Chapter 5
Physical Environment

This chapter provides environmental analyses relative to physical parameters of the project area. Components of this study include a setting discussion, impact analysis criteria, project effects and significance, and applicable mitigation measures. This chapter is organized as follows:

- Section 5.1, Water Supply;
- Section 5.2, Delta Tidal Hydraulics;
- Section 5.3, Water Quality;
- Section 5.4, Geology, Seismicity, Soils, and Mineral Resources;
- Section 5.5, Flood Control and Levee Stability;
- Section 5.6, Sediment Transport;
- Section 5.7, Groundwater Resources;
- Section 5.8, Transportation and Navigation;
- Section 5.9, Air Quality; and
- Section 5.10, Noise.

5.1 Water Supply and Management

Introduction

The CVP and SWP reservoirs and Delta baseline conditions simulated by CALSIM for 2001 (existing conditions) and for 2020 (future no action) are described in this section. The SDIP involves operational changes at the CCF intake gates and subsequent changes in Delta channel flows and upstream reservoir operations and river flows. Because the SWP and CVP water supply systems are operated along with non-project (local) water supply and flood control reservoirs in a semi-integrated manner, monthly changes in SWP pumping that could be allowed with an SDIP alternative may cause changes in upstream SWP or CVP reservoir releases and storage, which may cause environmental impacts (e.g., on water quality, fish) in the reservoirs, downstream rivers, or in the Delta channels. Socioeconomic effects from these water management changes also may result (e.g., navigation, recreation, land uses, and growth).

The only changes from the baseline conditions that result from the SDIP alternatives that are evaluated in this section are the CVP and SWP exports and subsequent water deliveries. Environmental impacts that may result from changes in reservoir operations or Delta operations caused by the SDIP alternatives are identified and evaluated in subsequent resource topic sections (e.g., tidal hydraulics, water quality, fish, vegetation).

This section discusses Delta conditions related to water supply (the amount of water available for beneficial uses) and the possible effects of the SDIP on water supply conditions. Beneficial uses of Delta water include in-Delta use (e.g., agricultural and municipal) by other water-right holders, maintenance of fish and wildlife habitat, and export to users receiving water from the CVP or the SWP. The Affected Environment section discusses water rights; Delta objectives and requirements for protection of water quality and biological resources and the constraints placed on Delta water project operations by these objectives and requirements; and operations of the major water projects, the SWP and the CVP.

The water supply evaluations of the SDIP alternatives rely on the DWR and Reclamation joint planning model (CALSIM II) simulation results for likely future reservoir and Delta operations under a range of possible “rules” for allowable periods of increased SWP Banks pumping limits. The simulation of the CVP fish protection program (i.e., CVPIA (b)(2) water) and the EWA are included in the baseline and alternative simulations, assuming an equal and consistent implementation of both (b)(2) and EWA level of protection in the existing conditions (2001 level of development [LOD]) and future no action (2020 LOD) baseline and alternative simulations. The joint water supply planning model will be referenced as CALSIM (without the II).

Affected Environment

Numerous parties hold rights to divert water from the Delta and Delta 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, Reclamation's CVP, and other users divert water from the Delta under appropriative rights. Additionally, approximately 1,800 siphons and small pumps are used to divert water under riparian and appropriative rights from Delta channels to Delta islands for agricultural consumptive uses; most of these appropriative rights were applied for in the 1920s and are senior to those under which the SWP and CVP operate.

Various water quality and flow objectives have been established 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. None of these protective actions are being modified by the SDIP operational alternatives.

Sources of Information

Previous and ongoing studies and analyses of the Bay-Delta served as important sources of information for this analysis. Studies and reports that were used include San Francisco Estuary Project (1993) and the estuarine standards proposed in December 1993 by the EPA; Bay-Delta hearings and workshops sponsored by the State Water Board; evaluations of effects of SWP and CVP operations on two federally listed endangered species, winter-run Chinook salmon (National Marine Fisheries Service 1993) and delta smelt (U.S. Fish and Wildlife Service 1995); and draft environmental documents for major water resource projects in or adjacent to the Delta, including the Los Vaqueros Project (Contra Costa Water District and Reclamation 1993) and the Delta Wetlands Project (State Water Resources Control Board and U.S. Army Corps of Engineers 2000). The recently completed biological assessment and biological opinion documents for the OCAP have also been reviewed for consistency and approach (Bureau of Reclamation 2003b; National Marine Fisheries Service 2004; U.S. Fish and Wildlife Service 2004a).

