1984	0	0	0	0	0	0	0	0	0	1,300	0	146	0	0.0%	1,447	0.6%
1985	0	0	0	0	0	0	0	0	0	0	0	115	0	0.0%	115	0.0%
1986	697	0	0	0	0	0	0	0	0	6,575	1,129	0	0	0.0%	8,400	2.6%
1987	60	0	0	0	0	0	0	0	0	0	0	364	0	0.0%	424	0.2%
1988	0	0	0	0	0	0	0	0	0	2,396	2,222	0	0	0.0%	4,618	3.2%
1989	0	0	0	0	0	0	0	0	0	0	357	271	0	0.0%	628	0.3%
1990	152	0	0	0	0	0	0	0	0	0	0	0	0	0.0%	152	0.1%
1991	0	0	0	0	0	0	0	0	0	1,129	0	0	0	0.0%	1,129	0.9%
1992	0	0	0	0	0	0	0	0	0	8,921	99	0	0	0.0%	9,020	8.9%
1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%	0	0.0%
1994	91	386	0	0	0	0	0	0	0	0	0	0	0	0.0%	477	0.2%
1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%	0	0.0%
1996	0	0	0	0	0	0	0	0	0	6,180	917	0	0	0.0%	7,097	2.3%
1997	225	0	0	0	0	0	0	0	0	7,640	0	179	0	0.0%	8,044	3.7%
1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%	0	0.0%
1999	0	0	0	0	0	0	0	0	0	5,420	0	0	0	0.0%	5,420	2.2%
2000	362	0	0	0	0	0	0	0	0	2,673	0	0	0	0.0%	3,035	1.1%
2001	632	81	0	0	0	0	0	0	0	1,899	0	0	0	0.0%	2,611	1.9%
2002	0	0	0	0	0	0	0	0	0	0	844	352	0	0.0%	1,197	0.5%
2003	0	0	0	0	0	0	0	0	0	1,827	0	0	0	0.0%	1,827	0.6%
Average	116	19	0	0	0	0	0	0	0	1,940	387	66	0	0.0%	2,528	1.0%

Table B-92. Entrainment loss of delta smelt during existing agricultural diversions compared to entrainment loss during diversions to the Habitat Islands under the Project.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Number of adult fish	Number of juvenile fish
	Assumed density (Fish/taf)													
	7.9	4.6	7.3	19.8	18.1	13.5	12.9	363.6	265.9	55.4	14.2	2.6		
Agricultural diversions	1	0	2	6	5	0	0	98	358	89	17	1	13	564
Habitat island diversions	0	0	0	0	0	0	0	1	4	1	0	0	0	6
Project Benefit	0	0	0	2	5	0	0	2	1	0	0	0	13	558

Table B-93. Summary of adult delta smelt entrainment loss impacts of the Project compared to the baseline conditions.

	Baseline CVP/SWP Loss[1]	Baseline Delta Lowland Agriculture Loss[2]	Project Diversion Impact[3]		Project Export Impact[4]		Baseline Project Agricultural Diversion	Project Habitat Diversion	Project Benefit from Reduced and Screened Agricultural Diversions[7]		Net Project Impact	
			Loss	% of Baseline SWP/CVP	Loss	% of Baseline SWP/CVP	Loss[5]	Loss[6]	Reduced Loss	% of SWP/CVP	Loss	% of SWP/CVP
1980	39,070	256	105	0.3%	0	0.0%	13	0	13	0.0%	92	0.2%
1981	38,898	256	96	0.2%	0	0.0%	13	0	13	0.0%	83	0.2%
1982	40,951	256	39	0.1%	0	0.0%	13	0	13	0.0%	26	0.1%
1983	36,093	256	39	0.1%	0	0.0%	13	0	13	0.0%	26	0.1%
1984	32,721	256	39	0.1%	0	0.0%	13	0	13	0.0%	26	0.1%
1985	32,617	256	34	0.1%	0	0.0%	13	0	13	0.0%	22	0.1%
1986	42,200	256	105	0.2%	0	0.0%	13	0	13	0.0%	92	0.2%
1987	28,945	256	61	0.2%	0	0.0%	13	0	13	0.0%	48	0.2%
1988	22,605	256	89	0.4%	0	0.0%	13	0	13	0.1%	76	0.3%
1989	22,007	256	71	0.3%	0	0.0%	13	0	13	0.1%	58	0.3%
1990	24,471	256	0	0.0%	0	0.0%	13	0	13	0.1%	-13	-0.1%
1991	16,268	256	8	0.1%	0	0.0%	13	0	13	0.1%	-4	0.0%
1992	26,390	256	85	0.3%	0	0.0%	13	0	13	0.0%	72	0.3%

	Baseline CVP/SWP Loss[1]	Baseline Delta Lowland Agriculture Loss[2]	Project Diversion Impact[3]		Project Export Impact[4]		Baseline Project Agricultural Diversion	Project Habitat Diversion	Project Benefit from Reduced and Screened Agricultural Diversions[7]		Net Project Impact	
			Loss	% of Baseline SWP/CVP	Loss	% of Baseline SWP/CVP	Loss[5]	Loss[6]	Reduced Loss	% of SWP/CVP	Loss	% of SWP/CVP
1993	41,277	256	105	0.3%	0	0.0%	13	0	13	0.0%	92	0.2%
1994	32,279	256	0	0.0%	0	0.0%	13	0	13	0.0%	-13	0.0%
1995	43,502	256	105	0.2%	0	0.0%	13	0	13	0.0%	92	0.2%
1996	36,464	256	105	0.3%	0	0.0%	13	0	13	0.0%	92	0.3%
1997	38,994	256	39	0.1%	0	0.0%	13	0	13	0.0%	26	0.1%
1998	39,296	256	105	0.3%	0	0.0%	13	0	13	0.0%	92	0.2%
1999	38,101	256	39	0.1%	0	0.0%	13	0	13	0.0%	26	0.1%
2000	39,543	256	104	0.3%	0	0.0%	13	0	13	0.0%	91	0.2%
2001	40,302	256	19	0.0%	0	0.0%	13	0	13	0.0%	6	0.0%
2002	24,536	256	65	0.3%	0	0.0%	13	0	13	0.1%	53	0.2%
2003	28,183	256	38	0.1%	0	0.0%	13	0	13	0.0%	26	0.1%
Average	33,571	256	62	0.2%	0	0.0%	13	0	13	0.0%	50	0.1%

Notes.
[1]Based on average of monthly fish densities at salvage (fish/taf) extrapolated to account for pre- and postsalvage losses and multiplied by export flows.
[2] Assumes baseline loss is 20 times that of the Project agricultural diversion loss (based on the Project being 5% of irrigated Delta acreage).
[3]Assumes diversions from December to March, 50% small-intake correction, and 95% screening efficiency.
[4]Increased loss of fish assuming SWP export of discharged Project water from July to November.
[5]Assumes similar pattern of agricultural diversions each year, and10% small-intake correction..
[6]Assumes 95% screening efficiency, 10% small-intake correction, and similar pattern of habitat diversions each year.
[7] Calculated as entrainment loss to existing Project agricultural diversions minus entrainment loss to Project wetland habitat diversions.

Table B-94. Summary of juvenile delta smelt entrainment loss impacts of the Project compared to the baseline conditions.

	Baseline CVP/SWP Loss[1]	Baseline Delta Lowland Agriculture Loss[2]	Project Diversion Impact[3]		Project Export Impact[4]		Baseline Project Agricultural Diversion	Project Habitat Diversion	Project Benefit from Reduced and Screened Agricultural Diversions[7]		Net Project Impact	
			Loss	% of Baseline SWP/CVP	Loss	% of Baseline SWP/CVP	Loss[5]	Loss[6]	Reduced Loss	% of SWP/CVP	Loss	% of SWP/CVP
1980	281,781	11,279	0	0.0%	1,778	0.6%	564	6	558	0.2%	1,220	0.4%
1981	250,482	11,279	0	0.0%	3,265	1.3%	564	6	558	0.2%	2,707	1.1%
1982	431,800	11,279	0	0.0%	0	0.0%	564	6	558	0.1%	-558	-0.1%
1983	437,071	11,279	0	0.0%	0	0.0%	564	6	558	0.1%	-558	-0.1%
1984	237,625	11,279	0	0.0%	1,447	0.6%	564	6	558	0.2%	889	0.4%
1985	254,162	11,279	0	0.0%	115	0.0%	564	6	558	0.2%	-443	-0.2%
1986	326,289	11,279	0	0.0%	8,400	2.6%	564	6	558	0.2%	7,842	2.4%
1987	228,280	11,279	0	0.0%	424	0.2%	564	6	558	0.2%	-134	-0.1%
1988	142,180	11,279	0	0.0%	4,618	3.2%	564	6	558	0.4%	4,060	2.9%
1989	202,446	11,279	0	0.0%	628	0.3%	564	6	558	0.3%	70	0.0%
1990	157,320	11,279	0	0.0%	152	0.1%	564	6	558	0.4%	-405	-0.3%
1991	120,967	11,279	0	0.0%	1,129	0.9%	564	6	558	0.5%	571	0.5%
1992	101,456	11,279	0	0.0%	9,020	8.9%	564	6	558	0.5%	8,462	8.3%
1993	309,790	11,279	0	0.0%	0	0.0%	564	6	558	0.2%	-558	-0.2%
1994	219,701	11,279	0	0.0%	477	0.2%	564	6	558	0.3%	-81	0.0%
1995	436,415	11,279	0	0.0%	0	0.0%	564	6	558	0.1%	-558	-0.1%
1996	311,150	11,279	0	0.0%	7,097	2.3%	564	6	558	0.2%	6,539	2.1%
1997	218,126	11,279	0	0.0%	8,044	3.7%	564	6	558	0.3%	7,486	3.4%
1998	427,128	11,279	0	0.0%	0	0.0%	564	6	558	0.1%	-558	-0.1%
1999	250,932	11,279	0	0.0%	5,420	2.2%	564	6	558	0.2%	4,862	1.9%
2000	273,821	11,279	0	0.0%	3,035	1.1%	564	6	558	0.2%	2,477	0.9%
2001	134,047	11,279	0	0.0%	2,611	1.9%	564	6	558	0.4%	2,054	1.5%

	Baseline CVP/SWP Loss[1]	Baseline Delta Lowland Agriculture Loss[2]	Project Diversion Impact[3]		Project Export Impact[4]		Baseline Project Agricultural Diversion	Project Habitat Diversion	Project Benefit from Reduced and Screened Agricultural Diversions[7]		Net Project Impact	
			Loss	% of Baseline SWP/CVP	Loss	% of Baseline SWP/CVP	Loss[5]	Loss[6]	Reduced Loss	% of SWP/CVP	Loss	% of SWP/CVP
2002	234,449	11,279	0	0.0%	1,197	0.5%	564	6	558	0.2%	639	0.3%
2003	292,003	11,279	0	0.0%	1,827	0.6%	564	6	558	0.2%	1,269	0.4%
Average	261,643	11,279	0	0.0%	2,528	1.3%	564	6	558	0.2%	1,971	1.1%

Notes.
[1]Based on average of monthly fish densities at salvage (fish/taf) extrapolated to account for pre- and postsalvage losses and multiplied by export flows.
[2] Assumes baseline loss is 20 times that of the Project agricultural diversion loss (based on the Project being 5% of irrigated Delta acreage).
[3]Assumes diversions from December to March, 50% small-intake correction, and 95% screening efficiency.
[4]Increased loss of fish assuming SWP export of discharged Project water from July to November.
[5]Assumes similar pattern of agricultural diversions each year, and10% small-intake correction..
[6]Assumes 95% screening efficiency, 10% small-intake correction, and similar pattern of habitat diversions each year.
[7] Calculated as entrainment loss to existing Project agricultural diversions minus entrainment loss to Project wetland habitat diversions.

Green Sturgeon

The baseline entrainment loss of green sturgeon by SWP and CVP averaged over 240 fish from 1980 to 2003 (Table B-95). The lowest entrainment loss of 121 fish occurred in 1988 and the maximum entrainment was almost 310 fish in 1982. Direct entrainment loss of green sturgeon estimated for the Project was zero, or more accurately less than 0.1% fish per year (Table B-96); this represented an average increased entrainment over baseline conditions of 0–0.2%. Loss of green sturgeon due to export of discharged Project water averaged 6 fish per year, with values ranging from 0 (several years) to 20 fish in 1988. This was 0–16.3% of baseline SWP/CVP losses (Table B-97).

Based on the assumed monthly density of green sturgeon and the schedule of diversions for agriculture (under the existing/baseline conditions) and for the Habitat Islands (under the Project), it was estimated there would be a very small net benefit of the Project: one less green sturgeon would be entrained annually (Table B-98). As a whole, the Project was estimated to result in a net loss to green sturgeon because the potential increase in entrainment caused by Project diversions (to the reservoir and Habitat Islands) from December to March and the export of Project water from July to November was not offset by the decrease in entrainment attributable to the reduction and screening of the agricultural diversions. This net loss averaged 5 fish per year, or 2.6% of the baseline entrainment by SWP and CVP (Table B-99).

Table B-95. Baseline entrainment loss of green sturgeon by SWP and CVP export facilities assumed in the analysis of small juvenile and adult fish.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
	Assumed density (Fish/taf)												Estimated
Water year	0.0	0.1	0.1	0.0	0.1	0.1	0.1	0.0	0.0	0.2	0.4	0.1	loss
1980	10	19	18	2	19	15	15	5	1	46	79	30	259
1981	12	15	16	2	21	17	9	4	1	53	71	24	245
1982	12	19	18	2	21	18	17	8	2	55	105	30	308
1983	14	19	18	2	18	12	18	8	2	55	105	30	303
1984	14	19	17	2	17	16	9	3	1	50	105	28	281
1985	14	19	18	2	16	10	8	4	1	55	105	27	278
1986	11	16	18	2	24	18	16	7	1	39	92	30	275
1987	13	16	13	1	16	14	2	3	1	51	28	13	172
1988	8	10	18	2	4	3	6	1	1	42	14	12	121
1989	5	9	11	1	4	19	10	2	1	53	98	21	234
1990	10	13	12	2	6	9	2	2	1	36	36	14	144
1991	5	8	4	1	5	20	3	2	0	33	33	14	128
1992	6	5	7	1	22	13	4	1	1	19	58	15	151
1993	5	7	12	2	23	20	13	4	2	55	101	30	274
1994	13	14	15	2	20	11	5	3	1	55	97	16	252
1995	9	8	17	2	24	20	20	9	2	55	105	30	300
1996	14	19	18	2	18	14	16	6	1	38	95	30	272
1997	10	19	19	2	22	15	11	3	1	31	105	25	262
1998	10	18	18	2	22	15	18	8	2	55	105	30	303
1999	14	19	18	2	19	16	14	4	1	46	100	30	285
2000	13	19	14	2	22	19	14	4	1	37	105	29	279
2001	12	19	18	2	22	18	6	2	1	43	33	15	190
2002	7	14	18	2	2	8	8	3	1	54	93	18	229
2003	7	19	18	2	2	16	12	5	1	40	103	29	254
Average	10	15	15	2	16	15	11	4	1	46	82	24	242

Table B-96. Entrainment loss of green sturgeon during diversions onto the Project Reservoir Islands.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		
	Assumed density (Fish/taf)													
Water year	0.0	0.1	0.1	0.0	0.1	0.1	0.1	0.0	0.0	0.2	0.4	0.1	Estimated loss	% of baseline
1980	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0%
1981	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0%
1982	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1%
1983	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1%
1984	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1%
1985	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1%
1986	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.2%
1987	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.2%
1988	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0%
1989	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.2%
1990	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0%
1991	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0%
1992	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.2%
1993	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0%
1994	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0%
1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0%
1996	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0%
1997	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1%
1998	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0%
1999	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1%
2000	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0%
2001	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0%
2002	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1%
2003	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1%
Average	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1%

Table B-97. Entrainment loss of green sturgeon during export of water discharged from the Project Islands.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		
	Assumed density (Fish/taf)													
Water year	0.0	0.1	0.1	0.0	0.1	0.1	0.1	0.0	0.0	0.2	0.4	0.1	Estimated loss	% of baseline
1980	0	0	0	0	0	0	0	0	0	0	14	0	14	5.4%
1981	1	0	0	0	0	0	0	0	0	1	15	2	19	7.6%
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1984	0	0	0	0	0	0	0	0	0	1	0	2	3	1.1%
1985	0	0	0	0	0	0	0	0	0	0	0	1	1	0.5%
1986	1	0	0	0	0	0	0	0	0	7	9	0	17	6.1%
1987	0	0	0	0	0	0	0	0	0	0	0	4	5	2.6%
1988	0	0	0	0	0	0	0	0	0	2	17	0	20	16.3%
1989	0	0	0	0	0	0	0	0	0	0	3	3	6	2.6%
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2%
1991	0	0	0	0	0	0	0	0	0	1	0	0	1	0.9%
1992	0	0	0	0	0	0	0	0	0	9	1	0	10	6.6%
1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1994	0	2	0	0	0	0	0	0	0	0	0	0	2	0.8%
1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1996	0	0	0	0	0	0	0	0	0	6	7	0	13	5.0%
1997	0	0	0	0	0	0	0	0	0	8	0	2	10	4.0%
1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
1999	0	0	0	0	0	0	0	0	0	6	0	0	6	2.0%
2000	1	0	0	0	0	0	0	0	0	3	0	0	3	1.2%
2001	1	0	0	0	0	0	0	0	0	2	0	0	3	1.8%
2002	0	0	0	0	0	0	0	0	0	0	7	4	11	4.7%
2003	0	0	0	0	0	0	0	0	0	2	0	0	2	0.7%
Average	0	0	0	0	0	0	0	0	0	2	3	1	6	2.5%

Table B-98. Entrainment loss of green sturgeon during existing agricultural diversions compared to entrainment loss during diversions to the Habitat Islands under the Project.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Number of fish
	Assumed density (Fish/taf)												
	0.0	0.1	0.1	0.0	0.1	0.1	0.1	0.0	0.0	0.2	0.4	0.1	
Agricultural diversions	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	0.1	1
Habitat island diversions	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Project Benefit	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	0.1	1

Table B-99. Summary of green sturgeon entrainment loss impacts of the Project compared to the baseline conditions.