Other sources of information for this section are the environmental report prepared by the State Water Board on the 1995 WQCP (State Water Resources Control Board 1995a) and the description and analysis of California water supply and water use demands provided in the California Water Plan Update (California Department of Water Resources 1998a) that describes the potential effects of environmental requirements, including Delta outflow and export limits to protect fish and wildlife species, on Delta water supply.

Several CALFED documents provide additional background information and a general description of the purposes for the SDIP. These include the Programmatic EIR/EIS and the ROD. There are several technical reports that also provide more specific details on Delta water operations.

DWR Modeling staff prepared an initial simulation of the 8,500 cfs diversion limits (California Department of Water Resources 2001a). This was the first use of the CALSIM monthly planning model to evaluate the effects of the CVPIA (b)(2) and EWA water management programs on the CVP and SWP operations, as well as study the incremental effects of allowing 8,500 cfs of SWP Banks pumping year-round.

Another important study by DWR Bay-Delta Office was on water supply reliability (California Department of Water Resources 2002a). This report discusses the SWP demands, full entitlements, and shows CALSIM results for 2001 and 2020 level of development. The difficulties of delivering the full Table A contractual amounts with the existing facilities (including the 6,680 cfs limit on SWP Banks) are described.

The comparative information for this water supply evaluation was the CALSIM II monthly model results. CALSIM II refers to the CVP-SWP implementation of the CALSIM model code. The CALSIM II modeling inputs and assumptions (i.e., model improvements) are being incorporated in an ongoing effort by Reclamation and DWR. The version of CALSIM used for the evaluation of SDIP operational scenarios is presented in detail in a series of DWR reports. These reports can be obtained from the DWR Bay-Delta Office (formerly Office of State Water Supply Planning) modeling web site at:

http://modeling.water.ca.gov

The model documentation is available in three segments—a user’s manual that describes the model formulation and development, a user’s guide that describes the steps in actually setting up assumptions and input data files for running the model, and a model language reference that gives technical details of the computer instructions that can be modified by the user to change the model structure and formulation. A recent review by the California Bay-Delta Authority Science Program describes some general aspects of the CALSIM model performance based on interviews with current model users (CALFED Bay-Delta Authority Science Office 2003). A recent report (California Department of Water Resources Bay-Delta Office 2003) provides some comparison and discussion of CALSIM results with recent historical CVP and SWP operations (i.e., water years [WY] 1975–1998) that indicates the general ability of the CALSIM model to reproduce historical operations if the rules and water supply demands are properly specified.

The CALSIM assumptions for the simulations of the SDIP operational scenarios are described in the September 2002 Benchmark Studies for 2001 and 2020 Level of Development. There are three reports in this series that are available in pdf format from the modeling website:

Benchmark Assumptions and Appendices

2001 LOD Benchmark Study

2020 LOD Benchmark Study

Additional material summarized and used in this section can be found in Appendix B, *Simulation of Environmental Water Account Actions to Reduce Fish Entrainment Losses (Interactive Daily EWA Gaming Evaluations)*. Results from the daily water supply planning model, DailySOS, are used to describe likely daily operations of CVP and SWP Delta pumping facilities. The appendix discusses potential EWA actions to reduce entrainment losses and describes the differences between impact assessment based on monthly average hydrologic conditions and impact assessment based on actual daily hydrologic conditions.

The reader is directed to these DWR documents and Appendix B for a more detailed explanation of the analytical methods and assumptions used for estimating water supply effects of SDIP alternative operational scenarios.

Table 5.1-1 gives a general list of the CALSIM assumptions used for the 2001 and 2020 simulations of the baseline and SDIP operational scenarios. Although this list does not indicate the amount of water required for each minimum flow or Delta objective that is simulated by the model, it can be used to distinguish the 2001 and 2020 simulations, as well as differences in other studies of water supply projects that also use CALSIM modeling results in the environmental review and documentation (i.e., OCAP, Freeport Diversion, Trinity River Restoration, Integrated Storage Investigations).

Appendix I, “Results from CALSIM II Modeling of the SDIP Alternatives,” provides detailed results for the 2001 and 2020 baseline and each of the SDIP alternative operational scenarios. A review and discussion of the major CALSIM results for each CVP and SWP reservoir and the simulated Delta water management conditions (i.e., CVP and SWP pumping) for both the 2001 and 2020 baseline simulations are given in the following sections.

Delta Water Rights

Riparian Water 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 (State Water Resources Control Board 1989). Natural flows do not include return flows from use of groundwater (e.g., for irrigation), water seasonally stored and later

Table 5.1-1. CALSIM II Model Assumptions for SDIP Baselines and Operational Scenarios for 1992–1994 (73 Years)

	Benchmark 2001	SDIP 2001 Baseline Existing Conditions	Benchmark 2020	SDIP 2020 Baseline Future No-Action	SDIP Scenario A	SDIP Scenario B	SDIP Scenario C
FACILITIES							
Level of Development (Land Use)	2001 Level, DWR Bulletin 160-98	Same	2020 Level, DWR Bulletin 160-98	Same	Same as 2001 Baseline or 2020 Baseline Unless Indicated	Same as 2001 Baseline or 2020 Baseline Unless Indicated	Same as 2001 Baseline or 2020 Baseline Unless Indicated
North of Delta							
CVP (non-settlement)	Land Use–based, limited by Full Contract	Same	Same	Same			
(Settlement)	Land Use–based, historical	Same	Same	Same			
SWP (FRSA)	Land Use–based, limited by Full Contract	Same	Same	Same			
Non-Project	Land Use–based	Same	Same	Same			
CVP Refuges	Firm Level 2	Same	Same	Same			
American River Basin							
Water rights and CVP	1998 Water Forum Demands	Same	2025 Water Forum Demands	Same			
San Joaquin River Basin							
Friant Unit	Regression of historical	Same	Same	Same			
Merced and Tuolumne	Fixed annual demands	Same	Same	Same			
Stanislaus River Basin	New Melones Interim Operations Plan	Same	Same	Same			
South of Delta							
CVP	Full Contract	Same	Same	Same			
CCWD	140 taf/yr	Same	195 taf/yr	Same			
SWP (w/ North Bay Aqueduct)	3.0–4.1 maf/yr	Same	3.4–4.2 maf/yr	Same			
SWP Article 21 Demand	MWD up to 50 taf/month, Dec–Mar, others up to 84 taf/month	Same	Same	Same			
REGULATORY STANDARDS							
Trinity River							
Minimum Flow below Lewiston Dam	Trinity EIS Preferred Alternative (369–815 taf/yr)	369–452 taf/yr	369–815 taf/yr	Same			

Table 5.1-1. Continued

	Benchmark 2001	SDIP 2001 Baseline Existing Conditions	Benchmark 2020	SDIP 2020 Baseline Future No-Action	SDIP Scenario A	SDIP Scenario B	SDIP Scenario C
Clear Creek							
Minimum Flow below Whiskeytown Dam	Downstream water rights, 1963 Reclamation Proposal to USFWS and NPS, and USFWS discretionary use of CVPIA 3406(b)(2)	Same	Same	Same			
Upper Sacramento River							
Shasta Lake End-of-September Minimum Storage	State Water Board WR 1993 Winter-run Biological Opinion (1900 taf)	Same	Same	Same			
Minimum Flow below Keswick Dam	Flows for State Water Board WR 90-5 and 1993 Winter-run Biological Opinion temperature control, and USFWS discretionary use of CVPIA 3406(b)(2)	Same	Same	Same			
Feather River							
Minimum Flow below Thermalito Diversion Dam	1983 DWR, DFG Agreement (600 cfs)	Same	Same	Same			
Minimum Flow below Thermalito Afterbay outlet	1983 DWR, DFG Agreement (1,000–1,700 cfs)	Same	Same	Same			
Yuba River	None	Input data updated to represent State Water Board D-1644 minimum flows	None	Input data updated to represent State Water Board D-1644 minimum flows			
American River							
Minimum Flow below Nimbus Dam	State Water Board D-893 (see accompanying Operations Criteria), and USFWS discretionary use of CVPIA 3406(b)(2)	Same	Same	Same			
Minimum Flow at H Street Bridge	State Water Board D-893	Same	Same	Same			