			Project Diversion Impact[3]		Project Export Impact[4]		Baseline Project Agricultural Diversion	Project Habitat Diversion	Project Benefit from Reduced and Screened Agricultural Diversions[7]		Net Project Impact	
	Baseline CVP/SWP Loss[1]	Baseline Delta Lowland Agriculture Loss[2]	Loss	% of Baseline SWP/CVP	Loss	% of Baseline SWP/CVP	Loss[5]	Loss[6]	Reduced Loss	% of SWP/CVP	Loss	% of SWP/CVP
1980	259	17	0	0.0%	14	5.4%	1	0	1	0.3%	13	5.1%
1981	245	17	0	0.0%	19	7.6%	1	0	1	0.3%	18	7.3%
1982	308	17	0	0.1%	0	0.0%	1	0	1	0.3%	-1	-0.2%
1983	303	17	0	0.1%	0	0.0%	1	0	1	0.3%	-1	-0.2%
1984	281	17	0	0.1%	3	1.1%	1	0	1	0.3%	3	0.9%
1985	278	17	0	0.1%	1	0.5%	1	0	1	0.3%	1	0.3%
1986	275	17	0	0.2%	17	6.1%	1	0	1	0.3%	16	6.0%
1987	172	17	0	0.2%	5	2.6%	1	0	1	0.5%	4	2.3%
1988	121	17	0	0.0%	20	16.3%	1	0	1	0.7%	19	15.7%
1989	234	17	0	0.2%	6	2.6%	1	0	1	0.4%	6	2.4%
1990	144	17	0	0.0%	0	0.2%	1	0	1	0.6%	-1	-0.4%
1991	128	17	0	0.0%	1	0.9%	1	0	1	0.6%	0	0.3%

			Project Diversion Impact[3]		Project Export Impact[4]		Baseline Project Agricultural Diversion	Project Habitat Diversion	Project Benefit from Reduced and Screened Agricultural Diversions[7]		Net Project Impact	
	Baseline CVP/SWP Loss[1]	Baseline Delta Lowland Agriculture Loss[2]	Loss	% of Baseline SWP/CVP	Loss	% of Baseline SWP/CVP	Loss[5]	Loss[6]	Reduced Loss	% of SWP/CVP	Loss	% of SWP/CVP
1992	151	17	0	0.2%	10	6.6%	1	0	1	0.5%	9	6.3%
1993	274	17	0	0.0%	0	0.0%	1	0	1	0.3%	-1	-0.3%
1994	252	17	0	0.0%	2	0.8%	1	0	1	0.3%	1	0.4%
1995	300	17	0	0.0%	0	0.0%	1	0	1	0.3%	-1	-0.3%
1996	272	17	0	0.0%	13	5.0%	1	0	1	0.3%	13	4.7%
1997	262	17	0	0.1%	10	4.0%	1	0	1	0.3%	10	3.8%
1998	303	17	0	0.0%	0	0.0%	1	0	1	0.3%	-1	-0.3%
1999	285	17	0	0.1%	6	2.0%	1	0	1	0.3%	5	1.8%
2000	279	17	0	0.0%	3	1.2%	1	0	1	0.3%	3	1.0%
2001	190	17	0	0.0%	3	1.8%	1	0	1	0.4%	3	1.4%
2002	229	17	0	0.1%	11	4.7%	1	0	1	0.4%	10	4.5%
2003	254	17	0	0.1%	2	0.7%	1	0	1	0.3%	1	0.5%
Average	242	17	0	0.1%	6	2.9%	1	0	1	0.4%	5	2.6%

Notes.

[1]Based on average of monthly fish densities at salvage (fish/taf) extrapolated to account for pre- and postsalvage losses and multiplied by export flows.

[2] Assumes baseline loss is 20 times that of the Project agricultural diversion loss (based on the Project being 5% of irrigated Delta acreage).

[3]Assumes diversions from December to March, 50% small-intake correction, and 95% screening efficiency.

[4]Increased loss of fish assuming SWP export of discharged Project water from July to November.

[5]Assumes similar pattern of agricultural diversions each year, and10% small-intake correction..

[6]Assumes 95% screening efficiency, 10% small-intake correction, and similar pattern of habitat diversions each year.

[7] Calculated as entrainment loss to existing Project agricultural diversions minus entrainment loss to Project wetland habitat diversions.

Effects of Old and Middle River Flows on Delta Smelt Loss

The USWFS (2008a) OCAP BO for delta smelt examined a number of potential hydrodynamic variables that could quantitatively predict losses of adult and juvenile delta smelt. For adults, a predictive equation was developed (USFWS 2008a, 212) that described percentage loss in terms of Old and Middle River (OMR) flows:

> Adult entrainment loss (Annual % of whole population) = 6.243 – 0.000957*OMR flows (average, December–March).

The estimates of percentage loss were from Kimmerer's (2008, 21) estimates based on FMWT data from 1995 to 2006. The equation suggested that as OMR flows decrease, entrainment loss of adult delta smelt increases. The equation explained a modest proportion of the variability in the data (Adjusted $R^2 = 0.36$). USFWS (2008a, 212) noted that the unexplained variability is because "adult salvage and entrainment is not solely explained by OMR flows" and that "there is wide, apparently random variation in the use of the Central and South Delta by spawning delta smelt." However, USFWS (2008a, 212) suggested that the approach remained useful because "it provides expected salvage and entrainment losses given an OMR flow."

Losses of larval-juvenile delta smelt (as estimated by Kimmerer [2008, 23] for 1995–2006) were also described in terms of OMR flows, but with the addition of a second predictor, X2. Two predictive equations were described by USFWS (2008a, 220):

> Larval-juvenile loss (March–June proportion of whole population) = (0.00933*March–June X2) – (0.0000207*March–June OMR) – 0.556 (Adjusted $R^2 = 0.90$);
>
> Larval-juvenile loss (April–May proportion of whole population) = (0.00839*April–May X2) – (0.000029*April–May OMR) – 0.487 (Adjusted $R^2 = 0.87$).

The two equations were developed "to demonstrate that the conclusions are robust with regard to the choice of averaging period" (USFWS 2008a, 220). Estimates for 1995 and 1998 were excluded during model formulation because "the relationship between [OMR, X2, and entrainment loss] is linear when only years that had entrainment higher than 0 were modeled" (USFWS 2008a, 220). The equations suggested that the percentage loss of larval-juvenile delta smelt would increase as OMR flows decrease and as X2 increases (i.e., moves upstream).

There is potential for the Project to influence OMR flows during the assumed diversion period (December–March). Measured OMR flows will not be affected because the OMR flow measurement gauges are upstream of the project reservoir diversions on Webb Tract and Bacon Island. Although the Project intakes will be screened and therefore will probably exclude 95% of fish large enough to be screened, diversions may make delta smelt more susceptible to entrainment by the SWP/CVP export facilities. This possibility was examined by assuming project diversions would decrease OMR flows and therefore increase entrainment loss of delta smelt at the export facilities. It is probable that this analysis represents a worse-case scenario because Project diversions are unlikely to cause the same population-level losses as SWP/CVP exports of Delta water.

Methods

For analyses of both adult and larval-juvenile delta smelt, losses were calculated for baseline conditions and for Project conditions using the equations calculated by USFWS (2008a; 212, 22) described above. The values of OMR flows and X2 that were used in the predictive equations were averages of monthly averages from the IDSM/CALSIM outputs calculated for each period (adults: December–March; larvae/juveniles: March–June). The March–June averaging period was used for larvae/juveniles because the April–May period would not overlap the assumed project diversion period (December–March). Kimmerer's (2008) estimates of % loss were not provided by USFWS (2008a), so the equations were applied without any attempt to adjust for possible differences in the OMR and X2 input values between this analysis of Project effects and that of USFWS (2008a). Calculations of average X2 for March–June used data from February to June because the flows simulated for the Project operations provided end-of-month values. The equations predict negative losses in some years; following USFWS (2008a), negative values were changed to zeros before calculating average loss over the baseline period.

Main Assumptions

The main assumptions of this analysis were:

- Diversions to the Project Reservoir Islands occur in December–March;
- Project diversions to the Reservoir Islands on Webb Tract and Bacon Island decrease OMR flows by the same amount of flow that is diverted and therefore increase the percentage of adult and juvenile delta smelt that is lost due to entrainment at the SWP/CVP export facilities;
- Loss of adult delta smelt to entrainment at the SWP/CVP export facilities is influenced by OMR flows from December to March and can be estimated from an equation in the USFWS (2008a) OCAP BO;
- Loss of larval-juvenile delta smelt to entrainment at the SWP/CVP export facilities is influenced by OMR flows from March to June and can be estimated from an equation in the USFWS (2008a) OCAP BO.

Results

Adult Delta Smelt

Baseline December–March losses of delta smelt adults due to entrainment at the SWP/CVP export facilities from 1980 to 2003 averaged 10.7% of the population and ranged from 0% in 1983 to 14.8% in 2001 (Table B-100). Additional losses due to Project diversions decreasing OMR flows averaged 0.70% of the population and ranged from 0% in 1989 and 1994 to 0.94% in 1986 (Table B-100).

Table B-100. Predicted Percentage Losses of Adult Delta Smelt in December–March 1980–2003 Due to Entrainment By The SWP/CVP Export Facilities Under Baseline and Project Conditions.

	Baseline	Project
1980	8.97%	0.84%
1981	14.42%	0.84%
1982	11.17%	0.85%
1983	0.00%	0.85%
1984	7.50%	0.85%
1985	13.08%	0.75%
1986	9.40%	0.93%
1987	12.35%	0.72%
1988	11.25%	0.72%
1989	11.14%	0.84%
1990	11.57%	0.00%
1991	9.67%	0.10%
1992	11.56%	0.75%
1993	13.63%	0.84%
1994	13.22%	0.00%
1995	12.43%	0.84%
1996	11.42%	0.84%
1997	0.37%	0.85%
1998	9.40%	0.84%
1999	12.31%	0.85%
2000	12.81%	0.86%
2001	14.77%	0.17%
2002	11.39%	0.84%
2003	12.53%	0.84%

Larval-Juvenile Delta Smelt

Baseline March–June losses of delta smelt larvae/juveniles due to entrainment at the SWP/CVP export facilities from 1980 to 2003 averaged 17.4% of the population and ranged from 0% in 1983 to 27.0% in 1991 (Table B-101). Additional losses due to Project diversions decreasing OMR flows averaged 0.24% of the population and ranged from 0% in 1994 to almost 2% in 1989 (Table B-101).

Table B-101. Predicted Percentage Losses of Larval-Juvenile Delta Smelt in March-June 1980–2003 Due to Entrainment By The SWP/CVP Export Facilities Under Baseline and Project Conditions.

	Baseline	Project
1980	10.81%	0.04%
1981	25.30%	0.64%
1982	6.58%	0.02%
1983	0.00%	0.02%
1984	17.12%	0.02%
1985	26.43%	0.06%
1986	6.90%	0.08%
1987	24.01%	1.85%
1988	23.41%	0.11%
1989	25.40%	1.99%
1990	25.96%	0.00%
1991	26.98%	0.25%
1992	22.82%	0.30%
1993	17.77%	0.05%
1994	26.02%	0.00%
1995	6.20%	0.03%
1996	10.03%	0.03%
1997	16.04%	0.02%
1998	3.31%	0.05%
1999	14.43%	0.03%
2000	17.37%	0.08%
2001	23.19%	0.08%
2002	20.69%	0.04%
2003	21.10%	0.03%

Through-Delta Migration of Salmonids Originating in the Sacramento River Watershed and the Mokelumne River

Outmigrating Central Valley salmonid smolts must pass through the Delta. Endangered Sacramento River winter-run Chinook salmon and threatened Central Valley spring-run Chinook salmon currently spawn only within the Sacramento River watershed (Moyle et al. 2008); threatened Central Valley steelhead originate mostly from the Sacramento River watershed because the San Joaquin watershed populations are diminished to very low abundance (McEwan 2001). Fish entering the Delta from the Sacramento River may migrate through the river's mainstem or through smaller tributaries to the west (Sutter and Steamboat sloughs). Other fish may enter the central Delta through two main routes, the Delta Cross Channel (DCC) and Georgiana Slough. The proportion of fish entering the central Delta depends on the position of the DCC gates (open or closed) and the amount of flow in the Sacramento River. NMFS (2009, 631) describes an average of about 45% of Sacramento River flow being diverted into the central Delta through the DCC and Georgiana Slough, with 25% being diverted in November and December. Smolts entering the central Delta have reduced probability of surviving passage through the Delta compared to smolts remaining in the mainstem or entering Steamboat and Sutter sloughs. Brandes and McLain (2001) summarized coded-wire-tag studies that showed survival to Chipps Island (just downstream of the Delta) for fish passing through the central Delta (having been released in Georgiana Slough) was around half that of fish released on the mainstem Sacramento River (at Ryde) at low export levels, declining to around 15% at high export levels (~10,000 cfs). Lower survival may have been a result of the greater distance to travel (37%; White 1998, as cited by Brandes and McLain 2001) but could also have been due to greater residence time caused by lower river flows and high levels of export. A greater residence time in the central Delta may expose fish to an increased threat of predation or poorer water quality compared to the mainstem Sacramento River (NMFS 2009).

Methods

The previous analysis included in the 2001 FEIR and preceding draft documents included a model by Kjelson et al. (1989) to assess the possible effects of the Project on outmigrating salmonids. A similar approach was adopted in this analysis based on more recent information. An assessment was made of the potential effects of the Project on mortality of salmonid smolts migrating through the Delta from the Sacramento River. For each salmonid species (i.e., steelhead and winter-run, spring-run, fall-run, and late-fall-run Chinook salmon), the percentage of the total number of smolts entering the Delta in each month was assumed to be the same as the values used in the analysis of fish entrainment (Table B-102), which corresponded to observed migration patterns deduced from salvage data. Baseline mortality (percentage of all smolts entering the Delta) was calculated for the SWP/CVP exports over 1980-2003. The additional mortality increment attributable to the Project was then calculated and compared to the baseline value.

Main Assumptions

The main assumptions of the analysis were:

- Brandes and McLain's (2001) findings can be applied to steelhead and winter-run and spring-run Chinook salmon (their observations were for fall-run and late-fall-run Chinook salmon);
- The DCC gates are closed from January to June;
- If the DCC gates are closed, the flow of water into the Central Delta is represented by 0.133(Sacramento River flow at Hood, cfs) + 829;
- If the DCC gates are open, the flow of water into the Central Delta is represented by 0.293(Sacramento River flow at Hood, cfs) + 2090;
- The percentage of smolts leaving the Sacramento River and entering the central Delta is equivalent to the percentage of Sacramento River flow entering the central Delta;
- 90% of smolts entering the Delta and remaining in the Sacramento River (or passing through Steamboat and Sutter Sloughs) would survive to Chipps Island (i.e., 10% mortality)—this mortality rate is at the high end of recent estimates based on acoustic tagging (e.g., Perry and Skalski 2008, as cited by NMFS 2009);
- 45% of smolts entering the Delta and subsequently moving into the central Delta through the DCC or Georgiana Slough would survive to Chipps Island at zero exports (i.e., a minimum of 55% mortality would always occur for smolts moving through the central Delta);
- Additional mortality of smolts passing through the central Delta would be proportional to the amount of exports, up to a maximum of 100% mortality (at exports of 15,000 cfs), in addition to the 55% baseline central Delta mortality (i.e., a total minimum survival of 0% or maximum mortality of 100% for fish entering the central Delta);
- Project diversions to storage can be treated similarly to increased levels of export, except that the associated mortality is reduced by 50% (due to the intakes being smaller and screened, but acknowledging the potential for the diversions to cause salmonids to follow false migration cues such as reversed flows, resulting in greater probability of predation within the Delta channels or entrainment by the SWP/CVP export facilities)—comparative analyses assuming values of 100% and 25% were also conducted to examine the effect of changing this value;
- Project discharges to export are equivalent to increased levels of export (however, no exports were simulated as occurring during the salmonids' outmigration periods, so there was no effect of this aspect of the Project in this analysis);
- Diversions for agriculture under the baseline conditions or to the Habitat Islands under the Project gave negligible effects on mortality (always <0.01% total-population mortality, with the Project beneficial effect of removing the unscreened agricultural diversions always being greater than

the negative effects of the habitat island diversions)—these effects were therefore excluded from the analysis for simplicity.

- The percentage mortality due to the Project of fall-run Chinook salmon and steelhead originating in the Mokelumne River can be estimated from the percentage of Sacramento River fish that entered the central Delta and the total mortality attributable to the Project of these fish: % mortality of Mokelumne fish = % mortality of Sacramento fish × (100/% of Sacramento fish entering the central Delta). This assumes that the path of Sacramento-origin fish through the central Delta is similar to those from the Mokelumne River.

The mortality index should not be construed as the actual level of mortality that would occur because simulated monthly conditions cannot accurately characterize the complex conditions and variable time periods that affect survival during migration through the Delta. The mortality index provides a basis for comparing the effects of the Project Alterative operations on outmigrating salmonid smolts that could result from changes in diversions and Delta flows.

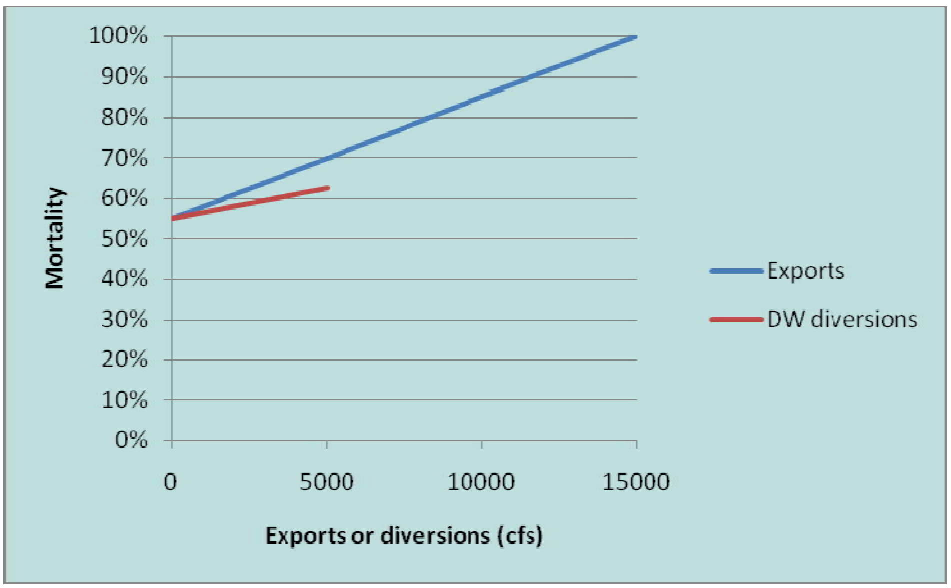


Figure B-3. Assumed increases in salmonid through-Delta mortality with increases in SWP/CVP exports and Project diversions. A baseline 55% mortality is assumed to occur for all salmonids entering the central Delta through the Delta Cross Channel or Georgiana Slough.

Table B-102. Monthly percentages of juvenile salmonids entering the Delta that were used in the analysis of through-Delta migration mortality.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fall-run Chinook	0.9%	5.9%	2.8%	11.3%	54.4%	22.0%	0.4%	0.0%	0.0%	0.8%	1.1%	0.3%
Late-fall-run Chinook	9.8%	4.3%	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%	0.1%	5.5%	25.9%	53.9%
Winter-run Chinook	0.0%	0.6%	8.8%	63.5%	26.5%	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Spring-run Chinook	11.7%	46.8%	23.2%	5.7%	0.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	11.9%
Steelhead	8.2%	26.2%	28.7%	22.4%	9.8%	1.1%	0.1%	0.0%	0.0%	0.1%	1.1%	2.2%

Results

Fall-Run Chinook Salmon

Total mortality of fall-run Chinook salmon juveniles between the Sacramento River entrance to the Delta and Chipps Island averaged 23.9% from 1980 to 2003 and ranged from 22.5% in 2003 to 26.1% in 1986 (Table B-103). The proportion of juveniles entering the central Delta averaged 19.3% (range: 15.1% [1983] to 24.2% [1990]). Baseline mortality through the central delta due to SWP/CVP exports plus predation and reduced water quality averaged 13.9% and ranged from 12.5% (2003) to 16.1% (1986). Mortality attributable to the Project diversions averaged 0.02% (range: 0% [several years] to 0.08% [1986]) (Table B-103).

Table B-103. Annual mortality of fall-run Chinook salmon juveniles originating in the Sacramento River watershed during through-Delta migration under simulated baseline and Project conditions. The values represent losses of fish entering the Delta on the Sacramento River.

	Total mortality	Sacramento River mortality (assumed)	% entering central Delta	Baseline % mortality (CVP/SWP + predation/water quality losses in central Delta)	Project % mortality
1980	24.6%	10.0%	19.6%	14.6%	0.01%
1981	24.8%	10.0%	20.6%	14.8%	0.03%
1982	23.8%	10.0%	16.3%	13.8%	0.00%
1983	22.8%	10.0%	15.1%	12.8%	0.00%
1984	23.7%	10.0%	19.5%	13.7%	0.01%
1985	23.9%	10.0%	19.5%	13.9%	0.01%
1986	26.1%	10.0%	20.2%	16.1%	0.08%
1987	23.9%	10.0%	20.0%	13.9%	0.02%
1988	24.2%	10.0%	22.4%	14.1%	0.01%
1989	23.3%	10.0%	19.9%	13.2%	0.02%
1990	25.5%	10.0%	24.2%	15.5%	0.00%
1991	25.0%	10.0%	23.8%	15.0%	0.00%
1992	23.8%	10.0%	21.9%	13.7%	0.06%
1993	22.8%	10.0%	17.1%	12.8%	0.01%
1994	24.4%	10.0%	21.0%	14.4%	0.02%
1995	23.4%	10.0%	15.7%	13.4%	0.01%
1996	22.8%	10.0%	16.6%	12.8%	0.02%
1997	24.0%	10.0%	19.8%	14.0%	0.02%
1998	23.3%	10.0%	15.8%	13.3%	0.01%
1999	22.9%	10.0%	17.8%	12.9%	0.01%
2000	24.0%	10.0%	18.7%	13.9%	0.03%
2001	24.3%	10.0%	21.7%	14.2%	0.03%
2002	23.7%	10.0%	20.0%	13.7%	0.01%
2003	22.5%	10.0%	16.9%	12.5%	0.01%
Average	23.9%	10.0%	19.3%	13.9%	0.02%

The average percentage loss for fall-run Chinook salmon originating in the Mokelumne River was 0.09% (range: 0.02% [several years] to 0.38% [1986]).

Late-Fall-Run Chinook Salmon

Total mortality of late-fall-run Chinook salmon juveniles between the Sacramento River entrance to the Delta and Chipps Island averaged 38.7% from 1980 to 2003 and ranged from 24.3% in 1984 to 45.5% in 1987 (Table B-104). The proportion of juveniles entering the central Delta averaged 35.2% (range: 16.1% [1984] to 54.3% [1991]). Baseline mortality through the central delta due to SWP/CVP exports plus predation and reduced water quality averaged 28.5% and ranged from 13.9% (1984) to 35.5% (1987). Mortality attributable to the Project diversions averaged 0.23% (range: 0.00% [1989 and 1991] to 0.99% [1985]) (Table B-104).

Table B-104. Annual mortality of late-fall-run Chinook salmon juveniles originating in the Sacramento River watershed during through-Delta migration under simulated baseline and Project conditions. The values represent losses of fish entering the Delta on the Sacramento River.

	Total mortality	Sacramento River mortality (assumed)	% entering central Delta	Baseline % mortality (CVP/SWP + predation/water quality losses in central Delta)	Project % mortality
1980	43.1%	10.0%	37.5%	33.0%	0.08%
1981	45.0%	10.0%	41.4%	34.8%	0.16%
1982	25.0%	10.0%	16.5%	14.6%	0.41%
1983	24.8%	10.0%	16.2%	14.4%	0.41%
1984	24.3%	10.0%	16.1%	13.9%	0.41%
1985	37.9%	10.0%	30.5%	27.0%	0.99%
1986	44.6%	10.0%	39.9%	34.4%	0.15%
1987	45.5%	10.0%	43.7%	35.5%	0.02%
1988	43.9%	10.0%	41.5%	33.8%	0.07%
1989	44.7%	10.0%	47.5%	34.7%	0.00%
1990	42.7%	10.0%	41.9%	32.7%	0.03%
1991	44.9%	10.0%	54.3%	34.9%	0.00%
1992	45.1%	10.0%	52.2%	35.1%	0.03%
1993	43.5%	10.0%	45.4%	33.4%	0.08%
1994	44.8%	10.0%	41.7%	34.2%	0.54%
1995	43.9%	10.0%	41.9%	33.9%	0.07%
1996	32.6%	10.0%	25.5%	22.5%	0.08%
1997	31.5%	10.0%	24.0%	21.0%	0.45%
1998	43.3%	10.0%	38.3%	33.2%	0.08%
1999	25.7%	10.0%	17.3%	15.3%	0.44%
2000	44.7%	10.0%	41.2%	34.6%	0.13%

	Total mortality	Sacramento River mortality (assumed)	% entering central Delta	Baseline % mortality (CVP/SWP + predation/water quality losses in central Delta)	Project % mortality
2001	44.8%	10.0%	39.3%	34.6%	0.22%
2002	31.9%	10.0%	26.7%	21.6%	0.30%
2003	31.1%	10.0%	24.2%	20.7%	0.45%
Average	38.7%	10.0%	35.2%	28.5%	0.23%

Winter-Run Chinook Salmon

Total mortality of winter-run Chinook salmon juveniles between the Sacramento River entrance to the Delta and Chipps Island averaged 25.3% from 1980 to 2003 and ranged from 21.6% in 2002 to 27.8% in 2001 (Table B-105). The proportion of juveniles entering the central Delta averaged 19.0% (range: 14.4% [1983] to 26.6% [1991]). Baseline mortality through the central delta due to SWP/CVP exports plus predation and reduced water quality averaged 15.2% and ranged from 11.5% (2002) to 17.7% (2001). Mortality attributable to the Project diversions averaged 0.12% (range: 0% [1990 and 1994] to 0.39% [1986]) (Table B-105).

Table B-105. Annual mortality of winter-run Chinook salmon juveniles originating in the Sacramento River watershed during through-Delta migration under simulated baseline and Project conditions. The values represent losses of fish entering the Delta on the Sacramento River.

	Total mortality	Sacramento River mortality (assumed)	% entering central Delta	Baseline % mortality (CVP/SWP + predation/water quality losses in central Delta)	Project % mortality
1980	25.3%	10.0%	17.8%	15.2%	0.09%
1981	27.1%	10.0%	19.8%	17.0%	0.13%
1982	22.8%	10.0%	14.5%	12.7%	0.09%
1983	22.1%	10.0%	14.4%	12.0%	0.09%
1984	22.9%	10.0%	15.7%	12.8%	0.09%
1985	27.6%	10.0%	21.6%	17.3%	0.22%
1986	26.6%	10.0%	18.2%	16.2%	0.39%
1987	27.0%	10.0%	21.4%	16.8%	0.17%
1988	26.1%	10.0%	23.0%	16.0%	0.09%
1989	27.0%	10.0%	23.9%	16.8%	0.18%
1990	26.1%	10.0%	22.8%	16.1%	0.00%
1991	27.5%	10.0%	26.6%	17.5%	0.02%
1992	27.6%	10.0%	22.4%	17.3%	0.36%
1993	26.3%	10.0%	18.9%	16.2%	0.09%
1994	27.3%	10.0%	21.2%	17.3%	0.00%
1995	26.4%	10.0%	18.2%	16.3%	0.09%

1996	22.5%	10.0%	14.9%	12.5%	0.10%
1997	23.4%	10.0%	15.5%	13.3%	0.09%
1998	25.4%	10.0%	17.6%	15.3%	0.09%
1999	22.8%	10.0%	14.9%	12.7%	0.10%
2000	26.1%	10.0%	18.6%	15.9%	0.17%
2001	27.8%	10.0%	20.3%	17.7%	0.08%
2002	21.6%	10.0%	16.8%	11.5%	0.10%
2003	21.9%	10.0%	16.4%	11.8%	0.10%
Average	25.3%	10.0%	19.0%	15.2%	0.12%

Spring-Run Chinook Salmon

Total mortality of spring-run Chinook salmon juveniles between the Sacramento River entrance to the Delta and Chipps Island averaged 22.9% from 1980 to 2003 and ranged from 21.8% in 1993 to 24.5% in 1986 (Table B-106). The proportion of juveniles entering the central Delta averaged 18.2% (range: 14.7% [1983] to 22.0% [1990]). Baseline mortality through the central Delta due to SWP/CVP exports plus predation and reduced water quality averaged 12.9% and ranged from 11.8% (1993) to 14.5% (1986). Mortality attributable to the Project diversions averaged 0.01% (range: 0.00% [many years] to 0.07% [1987 and 1989]) (Table B-106).

Table B-106. Annual mortality of spring-run Chinook salmon juveniles originating in the Sacramento River watershed during through-Delta migration under simulated baseline and Project conditions. The values represent losses of fish entering the Delta on the Sacramento River.

	Total mortality	Sacramento River mortality (assumed)	% entering central Delta	Baseline % mortality (CVP/SWP + predation/water quality losses in central Delta)	Project % mortality
1980	23.8%	10.0%	18.3%	13.8%	0.00%
1981	23.8%	10.0%	19.7%	13.8%	0.02%
1982	22.2%	10.0%	14.8%	12.2%	0.00%
1983	22.1%	10.0%	14.7%	12.1%	0.00%
1984	23.0%	10.0%	18.8%	13.0%	0.00%
1985	23.5%	10.0%	19.8%	13.5%	0.00%
1986	24.5%	10.0%	18.2%	14.5%	0.01%
1987	22.5%	10.0%	20.0%	12.5%	0.07%
1988	23.5%	10.0%	21.5%	13.5%	0.00%
1989	22.2%	10.0%	17.6%	12.1%	0.07%
1990	23.3%	10.0%	22.0%	13.3%	0.00%
1991	23.0%	10.0%	20.7%	13.0%	0.01%
1992	22.6%	10.0%	20.4%	12.6%	0.00%
1993	21.8%	10.0%	15.8%	11.8%	0.00%
1994	23.1%	10.0%	20.3%	13.1%	0.00%

1995	22.7%	10.0%	14.8%	12.7%	0.00%
1996	22.1%	10.0%	15.6%	12.1%	0.00%
1997	23.2%	10.0%	18.8%	13.2%	0.00%
1998	22.4%	10.0%	15.1%	12.4%	0.00%
1999	22.6%	10.0%	17.0%	12.6%	0.00%
2000	23.2%	10.0%	17.6%	13.2%	0.00%
2001	23.5%	10.0%	20.8%	13.5%	0.00%
2002	22.7%	10.0%	18.9%	12.7%	0.00%
2003	22.1%	10.0%	16.4%	12.1%	0.00%
Average	22.9%	10.0%	18.2%	12.9%	0.01%

Steelhead

Total mortality of steelhead juveniles between the Sacramento River entrance to the Delta and Chipps Island averaged 23.8% from 1980 to 2003 and ranged from 22.0% in 1983 to 25.4% in 2001 (Table B-107). The proportion of juveniles entering the central Delta averaged 18.0% (range: 14.6% [1983] to 22.3% [1991]). Baseline mortality through the central delta due to SWP/CVP exports plus predation and reduced water quality averaged 13.8% and ranged from 11.9% (1983) to 15.3% (2001). Mortality attributable to the Project averaged 0.07% (range: 0.00% [1990] to 0.23% [1986 and 1989]) (Table B-107).

Table B-107. Annual mortality of steelhead juveniles originating in the Sacramento River watershed during through-Delta migration under simulated baseline and Project conditions. The values represent losses of fish entering the Delta on the Sacramento River.

	Total mortality	Sacramento River mortality (assumed)	% entering central Delta	Baseline % mortality (CVP/SWP + predation/water quality losses in central Delta)	Project % mortality
1980	23.8%	10.0%	17.0%	13.8%	0.06%
1981	25.0%	10.0%	18.6%	14.9%	0.12%
1982	22.6%	10.0%	14.7%	12.6%	0.02%
1983	22.0%	10.0%	14.6%	11.9%	0.02%
1984	22.9%	10.0%	16.8%	12.9%	0.02%
1985	25.0%	10.0%	19.9%	14.9%	0.04%
1986	24.8%	10.0%	17.1%	14.6%	0.23%
1987	24.5%	10.0%	19.4%	14.3%	0.21%
1988	24.3%	10.0%	22.0%	14.2%	0.06%
1989	24.3%	10.0%	19.8%	14.0%	0.23%
1990	24.4%	10.0%	21.5%	14.4%	0.00%
1991	25.1%	10.0%	22.3%	15.1%	0.03%

1992	24.7%	10.0%	20.1%	14.5%	0.20%
1993	24.0%	10.0%	16.8%	13.9%	0.07%
1994	24.9%	10.0%	19.9%	14.9%	0.02%
1995	24.0%	10.0%	15.9%	13.9%	0.06%
1996	22.6%	10.0%	15.5%	12.5%	0.07%
1997	23.7%	10.0%	17.2%	13.7%	0.02%
1998	23.4%	10.0%	15.7%	13.3%	0.07%
1999	22.6%	10.0%	15.6%	12.6%	0.02%
2000	24.1%	10.0%	16.9%	14.0%	0.11%
2001	25.4%	10.0%	19.4%	15.3%	0.05%
2002	22.3%	10.0%	18.0%	12.3%	0.04%
2003	22.5%	10.0%	16.8%	12.4%	0.02%
Average	23.9%	10.0%	18.0%	13.8%	0.07%

The average percentage loss for steelhead originating in the Mokelumne River was 0.41% (range: 0.00% [1990] to 1.32% [1986]).