	Benchmark 2001	SDIP 2001 Baseline Existing Conditions	Benchmark 2020	SDIP 2020 Baseline Future No-Action	SDIP Scenario A	SDIP Scenario B	SDIP Scenario C
Mokelumne River							
Minimum Flow below Camanche Dam	FERC 2916-029, 1996 (Joint Settlement Agreement) (100–325 cfs)	Same	Same	Same			
Minimum Flow below Woodbridge Diversion Dam	FERC 2916-029, 1996 (Joint Settlement Agreement) (25–300 cfs)	Same	Same	Same			
Stanislaus River							
Minimum Flow below Goodwin Dam	1987 Reclamation, DFG agreement, and USFWS discretionary use of CVPIA 3406(b)(2)	Same	Same	Same			
Minimum Dissolved Oxygen	State Water Board D-1422	Same	Same	Same			
Merced River							
Minimum Flow below Crocker-Huffman Diversion Dam	Davis-Grunsky (180–220 cfs, Nov–Mar), and Cowell Agreement	Same	Same	Same			
Minimum Flow at Shaffer Bridge	FERC 2179 (25–100 cfs)	Same	Same	Same			
Tuolumne River							
Minimum Flow at Lagrange Bridge	FERC 2299-024, 1995 (Settlement Agreement) (94–301 taf/yr)	Same	Same	Same			
San Joaquin River							
Maximum Salinity near Vernalis	State Water Board D-1641	Same	Same	Same			
Minimum Flow near Vernalis	State Water Board D-1641, and VAMP per San Joaquin River Agreement	Same	Same	Same			
Sacramento River–San Joaquin River Delta							
Minimum Flow near Rio Vista	State Water Board D-1641	Same	Same	Same			
Delta Outflow Index (Flow and Salinity)	State Water Board D-1641	Same	Same	Same			
Delta Cross Channel Gate Operation	State Water Board D-1641	Same	Same	Same			

	Benchmark 2001	SDIP 2001 Baseline Existing Conditions	Benchmark 2020	SDIP 2020 Baseline Future No-Action	SDIP Scenario A	SDIP Scenario B	SDIP Scenario C
Delta Exports	State Water Board D-1641	Same	Same	Same			
OPERATIONS CRITERIA							
Flow Objective for Navigation (Wilkins Slough)	Discretionary 3,500–5,000 cfs based on Lake Shasta storage condition	Same	Same	Same			
Folsom Dam Flood Control	SAFCA, Operation of Folsom Dam, Variable 400/670 (without outlet modifications)	Same	Same	Same			
Flow below Nimbus Dam	Discretionary operations criteria corresponding to State Water Board D-893 required minimum flow	Same	Same	Same			
Sacramento Water Forum Mitigation Water	None	None	Up to 47 taf/yr in dry years	Same			
Flow below Goodwin Dam	1997 New Melones Interim Operations Plan	Same	Same	Same			
CVP Water Allocation							
CVP Settlement and Exchange	100% (75% in Shasta Critical years)	Same	Same	Same			
CVP Refuges	100% (75% in Shasta Critical years)	Same	Same	Same			
CVP Agriculture	100%–0% based on supply	Same	Same	Same			
CVP Municipal & Industrial	100%–50% based on supply	Same	Same	Same			
SWP Water Allocation							
North of Delta (FRSA)	Contract specific	Same	Same	Same			
South of Delta (including North Bay Aqueduct)	Based on supply; Equal prioritization between Ag and M&I	Same	Same	Same			
Delta Pumping							
Tracy Pumping Maximum	4,600 cfs from April–Sept, 4,300 cfs from Oct–Mar	Same	Same	Same			