Changes in Estuarine Habitat Area

Changes in estuarine habitat area between baseline and Project conditions were assessed using the same methods as those described in the 2001 FEIR and preceding draft documents. Salinity is an important habitat factor, and estuarine habitat is often defined in terms of a salinity range (Hieb and Baxter 1993). All estuarine species are assumed to have optimal salinity ranges, and different life stages within a species often vary in their salinity preferences. Species year-class production may be determined partly by the amount of rearing habitat available within the optimal salinity range (Unger 1994), although this is still under investigation (Kimmerer et al. 2009).

Methods

Rearing habitat area, based on the estimated optimal salinity range, was calculated for striped bass and delta and longfin smelt. The optimal salinity range was based on the locations of 10^{th} and 90^{th} percentiles of abundance from survey data: 0.1–2.5 ppt for striped bass larvae (5–9 mm), 0.3–1.8 ppt for delta smelt larvae and early juveniles, and 1.1–18.5 ppt for longfin smelt larvae and early juveniles (< 50 mm).

The Bay-Delta estuary has a complex shape, and the area of optimal salinity habitat varies greatly with its location. The geographical location of the upstream and downstream limits of the optimal salinity habitat was computed from monthly average Delta outflow and the optimal salinity range of the species. The surface area at 1-km segments from the Golden Gate to 100 km upstream was based on estimates made from nautical charts for the 2001 FEIR and preceding draft documents (Table B-108; Figure B-4). It was assumed that there was no functional habitat above km 100.

The Project operations effects on X2 were determined from the changes in Delta outflow, according to the monthly X2 equation developed from historical data (Kimmerer and Monismith 1992) as:

X2 (km) = 122.2 + 0.3278 (previous month X2) -17.65 x log [Outflow (cfs)]

The upstream and downstream limits of the optimal salinity range were calculated using the following equation (Unger 1994):

$$X2 \times \left[\frac{\ln \frac{31 - S}{515.67 \times S}}{-7} - 1.5 \right]$$

where X2 is the end-of-month X2 position and S is either the upstream or downstream limit of the optimal salinity range.

Total area of optimal salinity habitat was computed for each month through addition of all areas contained between the upstream and downstream limits of the optimal salinity range.

Table B-108. Habitat area (km^2) per km upstream from the Golden Gate (From Figure 9, Appendix A of Delta Wetlands 1995 DEIR/EIS)

km	area	km	area	km	area	km	area
0	1.5	26	11.8	52	1.8	78	1.5
1	9.2	27	13.0	53	1.9	79	1.8
2	6.6	28	13.2	54	2.0	80	1.5
3	7.1	29	17.8	55	1.8	81	2.8
4	6.6	30	17.1	56	1.5	82	3.8
5	5.6	31	15.5	57	2.0	83	2.0
6	17.1	32	16.2	58	3.1	84	2.0
7	15.5	33	15.8	59	3.6	85	2.5
8	15.5	34	16.0	60	3.8	86	2.3
9	15.8	35	16.2	61	4.3	87	2.3
10	15.0	36	16.3	62	6.9	88	2.3
11	13.5	37	12.2	63	8.4	89	2.3
12	12.0	38	12.2	64	6.6	90	3.1
13	9.9	39	10.7	65	7.4	91	2.3
14	6.1	40	9.4	66	5.9	92	1.8
15	5.9	41	3.6	67	3.2	93	1.8
16	7.0	42	3.1	68	3.6	94	3.1
17	14.0	43	2.0	69	3.2	95	4.6
18	10.3	44	2.3	70	3.1	96	3.6
19	8.9	45	1.8	71	3.2	97	2.3

km	area	km	area	km	area	km	area
20	7.6	46	0.8	72	3.9	98	1.8
21	6.1	47	1.0	73	3.9	99	1.3
22	6.6	48	0.8	74	3.6	100	1.8
23	4.8	49	2.0	75	1.0		
24	5.5	50	1.5	76	1.3		
25	9.2	51	1.5	77	1.3		

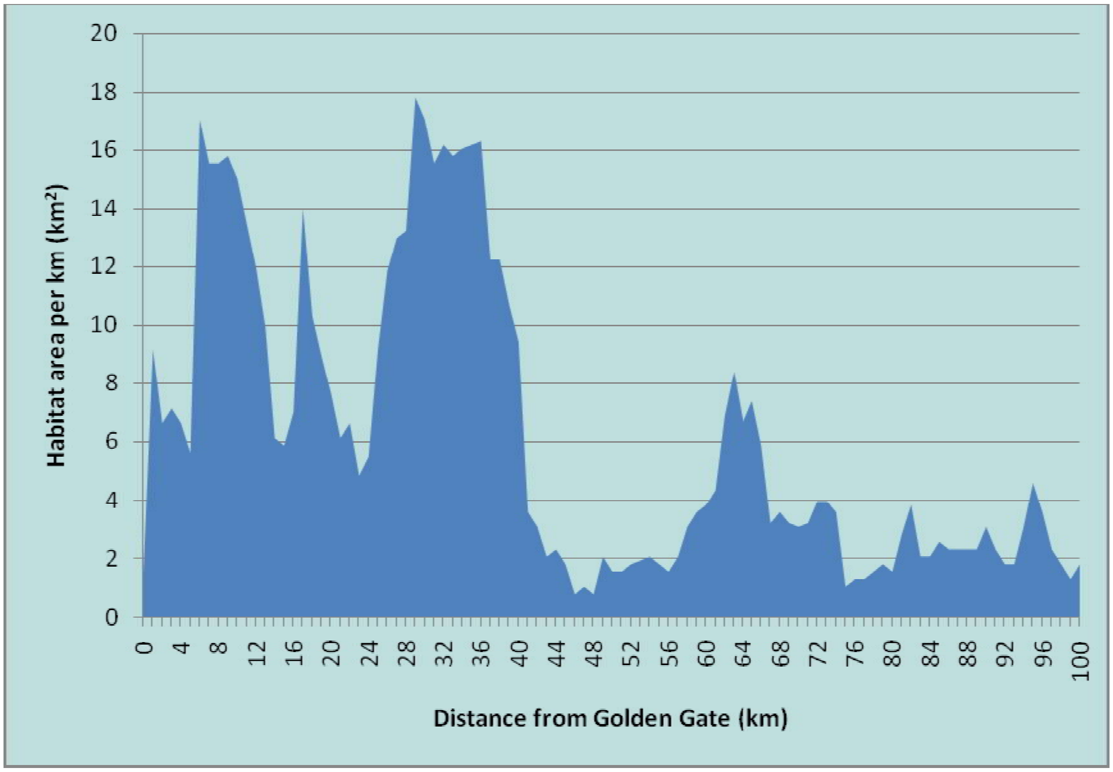


Figure B-4. Habitat area (km^2) per km upstream from the Golden Gate (From Figure 9, Appendix A of Delta Wetlands 1995 DEIR/EIS).

The annual optimal salinity habitat area (by water year, from 1980 to 2003) was the weighted sum of all months. Weighting was by month and was based on the monthly mean relative abundance of larvae and early juveniles (Table B-109; Unger 1994). Thus, if larvae are present only in April and May, if the area of optimal salinity habitat in April and May is 50 km^2 and 100 km^2, respectively, and if the proportion of larvae present in April and May is 30% and 70%, respectively, the weighted area would be (50 × 0.3) + (100 × 0.7) = 15 + 70 = 85 km^2. Weightings applied to longfin smelt were altered somewhat compared to the values used by Unger (1994) because more recent larval survey data (California Department of Fish and Game 2009a) suggested that a greater proportion of larvae were present in January.

Table B-109. Monthly weights applied in the analysis of change in optimal salinity area due to Project operations

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Delta smelt (larvae/early juveniles)	0	0	0	0	0.05	0.1	0.2	0.3	0.2	0.1	0.05	0
Longfin smelt (larvae/early juveniles)	0	0	0.1	0.15	0.4	0.25	0.09	0.01	0	0	0	0
Striped bass (larvae)	0	0	0	0	0	0	0.12	0.52	0.34	0.02	0	0

Main Assumptions

The assumptions of this analysis were:

- diversions to the Project Reservoir Islands occur in December–March;
- discharges for export occur in July–November;
- there is no functional habitat for delta smelt, longfin smelt, or striped bass above km 100 of the Sacramento River;
- the monthly weightings of relative abundance of the larval fish remain the same in all years;
- monthly minimum and maximum isohaline positions can be reasonably predicted from X2 position.

Results

Delta Smelt

Optimal salinity habitat for larval/early-juvenile Delta smelt averaged 51.0 km^2 under baseline conditions (range: 43.2–64.6 km^2). Under the Project, the average, minimum, and maximum area of optimal salinity habitat remained essentially the same. The average change in optimal salinity habitat area attributable to the Project was actually an increase of 0.09% (0.04 km^2), ranging from a gain of 1.90% (0.9 km^2) in 1987 to a loss of 1.6% (0.79 km^2) in 1981 (Figure B-5).

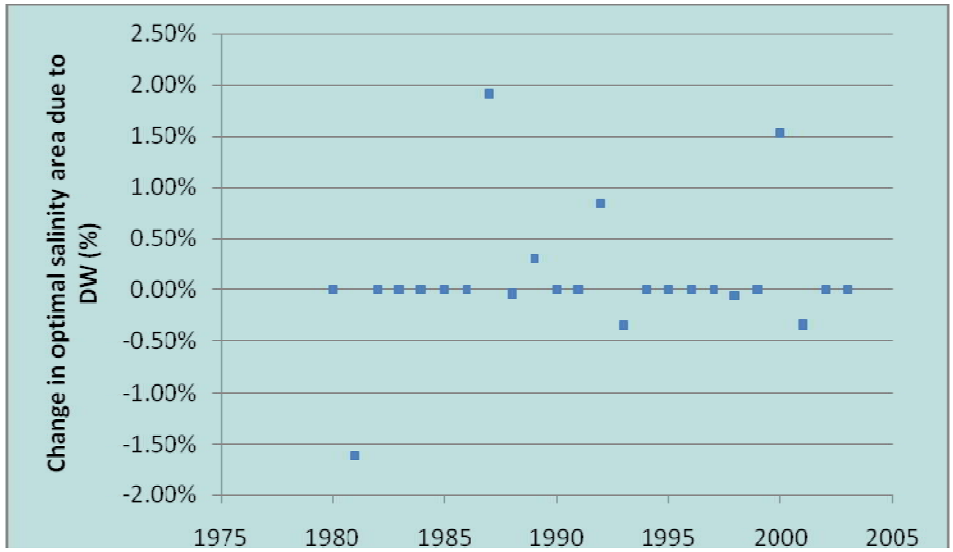


Figure B-5. Change in larval/early-juvenile delta smelt optimal salinity habitat area attributable to the Project (in relation to baseline conditions from 1980 to 2003).

Longfin Smelt

Optimal salinity habitat for larval/early-juvenile longfin smelt averaged 159.9 km^2 under baseline conditions (range: 121.1–226.1 km^2). Under the Project, the average area of the optimal salinity habitat was reduced to 159.6 km^2 (range: 120.3–226.1 km^2). The average decrease in optimal salinity habitat area attributable to the Project was 0.17% (0.26 km^2), ranging from a gain of 1.2% (2.34 km^2) in 1995 to a loss of 3.1% (5.74 km^2) in 1996 (Figure B-6).

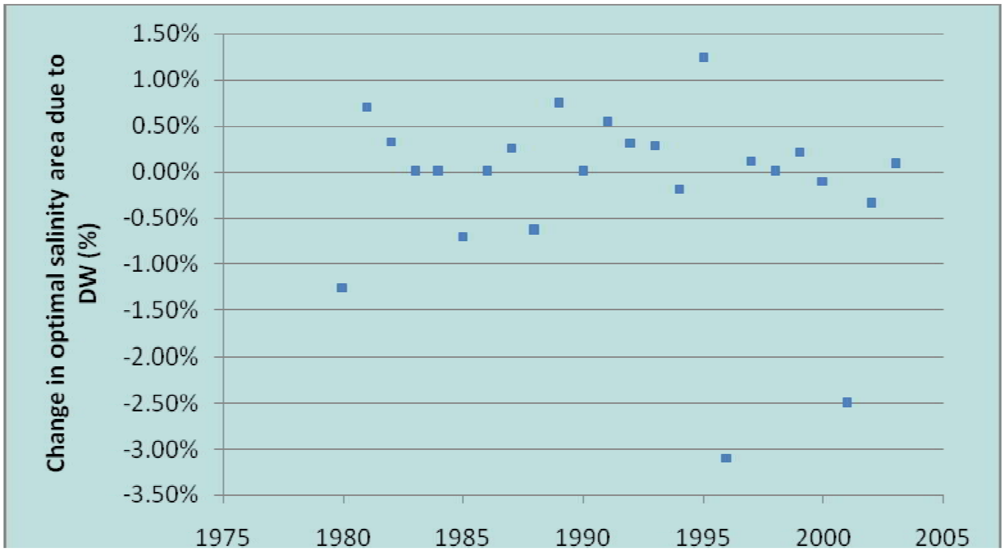


Figure B-6. Change in larval/early-juvenile longfin smelt optimal salinity habitat area attributable to the Project (in relation to baseline conditions from 1980 to 2003).

Striped Bass

Optimal salinity habitat for larval striped bass averaged 75.6 km^2 under baseline conditions (range: 51.9–100.7 km^2). Under the Project, the average area of the optimal salinity habitat was marginally reduced to 75.5 km^2 (range: 51.9–100.7 km^2). The average decrease in optimal salinity habitat area attributable to the Project was 0.16% (0.11 km^2), ranging from 0% (0 km^2) in nearly all years to a loss of 2.4% (1.65 km^2) in 2002 (Figure B-7). The relatively few years with change in area are likely to be a result of the coarseness of the analysis inputs (1-km segments of estuarine area were considered, whereas change probably would have occurred at a finer scale).

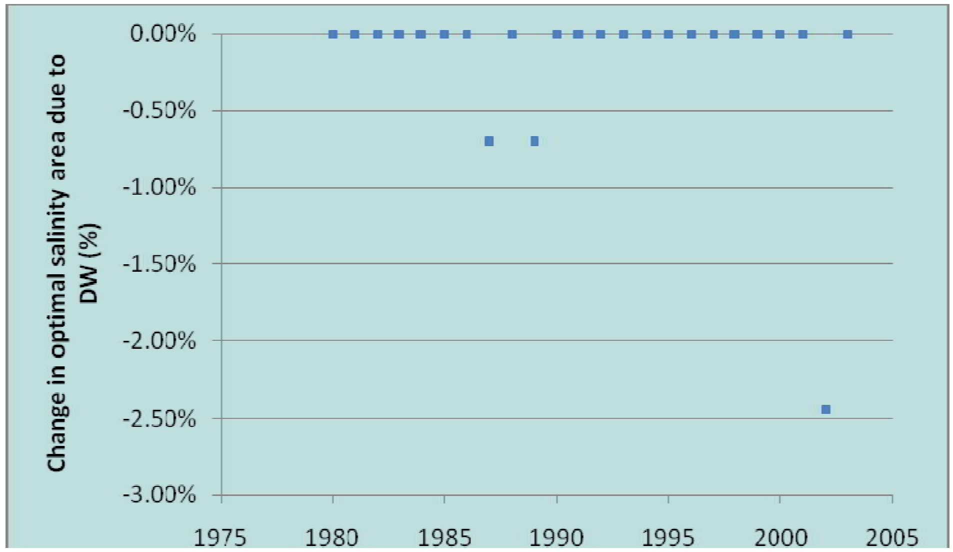


Figure B-7. Change in larval striped bass optimal salinity habitat area attributable to the Project (in relation to baseline conditions from 1980 to 2003).

Changes in Fish Population Abundance and Survival Caused by Shifts in X2

Beginning two decades ago, increasing concern over declines in estuarine species populations in the Bay-Delta spurred research into indicators of habitat quality or quantity (see Jassby et al. [1995] for a succinct summary). Use of the salinity field as an indicator was of interest “because it is well-defined and measurable, has ecological significance, integrates a number of important estuarine properties and processes, and is meaningful to a large number of constituencies” (Jassby et al. 1995, 274). The longitudinal location of the 2 ppt isohaline (X2) was chosen as a suitable indicator because knowledge of X2 allows the entire mean salt field to be calculated (i.e., where other salinity isohalines would be predicted to be) and also because its location is close to the entrapment zone and the estuarine turbidity maximum, regions of high zooplankton abundance with corresponding importance for juvenile fish (Jassby et al. 1995). Regressions of aquatic animal abundance or survival versus X2 have suggested the importance of X2 as a predictor in several studies (Jassby et al. 1995; Kimmerer 2002).

In most cases, movement upstream of X2 is correlated with a decrease in abundance or survival. The mechanisms underlying the link between X2 and fish abundance or survival are not clear: X2 may indicate quantity of habitat available or perhaps likelihood of retention within the entrapment zone (Kimmerer et al. 2009). Regardless, a number of significant X2-abundance relationships have been documented, most recently by Kimmerer et al. (2009). Some of the species for which relationships have been noted include those of conservation interest (longfin smelt) and recreational fishing importance (striped bass and American shad).

Delta smelt is a species for which a simple relationship between abundance and X2 does not exist, at least in recent years as the population has declined (Kimmerer 2009). As noted in the USFWS (2008, 236) OCAP delta smelt BO, indices of juvenile Delta smelt abundance from summer townet surveys are positively related to fall midwater trawl indices in the previous year, from 1987 onwards. Prediction of juvenile abundance from adult abundance is greatly improved when the average X2 location from September to December is included in the regression as a habitat indicator during the juvenile/subadult phase of the life cycle. The USFWS (2008) analysis built on the relationship noted by Feyrer et al. (2007), which used mean conductivity as the covariate rather than X2. In any case, a straightforward stock-recruitment relationship is suggested, wherein higher abundance of subadults in the fall presumably leads to higher abundance of spawning adults and thence to higher abundance of juveniles the following summer. Survival or growth of subadults in the fall may be enhanced by variables correlated with lower salinity or X2 being located further downstream.

The possible effects of the Project on the abundance or survival of several estuarine species due to X2 position alteration were assessed. It should be borne in mind that the regression relationships used in the analyses are based on data with an appreciable degree of variability, so that differences between baseline/existing conditions and the Project are typically much closer to each other than to the actual observed values. Assuming the abundance and survival indices are representative of the whole populations involved, then this analysis offers the advantage of placing the effects of the Project into the context of a whole population. This contrasts with the entrainment analyses based on salvage, which generally only examine the relative change in entrainment and do not indicate the population as a whole (unless an independent measure of population size can be obtained by other means; see section on “Population-Level Entrainment Estimates” below).

Methods

Kimmerer et al. (2009, 382) provided equations for significant relationships between X2 and survival or abundance of several species. Of these, striped bass survival from egg to first summer (Kimmerer 2002), American shad abundance, and longfin smelt abundance were chosen as representative examples of estuarine species that could be affected by the Project (Table B-110). The basic equation was:

Log_{10} (Predicted abundance or survival) = intercept + (slope × mean X2 position) + (step change × year dummy

The year dummy variable equaled zero before the step change and one after the step change. The mean X2 position was calculated for periods in each year corresponding to the early life stages of each species.

End-of-month X2 location was calculated for the simulated baseline condition. Predicted abundance indices of longfin smelt and American shad (from fall midwater trawl surveys) and survival indices of striped bass (from summer townet surveys) were calculated for the average baseline X2 location during several months of each year from 1967 to 2003. It was assumed that end-of-month X2 averaged for the period of interest for each species (Table B-110) was similar to the X2 averaging used by Kimmerer et al. (2009). The process was repeated for the X2 position under simulated Project conditions in order to assess the predicted change in abundance or survival indices from baseline attributable to the Project.

Table B-110. Regression statistics from the analysis of X2-abundance/survival (Kimmerer et al. 2009, 382). The equations were used to analyze the effects of the Project

Species	Source	N	*P*	Intercept	Slope (± confidence limits)	Step change (± confidence limits)	Comment
American shad (abundance index)	FMWT[a]	38	0.004	4.0	-0.013 (± 0.009)	0.21 (± 0.20)	1967–2007[b]; step change in 1987–1988; Feb–May X2 averaging period
Longfin smelt (abundance index)	FMWT[a]	38	<0.0001	7.0	-0.05 (± 0.01)	-0.81 (± 0.28)	1967–2007[b]; step change in 1987–1988; Jan–Jun X2 averaging period
Striped bass (survival from egg to first summer; Kimmerer 2002)	TNS[c]	32	<0.0001	4.6	-0.025 (± 0.011)	-0.79 (± 0.30)	1978–2007; step change in 1995–1996; Apr–Jun X2 averaging period

Notes:
a. FMWT – fall midwater trawl survey.
b. No data for 1974 and 1979.
c. TNS – summer townet survey.

For delta smelt, a procedure was developed that was similar to that adopted by the USFWS (2008) in the OCAP BO. A regression equation was calculated that predicted the juvenile delta smelt summer townet indices from 1988 to 2007 (California Department of Fish and Game 2009b) from the fall midwater trawl indices from 1987 to 2006 (California Department of Fish and Game 2008) and mean end-of-month X2 location for an August to December averaging period. The derived equation was:

Summer Townet Index = 26.67 + 0.00759 × (Fall Midwater Trawl index in previous year) – 0.304 × (mean end-of-month X2 in previous August–December), r^2 = 64.2%

This compares quite closely to the equation derived for a slightly shorter time period by USFWS (2008, 268):

> Summer Townet Index = 29.12 + 0.00708 × (Fall Midwater Trawl index in previous year) – 0.328 × (mean X2 in previous September–December), r^2 = 60.6%

The predicted summer townet indices from 1987 to 2003 were calculated under baseline conditions and then for the Project, first using the actual fall midwater trawl indices and modeled mean X2 values, then with the FMWT index held constant at a) the median value of 280 used by USFWS (2008), b) the recent low value of 23 observed in 2008, and c) a high value of around 1,000 that was observed in 1993.

Main Assumptions

The main assumptions of this analysis were:

- Diversions to the Project Reservoir Islands occur in December–March;
- Discharges for export occur in July–November;
- Occasional releases of Project water for Delta outflow occur in September–November;
- The average position of X2 for a period in a species' early life determines abundance or survival later in life;
- Relationships between X2 and abundance index or survival developed by Kimmerer et al. (2009) are valid for use with average end-of-month X2 values during the early life stages of a species;
- For delta smelt, the abundance index of juveniles in the summer townet survey can be predicted from the previous year's fall midwater trawl abundance index and average fall X2 position;
- Changes in abundance index are representative of changes in the overall population's absolute abundance.

Results

American Shad

The predicted FMWT index of American shad under the Project was on average 0.25% lower than the baseline (Table B-111). The greatest percentage reduction attributable to the Project was in 1992 (1.18%) and there were also increases in several years, the largest of which was 0.13% in 1994 (Table B-111). Differences in predicted FMWT indices between the modeled baseline and Project conditions were considerably less than differences between either baseline or Project conditions and the actual FMWT indices.

Table B-111. Results of the analysis comparing predicted fall midwater trawl indices of American shad from average end-of-month X2 location (February–May) for modeled baseline and Project conditions.

	Baseline	Project	% change	Actual
1967	1,720	1,718	-0.13%	3,422
1968	1,313	1,309	-0.28%	758
1969	1,971	1,969	-0.09%	3,688
1970	1,519	1,521	0.08%	856
1971	1,415	1,414	-0.07%	1,459
1972	1,106	1,095	-0.97%	335
1973	1,547	1,544	-0.19%	1,085
1975	1,556	1,550	-0.38%	2,491
1977	839	839	0.00%	636
1978	1,622	1,619	-0.17%	2,364
1980	1,640	1,639	-0.10%	3,916
1981	1,137	1,129	-0.71%	1,434
1982	2,087	2,086	-0.04%	5,389
1983	2,417	2,416	-0.02%	2,931
1984	1,411	1,411	-0.02%	817
1985	1,006	1,004	-0.22%	1,598
1986	1,766	1,764	-0.12%	1,860
1987	1,078	1,065	-1.14%	899
1988	1,568	1,561	-0.46%	1,550
1989	1,844	1,831	-0.70%	1,878
1990	1,529	1,529	0.01%	4,316
1991	1,575	1,572	-0.15%	2,988
1992	1,708	1,688	-1.18%	2,010
1993	2,463	2,459	-0.17%	5,157
1994	1,614	1,616	0.13%	1,334
1995	3,246	3,243	-0.09%	6,812
1996	2,997	2,994	-0.08%	4,286
1997	2,388	2,388	-0.03%	2,594
1998	3,352	3,347	-0.15%	4,140
1999	2,655	2,653	-0.08%	715
2000	2,524	2,517	-0.28%	764
2001	1,760	1,754	-0.31%	765
2002	1,976	1,973	-0.17%	1,919
2003	2,213	2,210	-0.12%	9,360
Average	1,840	1,836	-0.25%	2,545

Longfin Smelt

The predicted FMWT index of longfin smelt under the Project was on average 1.02% lower than the baseline (Table B-112). The greatest percentage reduction attributable to the Project was in 1981 (3.69%) and there were also increases in several years, the largest of which was 1.07% in 1994 (Table B-112). Differences in predicted FMWT indices between the modeled baseline and Project conditions were considerably less than differences between either baseline or Project conditions and the actual FMWT indices.

Table B-112. Results of the analysis comparing predicted fall midwater trawl indices of longfin smelt from average end-of-month X2 location (January–June) for modeled baseline and Project conditions.

	Baseline	Project	% change	Actual
1967	10,359	10,255	-1.00%	81,737
1968	3,092	3,026	-2.13%	3,279
1969	16,081	15,971	-0.68%	59,350
1970	7,194	7,245	0.70%	6,515
1971	5,044	5,019	-0.48%	15,903
1972	1,686	1,655	-1.82%	760
1973	6,408	6,316	-1.43%	5,896
1975	4,998	4,992	-0.11%	2,819
1977	653	653	0.00%	210
1978	7,031	6,941	-1.28%	6,619
1980	7,852	7,795	-0.73%	31,184
1981	1,991	1,917	-3.69%	2,202
1982	17,714	17,660	-0.31%	62,905
1983	34,389	34,347	-0.12%	11,864
1984	5,480	5,475	-0.08%	7,408
1985	1,301	1,278	-1.75%	992
1986	6,770	6,760	-0.14%	6,160
1987	1,493	1,449	-2.96%	1,520
1988	200	193	-3.54%	791
1989	267	262	-1.82%	456
1990	153	153	0.09%	243
1991	147	146	-0.39%	134
1992	205	199	-3.01%	76
1993	977	964	-1.27%	798
1994	178	180	1.07%	545
1995	2,552	2,534	-0.72%	8,205
1996	1,564	1,555	-0.59%	1,346
1997	1,073	1,071	-0.19%	690
1998	2,849	2,815	-1.16%	6,654
1999	1,079	1,072	-0.61%	5,243
2000	764	751	-1.80%	3,437

	Baseline	Project	% change	Actual
2001	242	240	-0.55%	245
2002	448	442	-1.35%	707
2003	710	703	-0.91%	467
Average	4,498	4,472	-1.02%	9,922

Striped Bass

The predicted egg-to-juvenile survival index of striped bass under the Project was on average 0.13% lower than the baseline (Table B-113). The greatest percentage reduction attributable to the Project was in 1987 (0.96%) and there were also slight increases in several years, the largest of which was 0.04% in 1994 (Table B-113).

Table B-113. Results of the analysis comparing predicted egg-to-juvenile survival indices of striped bass from average end-of-month X2 location (January–June) for modeled baseline and Project conditions.

	Baseline	Project	% change
1978	927	926	-0.05%
1979	647	646	-0.24%
1980	735	735	-0.03%
1981	479	478	-0.40%
1982	1,525	1,524	-0.01%
1983	2,041	2,041	0.00%
1984	624	624	-0.01%
1985	458	457	-0.06%
1986	792	792	-0.04%
1987	471	466	-0.96%
1988	395	394	-0.12%
1989	548	545	-0.59%
1990	354	354	0.00%
1991	387	386	-0.13%
1992	425	423	-0.32%
1993	932	932	-0.05%
1994	419	419	0.04%
1995	1,701	1,700	-0.03%
1996	178	178	-0.02%
1997	95	95	-0.01%
1998	266	266	-0.04%
1999	129	129	-0.02%
2000	111	110	-0.08%
2001	73	73	-0.08%
2002	84	84	-0.05%

	Baseline	Project	% change
2003	127	127	-0.03%
Average	574	573	-0.13%

Delta Smelt

For the analysis using observed FMWT indices, the predicted summer townet index of delta smelt under the Project was on average 1.16% greater than the baseline (Table B-114). The greatest percentage increase attributable to the Project was in 1989 (6.03%) whereas 2001 had the greatest decrease (0.71%). Differences in predicted summer townet indices between the modeled baseline and Project conditions were generally noticeably less than differences between either baseline or Project conditions and the actual summer townet indices.

The analyses using fixed values of the FMWT indices also gave average increases in predicted summer townet indices: as the fixed FWMT index decreased, so the average relative increase in predicted summer townet index went up (Tables B-115, B-116, and B-117). Thus the average change in predicted summer townet index was an increase of 6.06% for an FMWT index of 23, 2.02% for an FMWT index of 280, and 0.75% for an FMWT index of 1,000. The ranges of change also got correspondingly wider: for an FMWT index of 23 the range was from a decrease of 3.25% to an increase of 29.49%; for an FMWT index of 280 the range was from a decrease of 1.25% to an increase of 8.48%; and for an FMWT index of 1,000 the range was from a decrease of 0.46% to an increase of 3.19% (Tables B-115, B-116, and B-117).

Overall, the average predicted increase in summer townet index of juvenile delta smelt was attributable to the modeled Project scenario of beneficial water releases in October and November of some years. These releases moved X2 downstream and resulted in increased abundance because of the inverse relationship between X2 and summer townet index described in the regression equation above.

Table B-114. Results of the analysis comparing predicted summer townet indices of delta smelt from the previous year's fall midwater trawl index and average end-of-month X2 location (August–December) for modeled baseline and Project conditions.

	Baseline	Project	% change	Actual
1987	2.6	2.7	5.21%	1.2
1988	1.3	1.3	0.00%	2.2
1989	3.3	3.5	6.03%	2.2
1990	2.7	2.7	0.00%	2.0
1991	5.2	5.2	0.00%	2.6
1992	1.3	1.3	-0.01%	8.2
1993	9.0	9.3	2.79%	13.0
1994	1.3	1.3	0.00%	3.2
1995	10.1	10.4	3.43%	11.1
1996	4.0	3.9	-0.42%	4.0
1997	3.2	3.2	0.00%	3.3
1998	8.4	8.5	0.42%	11.9
1999	7.6	7.7	1.53%	8.0
2000	6.7	6.8	2.07%	3.5
2001	5.6	5.6	-0.71%	4.7
2002	2.8	2.7	-0.59%	1.6
2003	2.8	2.8	0.00%	2.9
Average	4.6	4.6	1.16%	5.0

Table B-115. Results of the analysis comparing predicted summer townet indices of delta smelt from a fixed fall midwater trawl index of 280 and average end-of-month X2 location (August–December) for modeled baseline and Project conditions.

	Baseline	Project	% change
1987	2.6	2.7	5.21%
1988	2.1	2.1	0.00%
1989	2.6	2.8	7.53%
1990	2.0	2.0	0.00%
1991	2.1	2.1	0.00%
1992	2.2	2.2	-0.01%
1993	3.0	3.2	8.48%
1994	2.6	2.6	0.00%
1995	5.4	5.7	6.43%
1996	5.1	5.1	-0.32%
1997	3.0	3.0	0.00%
1998	7.4	7.4	0.48%
1999	3.2	3.3	3.65%
2000	3.1	3.2	4.50%

	Baseline	Project	% change
2001	3.2	3.1	-1.25%
2002	3.8	3.8	-0.42%
2003	3.4	3.4	0.00%
Average	3.3	3.4	2.02%

Table B-116. Results of the analysis comparing predicted summer townet indices of delta smelt from a fixed fall midwater trawl index of 23 and average end-of-month X2 location (August–December) for modeled baseline and Project conditions.

	Baseline	Project	% change
1987	0.6	0.8	21.02%
1988	0.2	0.2	-0.03%
1989	0.7	0.9	29.49%
1990	0.1	0.1	0.00%
1991	0.1	0.1	-0.04%
1992	0.3	0.3	-0.04%
1993	1.0	1.3	24.77%
1994	0.7	0.7	0.00%
1995	3.4	3.8	10.09%
1996	3.2	3.1	-0.52%
1997	1.0	1.0	0.00%
1998	5.4	5.5	0.66%
1999	1.2	1.4	9.38%
2000	1.1	1.3	12.37%
2001	1.2	1.2	-3.25%
2002	1.9	1.9	-0.87%
2003	1.4	1.4	0.00%
Average	1.4	1.5	6.06%

Table B-117. Results of the analysis comparing predicted summer townet indices of delta smelt from a fixed fall midwater trawl index of 1,000 and average end-of-month X2 location (August–December) for modeled baseline and Project conditions.

	Baseline	Project	% change
1987	8.1	8.2	1.68%
1988	7.6	7.6	0.00%
1989	8.1	8.3	2.44%
1990	7.5	7.5	0.00%
1991	7.5	7.5	0.00%
1992	7.7	7.7	0.00%
1993	8.4	8.7	2.98%
1994	8.1	8.1	0.00%
1995	10.8	11.2	3.19%
1996	10.6	10.6	-0.16%
1997	8.4	8.4	0.00%
1998	12.8	12.9	0.28%
1999	8.7	8.8	1.35%
2000	8.5	8.7	1.62%
2001	8.6	8.6	-0.46%
2002	9.3	9.3	-0.17%
2003	8.8	8.8	0.00%
Average	8.8	8.9	0.75%

Changes in Upstream Movement of Adult Smelt from January to May

Both Delta and longfin smelt migrate upstream to spawn. Project water diversions from December to March have the potential to stimulate a migration further upstream than normal if the smelts are following a flow-based cue such as X2 position. Although entrainment at the Project diversions is unlikely to be an issue because the Project fish screens will be installed to Delta smelt standards, movement further upstream than normal would potentially increase the proportion of the population susceptible to entrainment by the SWP/CVP export facilities. A general pattern of increased smelt entrainment at the SWP fish collection facility during drier years was noted by Sommer et al. (1997). The potential for the Project to cause adult smelts to be distributed further upstream than normal was examined.

Methods

Monthly smelt density data from a series of DFG Spring Kodiak trawl survey stations (California Department of Fish Game 2009a) along an estuarine transect from Carquinez Strait to the Delta (Figure B-8) were extrapolated to total estimated numbers of fish upstream and downstream of the confluence of the Sacramento and San Joaquin rivers. Stations assumed to be above the confluence were numbered 801 and higher. Volumes used in the extrapolations were calculated from areas in the vicinity of each trawl location provided by Miller (2005a, 7) multiplied by 4 m, the assumed depth of the water column that smelt occupy (Kimmerer 2008, 12). The percentage of the population upstream of the confluence was taken as an indicator of the susceptibility of these individuals to entrainment. The percentage upstream of the confluence was compared to estimated X2 position for evidence of X2 position influencing upstream distribution. The analysis relied upon calculated end-of-month X2 positions, so the timing of each survey was examined to decide which X2 values were appropriate to include for a given survey. If the survey took place in the first week or so of a month, then the previous month's end-of-month X2 was used. If the survey was close to the end of a month, then that month's X2 value was used. If a survey was near the middle of a month, then the average X2 of the same and previous months was used.