Table 5.1-1. Continued

	Benchmark 2001	SDIP 2001 Baseline Existing Conditions	Benchmark 2020	SDIP 2020 Baseline Future No-Action	SDIP Scenario A	SDIP Scenario B	SDIP Scenario C
Banks Pumping Maximum	Max of 6,680 cfs from Mar 16–Dec 14. 6,680 cfs plus 1/3 SJR flow to max of 8,500 cfs from Dec 15–Mar 15. Up to 500 cfs dedicated to EWA from Jul–Sep above 6,680 cfs	Max of 6,680 cfs from Mar 16–Dec 14. 6,680 cfs plus 1/3 SJR flow to max of 8,500 cfs from Dec 15–Mar 15. Up to 500 cfs dedicated to EWA in Jul–Sep above 6,680 cfs	Max of 6,680 cfs from Mar 16–Dec 14. 6,680 cfs plus 1/3 SJR flow to max of 8,500 cfs from Dec 15–Mar 15. Up to 500 cfs dedicated to EWA from Jul–Sep above 6,680 cfs	Max of 6,680 cfs from Mar 16–Dec 14. 6,680 cfs plus 1/3 SJR flow to max of 8,500 cfs from Dec 15–Mar 15. Up to 500 cfs dedicated to EWA from Jul–Sep above 6,680 cfs	Max of 8,500 cfs year-around. Up to 30 taf in Jul and 70 taf in Aug dedicated to CVP. Up to 500 cfs dedicated to EWA from Jul–Sep	Max of 8,500 cfs from Jul–Nov. Max of 7,180 cfs from Dec–Jun. Up to 1,820 cfs dedicated to EWA from Jul–Sep	Max of 8,500 cfs from Jul 1–Mar 15. Max of 6,680 cfs from Mar 16–Jun 30. Up to 500 cfs dedicated to EWA from Jul–Sep.
Supply Transfer from Shasta to SWP for Delta Requirements	None	None	None	None	Minimum of 75 taf or CVP south-of-Delta Agricultural Allocation (%) times 100 taf	None	None
CVP/SWP Coordinated Operations							
Sharing of Responsibility for In-Basin-Use	Coordinated Operations Agreement	Same	Same	Same			
Sharing of Surplus Flows	Coordinated Operations Agreement						
Sharing of Restricted Export Capacity	Equal sharing of export capacity under State Water Board D-1641 E/I limits.	Same	Same	Same			
CVPIA 3406(b)(2)							
Allocation	800 taf/yr (600 taf/yr in Shasta Critical years)	Same	Same	Same			
Actions	1995 WQCP (non-discretionary), VAMP (Apr 15–May 16) CVP 3000 cfs CVP export limit in May and June (D-1485 Striped Bass), and Discretionary fish flow releases and/or CVP export reductions. (Dec–Jan).	Same	Same	Same			
Accounting Adjustments	Per February 2002 Interior Decision	Same	Same	Same			

Table 5.1-1. Continued

	Benchmark 2001	SDIP 2001 Baseline Existing Conditions	Benchmark 2020	SDIP 2020 Baseline Future No-Action	SDIP Scenario A	SDIP Scenario B	SDIP Scenario C
CALFED Environmental Water Account							
Actions	Total exports restricted to 4000 cfs, 1 wk/mon, Dec–Mar (wet year: 2 wk/mon), VAMP (Apr 15–May 16) export restriction, Pre (Apr 1–15) and Post (May 16–31) VAMP export restriction, Ramping of export (Jun)	Same	Same	Same			
Assets	50% of use of JPOD, 50% of any (b)(2) releases pumped by SWP, north-of-Delta (0–135 taf/yr) and south-of-Delta (50–185 taf/yr) purchases, and 200 taf south-of-Delta groundwater storage capacity	Same	Same	Same			

Notes:

CCWD = Contra Costa Water District.
cfs = cubic feet per second.
CVP = Central Valley Project.
CVPIA = Central Valley Project Improvement Act.
DFG = California Department of Fish and Game.
DWR = California Department of Water Resources.
E/I = export/import.
EIS = environmental impact statement.
EWA = Environmental Water Account.
FERC = Federal Energy Regulatory Commission.
FRSA = Feather River Service Area.
JPOD = joint powers of diversion.
maf = million acre-feet.
maf/yr = million acre-feet per year.
M&I = municipal and industrial.
MWD = The Metropolitan Water District of Southern California.
NPS = National Park Service.
Reclamation = U.S. Department of the Interior, Bureau of Reclamation.
SAFCA = Sacramento Area Flood Control Agency.
SJR = San Joaquin River.
State Water Board D- = State Water Resources Control Board Decision.
State Water Board WR = State Water Resources Control Board Water Right Order.
SWP = State Water Project.
taf = thousand acre-feet.
taf/yr = thousand acre-feet per year.
USFWS = U.S. Fish and Wildlife Service.
VAMP = Vernalis Adaptive Management Plan.
wk/mon = week per month.
WQCP = Water Quality Control Plan.

released (e.g., by the SWP or the CVP for Delta export), or water diverted from another watershed.

Appropriative Water Rights

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, including Delta and upstream riparian water users, and to protect the public interest in fish and wildlife resources. To a varying degree, 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 between the major water supply projects.

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 Tracy facility to the DMC and San Luis Canal, and DWR pumps for export through the California Aqueduct and South Bay Aqueduct at its SWP Banks facility in CCF. DWR also operates the North Bay Aqueduct, which diverts water at the Barker Slough Pumping Plant. The State Water Board first issued water right permits to Reclamation for operation of the CVP in 1958 (Water Right Decision 893 [D-893]) and to DWR for operation of the SWP in 1967 (D-1275 and D-1291).

A third substantial diverter of Delta water is CCWD, which currently diverts water from Rock Slough under Reclamation's CVP water rights and from a second intake constructed on Old River near the State Route (SR) 4 Bridge that serves as the pumping plant for Los Vaqueros Reservoir (Contra Costa Water District and Bureau of Reclamation 1993). Several municipal users and many agricultural users also divert water from the Delta under riparian and appropriative rights.

Protection of Water Quality and Biological Resources

The Delta Protection Act of 1959 declared that the maintenance of an adequate water supply for agriculture, M&I use, and recreation in the Delta area and for export to areas of water deficiency was necessary for people of the state. Since issuing CVP's water right permit in 1958, the State Water Board has established permit terms and conditions to protect beneficial uses of Delta water. The State Water Board decisions and water quality control plans and other agency's requirements and proposed standards for protection of Delta resources are described below.

D-1485 and the 1978 Water Quality Control Plan

In 1978, the State Water Board adopted D-1485 and the Water Quality Control Plan for the Sacramento–San Joaquin Delta and Suisun Marsh (1978 Delta Plan). D-1485 modified the Reclamation and DWR permits to require the CVP and the SWP to meet water quality standards specified in the 1978 Delta Plan. The general goal of D-1485 standards was to protect Delta resources by maintaining them under conditions that would have occurred in the absence of CVP and SWP operations. D-1485 also required extensive monitoring and special studies of Delta aquatic resources.

Suisun Marsh Preservation Agreement

The State Water Board's D-1485 directed Reclamation and DWR to develop a plan to protect Suisun Marsh resources. The Suisun Marsh Preservation and Restoration Act of 1979 authorized the Secretary of the Interior to enter into a cooperative agreement with the State of California to protect the marsh and specified the federal share of costs for water management facilities. An agreement between federal and state agencies was signed in 1987 with the goal to mitigate the effects of CVP and SWP operations and other upstream diversions on water quality in the marsh. A salinity control structure (tidal gate) was completed on Montezuma Slough in 1988 that is operated during periods of relatively high salinity (i.e., during periods of low outflow) to reduce the salinity in Suisun Marsh channels.