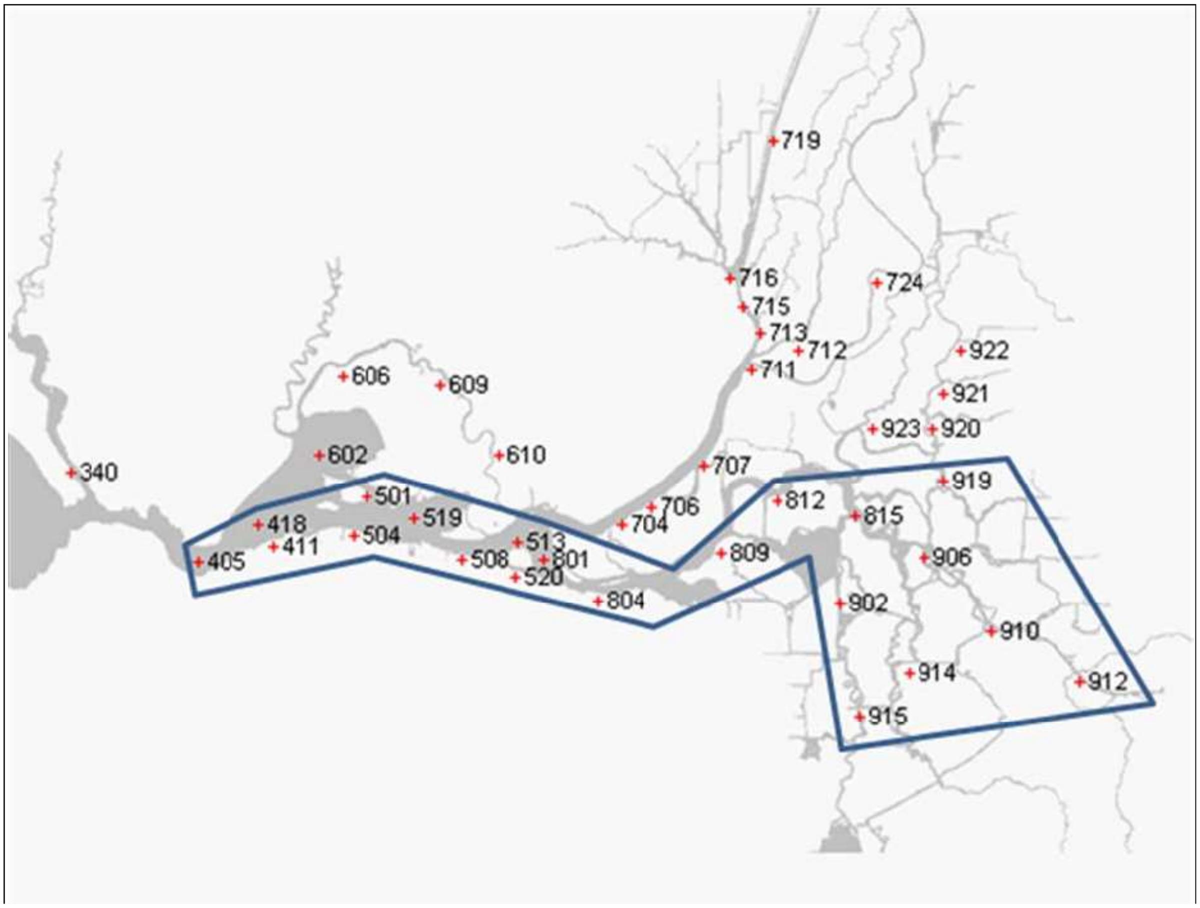


Figure B-8. Spring Kodiak Trawl sampling stations in The Bay-Delta. Data from stations enclosed by the blue polygon were used in the analysis of upstream smelt movement in relation to X2. Modified from California Department of Fish and Game (2009c).

Main Assumptions

The main assumptions of this analysis included:

- Smelt presence in the central Delta above the confluence of the Sacramento and San Joaquin Rivers indicates a susceptibility to entrainment by the SWP/CVP export facilities;
- The central Delta can be represented by DFG trawl stations 801 and higher (excluding the Mokelumne River stations);
- Smelt occupy the uppermost 4 m of the water column;
- The relationship between the proportion of smelt in the central Delta and X2 position can be assessed using multiple surveys within a single year—this assumption may be inappropriate because surveys within the same year may not be independent, so it is appropriate to consider averaging all surveys from the same year and comparing only across years.

Results

No longfin smelt were collected at the subset of stations included in the analysis. For delta smelt, there was no apparent relationship between X2 position and percentage of population along the Bay-Delta transect that was upstream of the Sacramento-San Joaquin confluence (Figure B-9). Averaging each year's monthly values did not give a different result (Figure B-10).

USFWS (2008a, 212) noted that "there is wide, apparently random variation in the use of the Central and South Delta by spawning delta smelt." The results of the analysis of potential effects of Project diversions on distribution of adult delta smelt support this statement.

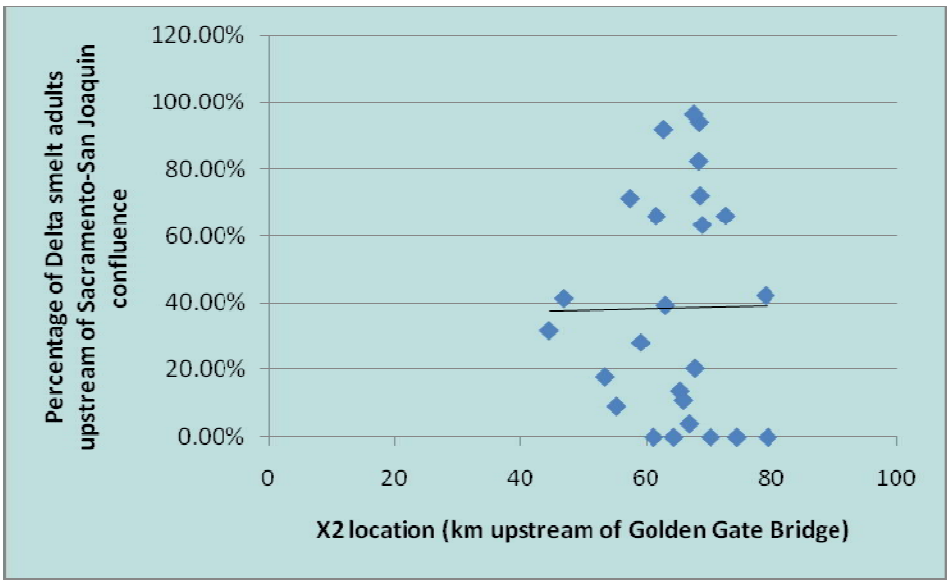


Figure B-9. Percentage of Delta smelt adults along an estuarine transect from Carquinez Strait to the Delta that were upstream of the Sacramento-San Joaquin confluence. A trendline is shown to demonstrate the lack of a relationship. Values are monthly estimates based on extrapolations of total abundance from Spring Kodiak trawling (January to May, 2002 to 2007) and do not include regions beyond the main transect (i.e., Montezuma Slough, the Sacramento River, and Cache Slough).

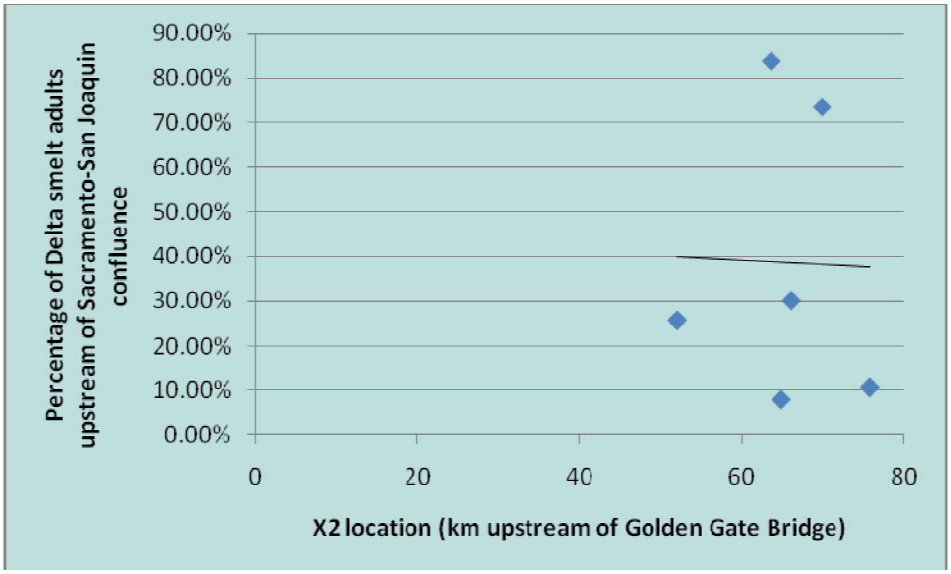


Figure B-10. Percentage of Delta smelt adults along an estuarine transect from Carquinez Strait to the Delta that were upstream of the Sacramento-San Joaquin confluence. A trendline is shown to demonstrate the lack of a relationship. Values are averaged of monthly estimates based on extrapolations of total abundance from Spring Kodiak trawling (January to May, 2002 to 2007) and do not include regions beyond the main transect (i.e., Montezuma Slough, the Sacramento River, and Cache Slough).

Entrainment Loss of Zooplankton from June to September

Juvenile delta smelt feed on zooplankton, primarily copepods. Moyle et al. (1992) described a shift in diet from *Eurytemora affinis* copepods in 1972–1974 to *Pseudodiaptomus forbesi* copepods following *P. forbesi*'s introduction to the Bay-Delta in 1987. The 2008 OCAP Delta smelt BO noted that the entrainment loss of *P. forbesi* during the June–September period of the juvenile-subadult phase of Delta smelt could be important in terms of food limitation. The Project proposes to discharge water from the Reservoir Islands for export during July–November. The potential impact of the Project's July–November discharges for export on entrainment of *P. forbesi* was examined using June–September IEP zooplankton monitoring data.

Methods

The analysis used IEP monitoring program zooplankton data from 1989 to 2003. Average monthly densities of *P. forbesi* in several regions of the Bay-Delta (Figure B-11) were extrapolated to total numbers using volume estimates for each region provided by Miller (2005a) (Table B-118). The percentage loss of *P. forbesi* in each month and region was then calculated based on the E/I ratio and sigmoidal loss relationships described above under the Methods for "Losses of

Fish Eggs and Larvae by Entrainment" (Figure B-12). The overall effect on the whole population was then assessed by combining the results from all regions. It was assumed that there were no entrainment losses attributable to the SWP/CVP or Project exports for the Suisun Bay, Suisun Marsh, and Chipps Island regions. Note that zooplankton data were not all available for all regions shown in Figure B-11 and so the analysis was only conducted for the eight regions shown in Table B-118. Zooplankton sampling did not take place in all months in all regions. Therefore results are presented in their entirety for individual regions and when results are combined for all regions, they omit the months that were missing in some regions.

The zooplankton loss calculation was performed for simulated baseline conditions (SWP/CVP exports only) and the results were compared with the results obtained from the simulated Project (baseline + discharge for exports), baseline + existing agricultural diversions, and the baseline + habitat island diversion conditions assumed for the Project. As with the fish egg/larval analysis, it was assumed that changes in E/I ratio due to agricultural habitat island diversions would affect the percentage loss of zooplankton in a similar manner to SWP/CVP exports.

The zooplankton entrainment index under the Project indicates the direction and magnitude of potential change in entrainment loss relative to conditions simulated for the baseline conditions. The entrainment index should not be construed as the actual level of entrainment that would occur, but an indication of loss based on flow diversions and assumptions of loss rates.

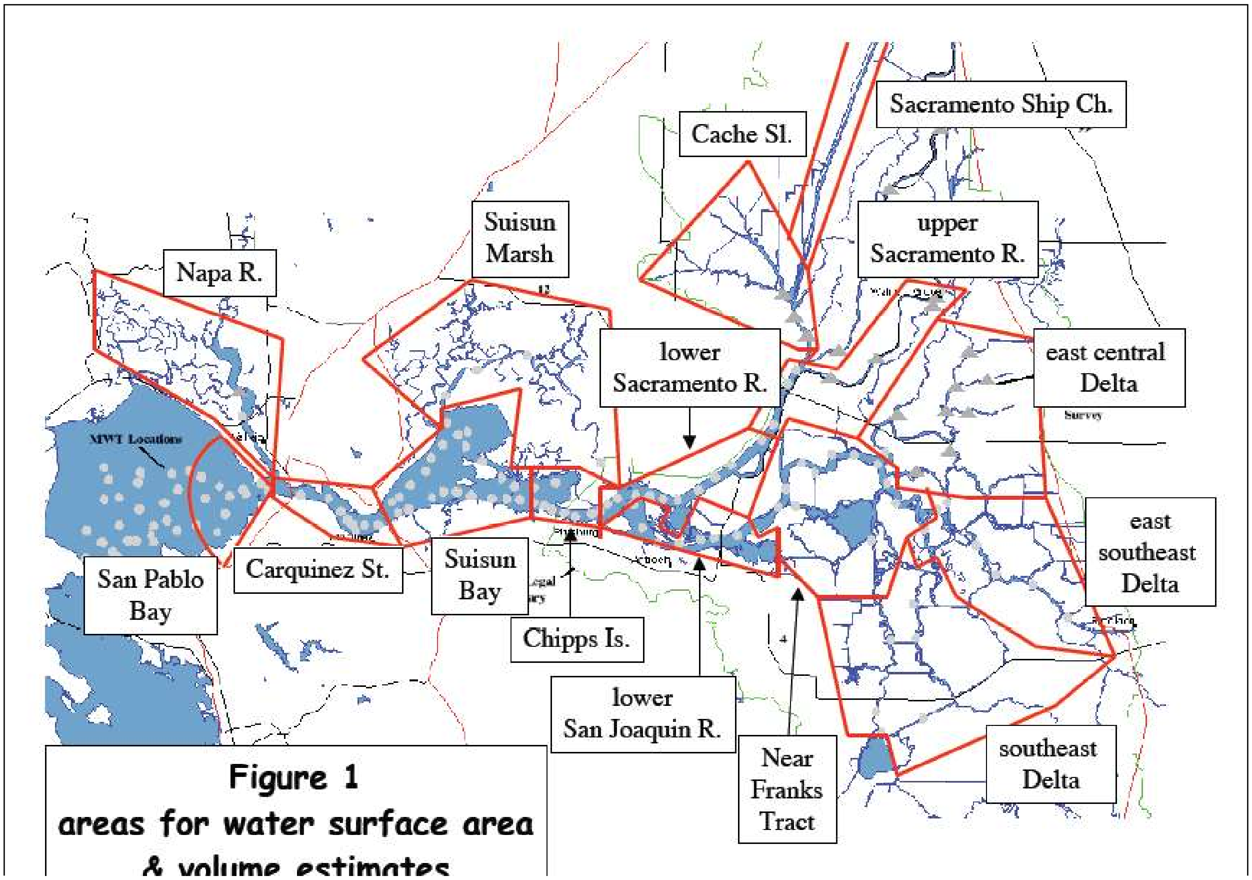
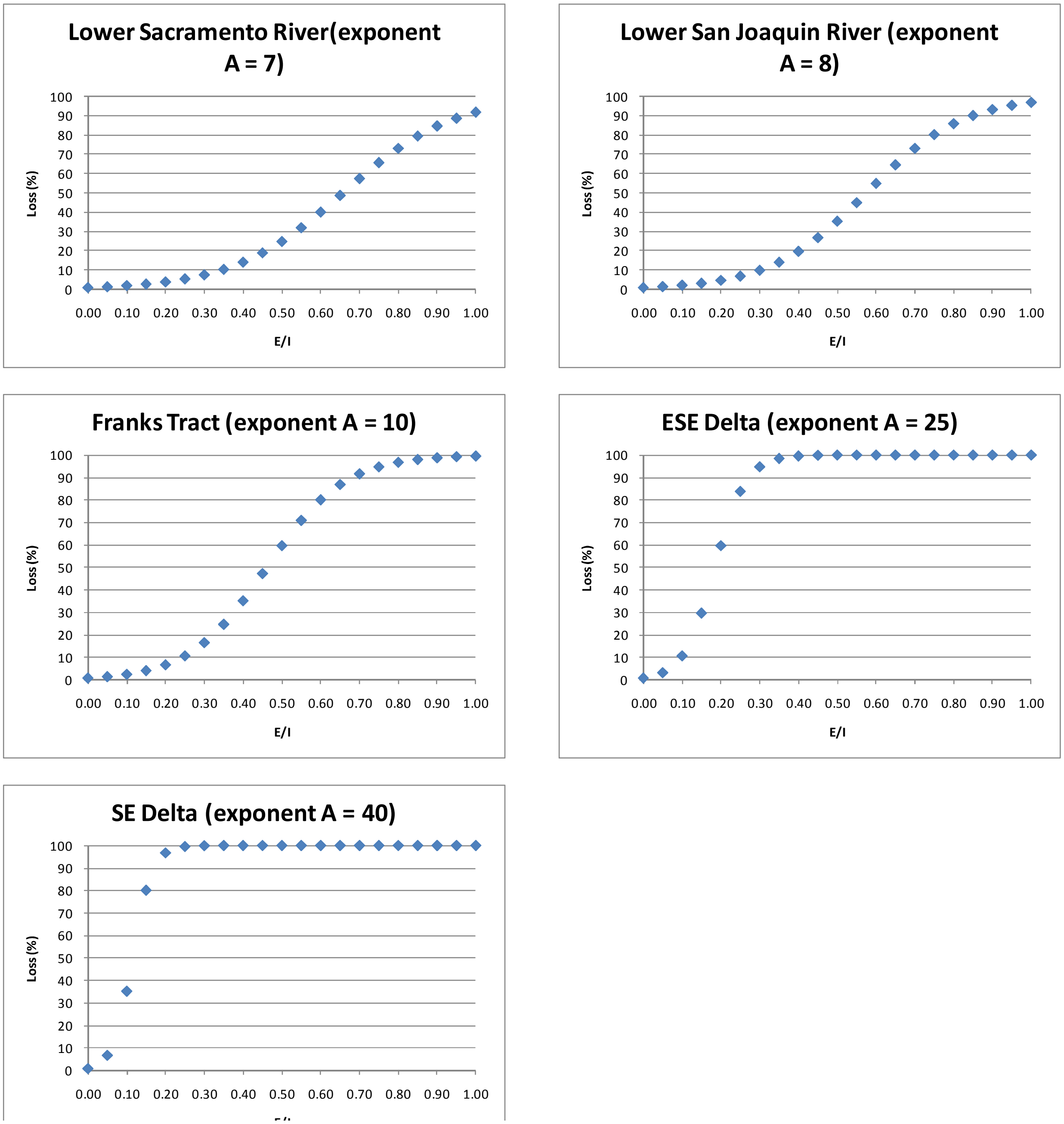


Figure B-11. Regions of the Bay-Delta for which Miller (2005a) provided area and volume estimates. Figure copied from Miller (2005a).