Endangered Fish Species and Operations Criteria and Plan

The ESA requires assessment of the effect of water project operations on fish species listed under the ESA as threatened or endangered. Reclamation issued a summary description of its operations of the CVP and DWR's operation of the SWP in the OCAP, which was recently revised (Bureau of Reclamation 2003b). NOAA Fisheries issued its first biological opinion on the effects of SWP and CVP operations on winter-run Chinook salmon in February 1993, and USFWS issued its first biological opinion on effects of SWP and CVP operations on delta smelt and splittail in March 1995. The biological opinions establish requirements to be met by the SWP and the CVP to protect these listed species. These include requirements for Delta inflow, Delta outflow, DCC gate closure, and reduced export pumping to meet specified incidental "take" limits. These fish protection requirements imposed substantial constraints on Delta water supply operations, and many were incorporated in the 1995 WQCP. Recent biological opinions from NOAA Fisheries and the USFWS (National Marine Fisheries Service 2004; U.S. Fish and Wildlife Service 2004a) have been issued for operations of CVP and SWP, which replace the earlier biological opinions.

1995 Water Quality Control Plan and D-1641

The State Water Board’s 1995 WQCP (adopted May 1995(b)) and the State Water Board and Reclamation’s Final EIR for implementation (November 1999) incorporated several elements of the EPA, NOAA Fisheries, and USFWS regulatory objectives for salinity and endangered species protection. The changes from D-1485 regulatory limits for CVP and SWP Delta operations are substantial. The State Water Board implemented the 1995 WQCP with decision 1641 in March 2000. The new provisions for X2, export/inflow ratio, and the VAMP that are implemented in D-1641 will be described in the section on Delta water operations because these are the basis for the 2001 and 2020 baseline operations assumed in CALSIM.

California Water Resources

California’s water supplies come from surface water and groundwater sources that vary in distribution and volume depending on the annual climatic conditions throughout the state. California’s Mediterranean climate provides wet winters and dry summers throughout most of the state. Pacific storms bring rain and snow, typically from October through April. Average annual statewide precipitation is about 23 inches corresponding to a water volume of nearly 200 maf over California's land surface. About 60% of this precipitation is retained as soil moisture until returned to the atmosphere through evaporation from the soils and transpiration from trees and other vegetation. Some precipitation (5%) recharges the groundwater basins that underlie much of California’s land surface. The remaining 35% represents the state's average annual runoff of about 70 maf. Less than half this runoff is diverted for M&I or agricultural water supplies. The other half of California’s runoff water provides the streamflow and shallow groundwater that maintain diverse aquatic ecosystems in California’s rivers, estuaries, and wetlands (California Department of Water Resources 1998a).

Because agricultural and M&I demands are highest during summer, there is an imbalance between when water supply is available in California and when most of it is needed. Another water supply imbalance is created by the differences in runoff and demand between northern and southern California. More than 70% of the runoff comes from northern California but more that 75% of M&I and agricultural demand is south of the Delta.

California water supply development includes many local water supply projects, the CVP, the SWP and the Corps reservoir projects. Because of the seasonal pattern of runoff, storage reservoirs are generally needed for effective development of surface supplies in California. Some of these surface supplies are now used for required environmental flows below reservoirs and as outflow from the Delta. All of the SWP and CVP upstream-of-the-Delta stored water that is appropriated for use in south-of-Delta export areas must pass through the Delta and the CVP or SWP Delta pumping plants. The following discussions of CVP and SWP storage reservoirs are focused on those facilities that are most relevant to the proposed SDIP.

Central Valley Project and State Water Project Surface Water Supply

The CALSIM 2001 LOD simulations were used to provide an evaluation of the SDIP operational alternatives under existing conditions as required by CEQA. *Existing conditions* refers to the current system of CVP and SWP reservoirs, current CVP and SWP water supply demands, and current Delta water quality objectives and constraints as required under the D-1641 water rights decision.

The CALSIM 2020 LOD simulations were used to provide an evaluation of the SDIP operational alternatives under future no action conditions as suggested for federal projects under NEPA guidelines. However, both the 2001 and 2020 LOD simulations provide an evaluation of likely SDIP operational alternatives for an assumed repeat of the 1922–1994 historical sequence of rainfall and runoff conditions. Both simulations, therefore, include a similar sequence of reservoir inflows and un-impounded river runoff flows. The water supply conditions simulated by CALSIM with the 2001 and 2020 LOD differ by the effects from adjustments in land use and associated consumptive water losses for M&I and agricultural uses between current conditions (2001) and future conditions (2020).