Table B-118. Volume estimates of various regions of the Bay-Delta (Miller 2005a) for extrapolations of zooplankton total abundance.

Region	Volume (m3)
Suisun Bay	361,878,949
Suisun Marsh	93,090,887
Chipps Island	125,408,115
Lower Sacramento River	186,292,786
Lower San Joaquin River	134,104,163
Franks Tract	242,724,588
ESE Delta	94,410,712
SE Delta	89,205,418



$$Loss = \frac{Maximum\ (100\%)}{1 + 100\ \times e^{(-A \times \frac{E}{I})}}$$

Figure B-12. Sigmoidal relationships between Export:Inflow ratio (E/I) and monthly percentage of zooplankton lost to entrainment for various regions in the Bay-Delta. The exponent A of the exponential equation was varied to give the different sigmoidal curves.

Main Assumptions

The analysis assumed:

- discharges for export occur in July–November (although only the July–September period is important for *P. forbesi*);
- *Pseudodiaptomus forbesi* is the principal prey item of juvenile delta smelt and is most susceptible to entrainment from June to September;
- absolute abundance of *P. forbesi* in a region can be estimated by multiplying density data (zooplankton per unit volume) by the volume of the region;
- zooplankton are passive and cannot avoid entrainment—losses are proportional to the volume of water diverted and density of zooplankton in that water;
- entrainment of zooplankton at the SWP export facility can be estimated using relationships similar to the E/I curves developed by Kimmerer and Nobriga (2008);
- zooplankton at Chipps Island, Suisan Bay, and Suisun Marsh are not susceptible to entrainment by the Project diversions or the export facilities.

Results

All Regions

As noted above, the summary of *Pseudodiaptomus forbesi* entrainment loss for all regions combined excludes periods for which data was missing in some regions; therefore the summary in Table B-119 should be viewed with caution when comparing different years. Based solely on water volumes and assumed density of zooplankton within the water, the percentage of the zooplankton population lost due to baseline SWP/CVP pumping from June to September averaged nearly 42% of the 'cumulative population', i.e., the sum of the populations over the four months (Table B-119). The range of baseline loss was from around 27% in 1998 to over 51% in 2000 and 2003. Losses due to SWP export of water discharged from Reservoir Islands under the Project averaged 1.93% and ranged from 0.00% in several years to nearly 7% in 1992. The benefit of the Project in terms of reducing agricultural diversions averaged a reduced loss of 0.78% per year (range: 0.53% [2000] to 1.54% [2001]). Overall, the net Project impact was an average annual loss of 1.15% of *P. forbesi*, and ranged from a reduced loss of 1.54% in 2001 (no exports of Project water occurred and reduced agricultural diversions were greater than habitat island diversions) to a loss of 6.11% in 2002 (Table B-119).

Table B-119. *Pseudodiaptomus forbesi* June–September cumulative population size in all regions combined and entrainment losses due to the baseline and Project conditions in all regions combined.

	Cumulative population size[1]	% loss (Baseline SWP/CVP exports)	% loss (Project discharges for export)[2]	% loss (Baseline Ag. diversions)[3]	% loss (Project Habitat diversions)[4]	Project benefit from reduced ag. diversions (% reduced loss)[5]	Net Project impact (% loss)
1989	15,829,707,306,019	44.35%	3.53%	0.87%	0.25%	0.63%	2.90%
1990	15,058,518,657,949	38.65%	0.00%	1.28%	0.34%	0.95%	-0.95%
1991	11,711,616,264,637	38.57%	0.49%	1.63%	0.43%	1.19%	-0.70%
1992	11,459,218,467,467	37.56%	6.37%	1.54%	0.41%	1.13%	5.24%
1993	7,378,582,689,517	42.29%	0.00%	0.90%	0.23%	0.67%	-0.67%
1994							
1995	4,865,282,970,170	31.83%	0.00%	0.59%	0.14%	0.45%	-0.45%
1996	3,870,142,063,002	32.64%	4.49%	0.86%	0.19%	0.67%	3.82%
1997	4,244,562,966,840	46.10%	1.95%	0.81%	0.23%	0.58%	1.37%
1998	11,567,229,769,559	27.12%	0.00%	0.72%	0.17%	0.55%	-0.55%
1999	7,642,478,696,043	39.33%	2.37%	0.80%	0.20%	0.60%	1.77%
2000	11,644,212,370,117	51.50%	0.50%	0.75%	0.22%	0.53%	-0.03%
2001	2,594,123,362,952	37.83%	0.00%	2.11%	0.57%	1.54%	-1.54%
2002	3,696,004,184,962	64.37%	6.92%	1.15%	0.34%	0.81%	6.11%
2003	5,759,417,730,958	51.53%	0.43%	0.81%	0.22%	0.59%	-0.16%
Avg.	8,380,078,392,871	41.69%	1.93%	1.06%	0.28%	0.78%	1.15%

Notes. [1] Sum of the calculated population size in June-September. [2] Assumes discharge for exports by SWP from July to November. [3] Assumes similar pattern of agricultural diversions each year. [4]Assumes similar pattern of habitat diversions each year. [5] Benefit is calculated as reduction in agricultural diversion entrainment loss minus increase in habitat diversion entrainment loss.

Lower Sacramento River

The percentage of the zooplankton population lost from the lower Sacramento River due to baseline SWP/CVP pumping from June to September averaged over 23% of the cumulative population (Table B-120). The range of baseline loss was from 8.55% in 1998 to 39.41% in 2000. Losses due to SWP export of water discharged from Reservoir Islands under the Project averaged 3.00% and ranged from 0.00% in several years to 14.67% in 2002. The benefit of the Project in terms of reducing agricultural diversions averaged a reduced loss of 0.77% per year (range: 0.21% [1998] to 1.05% [1989]). Overall the net Project impact was an average annual loss of 2.23% of *P. forbesi*, and ranged from a reduced loss of 1.04% in 1994 (no exports of Project water occurred and reduced agricultural diversions were greater than habitat island diversions) to a loss of 13.80% in 2002 (Table B-120).

Table B-120. *Pseudodiaptomus forbesi* June–September cumulative population size in the lower Sacramento River and entrainment losses due to the baseline and Project conditions.

	Cumulative population size(1)	% loss (Baseline SWP/CVP exports)	% loss (Project discharges for export)(2)	% loss (Baseline Ag. diversions)(3)	% loss (Project Habitat diversions)(4)	Project benefit from reduced ag. diversions (% reduced loss)(5)	Net Project impact (% loss)
1989	2,487,215,065,219	37.33%	10.39%	1.52%	0.47%	1.05%	9.34%
1990	3,151,664,546,469	16.11%	0.00%	1.28%	0.37%	0.91%	-0.91%
1991	2,239,575,697,278	14.62%	0.45%	1.17%	0.35%	0.82%	-0.37%
1992	2,064,841,156,890	15.26%	5.83%	1.21%	0.34%	0.87%	4.96%
1993	1,422,934,155,845	24.93%	0.00%	0.97%	0.27%	0.70%	-0.70%
1994	642,864,605,557	25.19%	0.00%	1.42%	0.38%	1.04%	-1.04%
1995	1,321,108,546,032	12.90%	0.00%	0.54%	0.13%	0.41%	-0.41%
1996	856,479,079,538	25.88%	4.94%	1.07%	0.30%	0.77%	4.16%
1997	717,389,925,574	30.77%	4.69%	1.23%	0.35%	0.89%	3.80%
1998	926,691,277,210	8.55%	0.00%	0.28%	0.08%	0.21%	-0.21%
1999	1,070,594,999,947	22.13%	2.63%	1.05%	0.26%	0.78%	1.84%
2000	2,850,059,199,610	39.41%	0.22%	1.03%	0.41%	0.62%	-0.41%
2001	597,325,190,690	10.96%	0.95%	0.91%	0.23%	0.68%	0.27%
2002	563,872,432,369	26.42%	14.67%	1.29%	0.43%	0.87%	13.80%
2003	1,332,693,245,849	34.76%	0.21%	1.30%	0.36%	0.94%	-0.72%
Avg.	1,483,020,608,272	23.01%	3.00%	1.09%	0.31%	0.77%	2.23%

Notes. (1) Sum of the calculated population size in June-September. (2) Assumes discharge for exports by SWP from July to November. (3) Assumes similar pattern of agricultural diversions each year. (4) Assumes similar pattern of habitat diversions each year. (5) Benefit is calculated as reduction in agricultural diversion entrainment loss minus increase in habitat diversion entrainment loss.

Lower San Joaquin River

The percentage of the zooplankton population lost from the lower Sacramento River due to baseline SWP/CVP pumping from June to September averaged 27.44% of the cumulative population (Table B-121). The range of baseline loss was from 11.35% in 2001 to 48.25% in 1989. Losses due to SWP export of water discharged from Reservoir Islands under the Project averaged 2.95% and ranged from 0.00% in several years to 8.63% in 1992. The benefit of the Project in terms of reducing agricultural diversions averaged a reduced loss of 0.96% per year (range: 0.28% [1998] to 1.42% [2002]). Overall the net Project impact was an average annual loss of 1.99% of *P. forbesi*, and ranged from a reduced loss of 1.35% in 1990 (no exports of Project water occurred and reduced agricultural diversions were greater than habitat island diversions) to a loss of 7.46% in 1992 (Table B-121).

Table B-121. *Pseudodiaptomus forbesi* June–September cumulative population size in the lower San Joaquin River and entrainment losses due to the baseline and Project conditions.

	Cumulative population size[1]	% loss (Baseline SWP/CVP exports)	% loss (Project discharges for export)[2]	% loss (Baseline Ag. diversions)[3]	% loss (Project Habitat diversions)[4]	Project benefit from reduced ag. diversions (% reduced loss)[5]	Net Project impact (% loss)
1989	2,272,916,750,881	48.25%	8.34%	1.85%	0.53%	1.32%	7.02%
1990	2,610,270,639,255	20.79%	0.00%	1.85%	0.50%	1.35%	-1.35%
1991	1,927,827,121,848	21.65%	0.64%	1.69%	0.53%	1.16%	-0.52%
1992	1,886,613,406,497	20.56%	8.63%	1.64%	0.47%	1.17%	7.46%
1993	2,207,037,010,395	33.47%	0.00%	1.20%	0.32%	0.88%	-0.88%
1994							
1995	54,625,362,926	22.26%	0.00%	0.48%	0.24%	0.25%	-0.25%
1996	887,120,475,332	24.72%	6.97%	1.33%	0.31%	1.02%	5.95%
1997	804,341,371,254	28.01%	5.29%	1.23%	0.33%	0.90%	4.38%
1998	1,095,714,238,894	11.74%	0.00%	0.40%	0.12%	0.28%	-0.28%
1999	995,688,212,727	32.09%	3.03%	1.33%	0.35%	0.98%	2.05%
2000	1,155,659,079,790	42.13%	0.48%	1.50%	0.39%	1.11%	-0.63%
2001	377,376,508,095	11.35%	0.00%	1.06%	0.29%	0.78%	-0.78%
2002	659,450,901,667	34.60%	7.35%	1.91%	0.49%	1.42%	5.93%
2003	743,760,894,816	32.54%	0.65%	1.18%	0.33%	0.85%	-0.20%
Avg.	1,262,742,998,170	27.44%	2.95%	1.33%	0.37%	0.96%	1.99%

Notes. [1] Sum of the calculated population size in June-September. [2] Assumes discharge for exports by SWP from July to November. [3] Assumes similar pattern of agricultural diversions each year. [4]Assumes similar pattern of habitat diversions each year. [5] Benefit is calculated as reduction in agricultural diversion entrainment loss minus increase in habitat diversion entrainment loss.

Franks Tract

The percentage of the zooplankton population lost from the Franks Tract region due to baseline SWP/CVP pumping from June to September averaged 43.92% of the cumulative population (Table B-122). The range of baseline loss was from 30.38% in 1992 to 63.88% in 1989. Losses due to SWP export of water discharged from Reservoir Islands under the Project averaged 3.59% and ranged from 0.00% in several years to 12.20% in 2002. The benefit of the Project in terms of reducing agricultural diversions averaged a reduced loss of 1.47% per year (range: 1.01% [1995] to 2.44% [1990]). Overall the net Project impact was an average annual loss of 2.13% of *P. forbesi*, and ranged from a reduced loss of 2.44% in 1990 (no exports of Project water occurred and reduced agricultural diversions were greater than habitat island diversions) to a loss of 10.33% in 1992 (Table B-122).

Table B-122. *Pseudodiaptomus forbesi* June–September cumulative population size in Franks Tract and entrainment losses due to the baseline and Project conditions.

	Cumulative population size[(1)]	% loss (Baseline SWP/CVP exports)	% loss (Project discharges for export)[(2)]	% loss (Baseline Ag. diversions)[(3)]	% loss (Project Habitat diversions)[(4)]	Project benefit from reduced ag. diversions (% reduced loss)[(5)]	Net Project impact (% loss)
1989	2,941,015,160,987	63.88%	3.77%	1.97%	0.50%	1.46%	2.31%
1990	2,995,786,022,517	33.98%	0.00%	3.24%	0.80%	2.44%	-2.44%
1991	3,383,238,673,413	27.67%	1.01%	2.91%	0.71%	2.19%	-1.19%
1992	3,462,838,091,973	30.38%	12.20%	2.51%	0.65%	1.86%	10.33%
1993	2,620,597,409,981	43.90%	0.00%	1.50%	0.36%	1.14%	-1.14%
1994	1,634,636,335,491	51.52%	0.00%	2.32%	0.61%	1.72%	-1.72%
1995	1,806,529,999,988	31.77%	0.00%	1.33%	0.32%	1.01%	-1.01%
1996	815,327,010,385	50.21%	8.43%	1.80%	0.46%	1.34%	7.09%
1997	1,527,756,407,098	56.14%	5.94%	1.43%	0.39%	1.04%	4.90%
1998	4,850,195,573,023	32.58%	0.00%	1.39%	0.32%	1.07%	-1.07%
1999	1,724,317,209,610	52.46%	7.01%	1.94%	0.46%	1.47%	5.54%
2000	2,093,778,662,909	39.92%	2.01%	1.83%	0.42%	1.41%	0.60%
2001	861,621,331,623	35.60%	0.71%	1.95%	0.63%	1.32%	-0.61%
2002	1,078,631,788,198	63.29%	11.56%	2.05%	0.63%	1.42%	10.14%
2003	1,244,078,869,749	45.52%	1.25%	1.45%	0.37%	1.08%	0.17%
Avg,	2,202,689,903,129	43.92%	3.59%	1.97%	0.51%	1.47%	2.13%

Notes. [(1)] Sum of the calculated population size in June-September. [(2)] Assumes discharge for exports by SWP from July to November. [(3)] Assumes similar pattern of agricultural diversions each year. [(4)]Assumes similar pattern of habitat diversions each year. [(5)] Benefit is calculated as reduction in agricultural diversion entrainment loss minus increase in habitat diversion entrainment loss.

ESE Delta

The percentage of the zooplankton population lost from the ESE Delta due to baseline SWP/CVP pumping from June to September averaged 95.12% of the cumulative population (Table B-123). The range of baseline loss was from 77.84% in 2001 to 99.90% in 1989. Losses due to SWP export of water discharged from Reservoir Islands under the Project averaged 0.17% and ranged from 0.00% in several years to 1.18% in 1992. The benefit of the Project in terms of reducing agricultural diversions averaged a reduced loss of 0.61% per year (range: 0.02% [1989] to 4.08% [2001]). Overall the net Project impact was actually positive (i.e., a net benefit) and amounted to an average 0.44% reduction in the loss of *P. forbesi*, ranging from a reduced loss of 4.07% in 2001 to a loss of 0.48% in 1997 (Table B-123).

Table B-123. *Pseudodiaptomus forbesi* June–September cumulative population size in the ESE Delta and entrainment losses due to the baseline and Project conditions.

	Cumulative population size(1)	% loss (Baseline SWP/CVP exports)	% loss (Project discharges for export)(2)	% loss (Baseline Ag. diversions)(3)	% loss (Project Habitat diversions)(4)	Project benefit from reduced ag. diversions (% reduced loss)(5)	Net Project impact (% loss)
1989	2,487,215,065,219	99.90%	0.00%	0.03%	0.01%	0.02%	-0.02%
1990	3,151,664,546,469	99.32%	0.00%	0.23%	0.06%	0.17%	-0.17%
1991	2,239,575,697,278	96.02%	0.04%	1.44%	0.37%	1.07%	-1.03%
1992	2,064,841,156,890	94.68%	1.18%	1.60%	0.40%	1.20%	-0.01%
1993	1,422,934,155,845	95.98%	0.00%	0.56%	0.13%	0.43%	-0.43%
1994	642,864,605,557	99.60%	0.00%	0.11%	0.03%	0.08%	-0.08%
1995	1,321,108,546,032	88.94%	0.00%	0.72%	0.17%	0.56%	-0.56%
1996	856,479,079,538	98.94%	0.11%	0.21%	0.05%	0.16%	-0.05%
1997	717,389,925,574	98.53%	0.77%	0.38%	0.10%	0.29%	0.48%
1998	926,691,277,210	79.92%	0.00%	0.74%	0.18%	0.56%	-0.56%
1999	1,070,594,999,947	98.73%	0.16%	0.29%	0.07%	0.22%	-0.06%
2000	2,850,059,199,610	99.60%	0.16%	0.10%	0.02%	0.07%	0.08%
2001	597,325,190,690	77.84%	0.01%	5.33%	1.25%	4.08%	-4.07%
2002	563,872,432,369	99.66%	0.00%	0.09%	0.02%	0.07%	-0.07%
2003	1,332,693,245,849	99.18%	0.11%	0.18%	0.05%	0.14%	-0.03%
Avg.	1,483,020,608,272	95.12%	0.17%	0.80%	0.19%	0.61%	-0.44%

Notes. (1) Sum of the calculated population size in June-September. (2) Assumes discharge for exports by SWP from July to November. (3) Assumes similar pattern of agricultural diversions each year. (4)Assumes similar pattern of habitat diversions each year. (5) Benefit is calculated as reduction in agricultural diversion entrainment loss minus increase in habitat diversion entrainment loss.

SE Delta

The percentage of the zooplankton population lost from the SE Delta due to baseline SWP/CVP pumping from June to September averaged 99.00% of the cumulative population (Table B-126). The range of baseline loss was from 93.93% in 1995 to 100% in several years. Losses due to SWP export of water discharged from Reservoir Islands under the Project averaged 0.00% and was 0.01% in 1992 and 2000. The benefit of the Project in terms of reducing agricultural diversions averaged a reduced loss of 0.11% per year (range: 0.00% [several years] to 0.65% [1995]). Overall the net Project impact was actually positive (i.e., a net benefit) and amounted to a 0.11% reduction in the loss of *P. forbesi*, ranging from a reduced loss of 0.65% in 1995 to no reduction (i.e., 0.00% loss) (Table B-124).

Table B-124. *Pseudodiaptomus forbesi* June–September cumulative population size in the SE Delta and entrainment losses due to the baseline and Project conditions.

	Cumulative population size(1)	% loss (Baseline SWP/CVP exports)	% loss (Project discharges for export)(2)	% loss (Baseline Ag. diversions)(3)	% loss (Project Habitat diversions)(4)	Project benefit from reduced ag. diversions (% reduced loss)(5)	Net Project impact (% loss)
1989	631,627,436,445	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1990	622,141,399,248	99.99%	0.00%	0.00%	0.00%	0.00%	0.00%
1991	688,588,017,917	99.67%	0.00%	0.19%	0.06%	0.14%	-0.14%
1992	596,390,807,082	99.71%	0.01%	0.14%	0.04%	0.10%	-0.09%
1993	216,109,623,901	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1994							
1995	218,951,931,258	93.93%	0.00%	0.85%	0.20%	0.65%	-0.65%
1996	112,896,758,700	99.93%	0.00%	0.02%	0.01%	0.02%	-0.02%
1997	131,624,646,402	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1998	646,781,295,362	94.05%	0.00%	0.32%	0.07%	0.25%	-0.25%
1999	487,689,675,092	99.97%	0.00%	0.01%	0.00%	0.01%	-0.01%
2000	712,250,801,673	99.99%	0.01%	0.00%	0.00%	0.00%	0.00%
2001	381,158,606,418	98.78%	0.00%	0.58%	0.16%	0.42%	-0.42%
2002	757,227,087,302	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2003	374,277,506,190	99.98%	0.00%	0.01%	0.00%	0.00%	0.00%
Average	469,836,828,071	99.00%	0.00%	0.15%	0.04%	0.11%	-0.11%

Notes. (1) Sum of the calculated population size in June-September. (2) Assumes discharge for exports by SWP from July to November. (3) Assumes similar pattern of agricultural diversions each year. (4)Assumes similar pattern of habitat diversions each year. (5) Benefit is calculated as reduction in agricultural diversion entrainment loss minus increase in habitat diversion entrainment loss.

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Appendix C
Air Quality Data

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Table C-1. Air Quality Monitoring Data at the Bethel Island Monitoring Station (2006–2008)

	Monitoring Data by Year		
Pollutant	2006	2007	2008
O_3			
Highest 1-hour average, ppm	**0.116**	0.093	**0.109**
Highest 8-hour average, ppm	0.090	0.078	0.090
Days > state 1-hour standard	9	0	4
Days > federal 8-hour standard	13	1	4
Percent of year covered	99	99	93
PM10			
Highest 24-hour average, $\mu g/m^3$	**84.3**	49.4	**77.0**
Days > state standard	4	4	0
Days > federal standard	0	0	0
Percent of year covered	93	75	86
CO			
Highest 8-hour average, $\mu g/m^3$	1.04	0.84	0.83
Days > federal standard	0	0	0
Percent of year covered	98	96	47

Source: California Air Resources Board 2009.

Note: **Bolded** values represent those in excess of the applicable California ambient air quality standards.

ppm = parts per million by volume.

$\mu g/m^3$ = micrograms per cubic meter.

Table C-2. Air Quality Monitoring Data at the Pittsburg Monitoring Station (2006–2008)

	Monitoring Data by Year		
Pollutant	2006	2007	2008
O_3			
Highest 1-hour average, ppm	**0.105**	**0.100**	**0.106**
Highest 8-hour average, ppm	0.093	0.074	0.083
Days > state 1-hour standard	3	1	1
Days > federal 8-hour standard	6	0	1
Percent of year covered	98	98	93
PM10			
Highest 24-hour average, $\mu g/m^3$	57.8	55.6	73.6
Days > state standard	2	4	2
Days > federal standard	0	0	0
Percent of year covered	93	75	86
CO			
Highest 24-hour average, $\mu g/m^3$	1.92	1.5	1.44
Days > federal standard	0	0	0
Percent of year covered	98	97	53

Source: California Air Resources Board 2009.

Note: **Bolded** values represent those in excess of the applicable California ambient air quality standards.

ppm = parts per million by volume.

$\mu g/m^3$ = micrograms per cubic meter.

Table C-3. Existing Conditions Assumptions

Data Type	Bacon Island	Webb Tract	Bouldin Island	Holland Tract
Recreation				
Number vehicles traveling to recreation area (trips/day)	6	8	5	2
Number vehicles traveling to recreation area (trips/year)	1,610	365	285	76
Number of recreational boats (boats/day)	–	–	–	–
Number of recreational boats (boats/year)	–	–	–	–
Agriculture				
Acres farmed	4859	4064	4933	2884
Number of harvest vehicles (trips/day)	20	10	15	3
Number of harvest vehicles (trips/year)	714	500	975	50
Gas used for ag activities (gallons/day)	17	33	67	0
Gas used for ag activities (gallons/year)	4,280	8,275	16,801	0
Diesel used for ag activities (gallons/day)	600	490	995	5
Diesel used for ag activities (gallons/year)	60,000	48,987	99,459	500
Acres disturbed by farming (acres/day)	243	203	247	144

Assumes 100 working days per year of farming. Also assumes that an acre of farmland is disturbed an average of 5 times per year, so the acres disturbed per day is total number of acres times 5, divided by 100.

Table C-4. Future No Project Assumptions

Data Type	Bacon Island	Webb Tract	Bouldin Island	Holland Tract
Recreation				
Number vehicles traveling to recreation area (trips/day)	43	38	42	29
Number vehicles traveling to recreation area (trips/year)	3,262	1,731	1,946	1,323
Number of recreational boats (boats/day)	–	–	–	–
Number of recreational boats (boats/year)	–	–	–	–
Agriculture				
Acres farmed	4,960	4,880	5,200	3,680
Number of harvest vehicles (trips/day)	61	4	13	3
Number of harvest vehicles (trips/year)	15,368	890	3,175	763
Gas used for ag activities (gallons/day)	433	245	276	136
Gas used for ag activities (gallons/year)	108,205	61,308	69,018	34,033
Diesel used for ag activities (gallons/day)	1,392	2,220	2,499	1,232
Diesel used for ag activities (gallons/year)	139,193	221,978	249,893	123,228
Acres disturbed by farming (acres/day)	248	244	260	184

Assumes 100 working days per year of farming. Also assumes that an acre of farmland is disturbed an average of 5 times per year, so the acres disturbed per day is total number of acres times 5, divided by 100.

Table C-5. Alternatives 1 and 2 Construction, Operational, Recreational, and Agricultural Unmitigated Assumptions

	Bacon Island	Webb Tract	Bouldin Island	Holland Tract
Construction				
Number worker vehicle trips per day to islands	67	53	30	14
Number worker vehicle trips per day to boat	3	31	1	1
Number of employee boat trips to islands per day	3	12	2	2
Number of material delivery truck trips to island per day	2	2	0	0
Number of barge trips to island per day	1	1	1	0
Number of hours of rock placement per day	5	4	2	2
Quantity of borrow (cubic yards/day)	6,634	5270	3,300	520
Operations				
Amount of diesel used to pump water (gallons/day)	1,355	1,178	–	–
Amount of diesel used to pump water (gallons/year)	81,300	70,700	–	–
Recreation				
Number of vehicles to recreation areas (trips/day)	521	521	474	284
Number of vehicles to recreation areas (trips/year)	87,585	87,585	79,684	47,743
Hours of recreational boats per day	320	320	291	174
Hours of recreational boats per year	116,773	116,773	106,289	63,629
Agriculture				
Number of harvest vehicles (trips/day)	–	–	1	1
Number of harvest vehicles (trips/year)	–	–	335	168
Gas used for operations(gallons/day)	–	–	60	30
Gas used for operations (gallons/year)	–	–	14,970	7,485
Diesel used for ag activities (gallons/day)	–	–	217	108
Diesel used for ag activities (gallons/year)	–	–	54,200	27,100
Acres disturbed by farming (acres/day)	0	0	44	22

Table C-6. Alternative 3 Construction, Operational, Recreational, and Agricultural Unmitigated Assumptions

	Bacon Island	Webb Tract	Bouldin Island	Holland Tract
Construction				
Number worker vehicle trips per day to islands	67	53	151	103
Number worker vehicle trips per day to boat	3	31	7	4
Number of employee boat trips to islands per day	3	12	12	16
Number of material delivery truck trips to island per day	2	2	1	1
Number of barge trips to island per day	1	1	1	1
Number of hours of rock placement per day	5	4	2	4
Quantity of borrow (cubic yards/day)	2,613	5,387	35,616	2,400
Operations				
Amount of diesel used to pump water (gallons/day)	228	228	228	228
Amount of diesel used to pump water (gallons/year)	57,000	57,000	57,000	57,000
Recreation				
Number of vehicles to recreation areas (trips/day)	521	521	474	379
Number of vehicles to recreation areas (trips/year)	87,480	87,480	79,588	63,637
Hours of recreational boats per day	320	320	291	232
Hours of recreational boats per year	116,623	116,623	106,152	84,850
Agriculture				
Number of harvest vehicles (trips/day)	0	0	0	0
Gas used for ag activities (gallons/day)	0	0	0	0
Diesel used for ag activities (gallons/day)	0	0	0	0
Acres disturbed by farming (acres/day)	0	0	0	0

Table C-7. Comparison of Unmitigated Criteria Pollutant Emissions for Existing, Future No-Project, and Build Alternatives with Diesel Used for Pumping (Pounds per Day)

Pounds per Day	ROG	NO_X	CO	PM10	PM2.5
Existing Emissions	94	500	624	8,401	2,040
Future No-Project	220	975	3,976	9,428	2,313
Construction of Alternatives 1 & 2	188	1,538	876	746	315
Operation of Alternatives 1 & 2	631	2,016	10,642	917	398
Construction of Alternative 3	514	4,302	2,220	993	506
Operation of Alternative 3	565	1,018	10,649	194	174
Net Increase: Operation 1&2 vs. Future No-Project	410	1,042	6,666	(8,511)	(1,914)
Net Increase: Operation 3 vs. Future No-Project	344	44	6,673	(9,234)	(2,139)

Notes: Assumes diesel engines used to pump water.

Based on assumptions in Tables C-1 through C-5.

Alternatives 1 and 2 assume 3 million kilowatt-hours per year required to pump water. Alternative 3 assumes 6 million kilowatt-hours per year required for pumping.

On-road vehicle trip emissions estimated with URBEMIS2007.

Table C-8. Comparison of Unmitigated Criteria Pollutant Emissions for Existing, Future No-Project, and Build Alternatives with Diesel Used for Pumping (Tons per Year)

Tons per Year	ROG	NO_X	CO	PM10	PM2.5
Existing Emissions	5.8	26.3	58.9	22.7	6.8
Future No-Project	18.6	55.0	440.2	28.8	11.0
Construction of Alternatives 1 & 2	23.5	192.3	109.5	93.2	39.4
Operation of Alternatives 1 & 2	95.3	132.6	1,867.5	30.0	27.2
Construction of Alternative 3	64.3	537.7	277.5	124.2	63.2
Operation of Alternative 3	100.0	153.8	1,928.8	30.7	29.1
Net Increase: Operation 1&2 vs. Future No-Project	77	78	1,427	1	16
Net Increase: Operation 3 vs. Future No-Project	81	99	1,489	2	18

Notes: Assumes diesel engines used to pump water.

Based on assumptions in Tables C-1 through C-5.

Alternatives 1 and 2 assume 3 million kilowatt-hours per year required to pump water. Alternative 3 assumes 6 million kilowatt-hours per year required for pumping.

On-road vehicle trip emissions estimated with URBEMIS2007.

Agricultural emissions estimated with OFFROAD2007.

Table C-9. Comparison of Mitigated Criteria Pollutant Emissions for Existing, Future No-Project and Build Alternatives (Pounds per Day)

Pounds per Day	ROG	NO_X	CO	PM10	PM2.5
Existing Emissions	94	500	624	8,401	2,040
Future No-Project	220	975	3,976	9,428	2,313
Construction of Alternatives 1 and 2	188	1,538	876	746	315
Operation of Alternatives 1 and 2	79	105	1,617	681	179
Construction of Alternative 3	514	4,302	2,220	993	506
Operation of Alternative 3	74	67	1,493	22	19
Net Increase: Operation 1 and 2 vs. Future No-Project	(142)	(869)	(2,359)	(8,747)	(2,134)
Net Increase: Operation 3 vs. Future No-Project	(147)	(908)	(2,483)	(9,406)	(2,294)

Notes: Assumes electricity used to pump water.
Based on assumptions in Tables C-1 through C-5.
Alternatives 1 and 2 assume 3 million kilowatt-hours per year required to pump water. Alternative 3 assumes 6 million kilowatt-hours per year required for pumping.
On-road vehicle trip emissions estimated with URBEMIS2007.
Agricultural emissions estimated with OFFROAD2007.

Table C-10. Comparison of Mitigated Criteria Pollutant Emissions for Existing, Future No-Project and Build Alternatives (Tons per Year)

Tons per Year	ROG	NO_X	CO	PM10	PM2.5
Existing Emissions	5.8	26.3	58.9	22.7	6.8
Future No-Project	18.6	55.0	440.2	28.8	11.0
Construction of Alternatives 1 and 2	23.5	192.3	109.5	93.2	39.4
Operation of Alternatives 1 and 2	13.5	16.5	276.9	5.4	3.9
Construction of Alternative 3	64.3	537.7	277.5	124.2	63.2
Operation of Alternative 3	13.4	12.1	271.3	3.7	3.4
Net Increase: Operation 1 and 2 vs. Future No-Project	(5)	(39)	(163)	(23)	(7)
Net Increase: Operation 3 vs. Future No-Project	(5)	(43)	(169)	(25)	(8)

Notes: Assumes electricity used to pump water.
Based on assumptions in Tables C-1 through C-5.
Alternatives 1 and 2 assume 3 million kilowatt-hours per year required to pump water. Alternative 3 assumes 6 million kilowatt-hours per year required for pumping.
On-road vehicle trip emissions estimated with URBEMIS2007.
Agricultural emissions estimated with OFFROAD2007.