This section presents existing (2001) and future (2020) water supply conditions in California that are relevant to the potential water supply effects of the SDIP and, therefore, is focused on CVP and SWP reservoirs. Only CVP or SWP water or water transfers to CVP or SWP contractors will be exported at the SWP Banks facility. The results from the CALSIM 2001 and 2020 baseline simulations of the CVP and SWP reservoir operations will be used to describe the general operations of these upstream-of-Delta reservoirs.

Many of the results from the CALSIM modeling with these two assumed LOD conditions are similar. Therefore, the potential environmental impacts that may result from the SDIP operational alternatives under these two LOD conditions are expected to be similar. The CALSIM 2020 baseline results are shown in comparison with the 2001 baseline results in this section to indicate the potential differences in the 2001 and 2020 CALSIM results. The 2001 project effects and the 2020 project effects have been separately evaluated in the impact assessments in other sections (e.g., Delta hydraulics and water quality, aquatic resources, vegetation). The potential environmental impacts resulting from the SDIP are fully disclosed and fully evaluated in Chapter 5 and Chapter 6 resource sections showing only the 2001 CALSIM results because the 2020 impact evaluations are similar. Results from the 2001 and 2020 impact assessments are presented in Appendix I, "Results from CALSIM II Modeling of the SDIP Alternatives," and data files that can be obtained from the SDIP ftp website at:

ftp://ftpmodeling.water.ca.gov/pub/sdelta/

Trinity River Division

The CVP Trinity River Division, completed in 1964, includes facilities to store and regulate water in the Trinity River and facilities to transfer water to the Sacramento River basin. Photograph 5.1-1 shows the Trinity Dam and powerhouse. Trinity (previously Clair Engle Lake) Reservoir (formed by Trinity Dam) has a maximum storage capacity of approximately 2.4 maf. All releases from Trinity Dam are re-regulated downstream at Lewiston Reservoir to meet downstream flow requirements, and supply exports through Clear Creek tunnel and the Judge Francis Carr Power Plant to Whiskeytown Reservoir (Photographs 5.1-2 and 5.1-3). Spring Creek tunnel and power plant conveys the exported water to Keswick Dam, located on the Sacramento River below Shasta Dam. The mean annual flow into Trinity Reservoir is approximately 1.2 maf, and the instream flow requirements range from about 350 taf to 800 taf, depending on the Trinity runoff volume. Flood control is not an authorized purpose of Trinity Reservoir, but Reclamation maintains some vacant storage space in the winter months, consistent with the Department of Safety of Dams [DSOD] guidance. Trinity Reservoir is also operated to meet temperature objectives for special-status species in the Trinity River and in the upper Sacramento River. More details of the operational constraints and objectives for the Trinity River Division facilities are described in the OCAP BA (Bureau of Reclamation 2003b).

Figure 5.1-1 shows the annual sequence of carryover storage in Trinity Reservoir for the 2001 and 2020 baseline simulations. The absolute minimum storage simulated was about 250 taf in a few years. Several other years have storage of about 500 taf. The typical carryover storage is between 1 maf and 2 maf. Only in the drought year sequences (i.e., 23–26, 29–37, 77, and 87–92) was the simulated carryover storage less than 1 maf.

Figure 5.1-2 shows the monthly cumulative distribution (range) of simulated Trinity Reservoir storage (taf) for the 2001 baseline (existing conditions) and the 2020 baseline (future no action) for the 1922–1994 period of historical inflows. The monthly values are sorted from minimum to maximum, and for the 73-year simulation period the 10-percentile values from the cumulative distribution (i.e., lowest, 8th, 15th, 22nd…73rd lowest) are used to summarize the probability of reservoir storage for each month. For example, the minimum September (carryover) storage value was 240 taf, the median (50%) storage value was 1,351 taf, and the maximum storage value was 1,975 taf (see Table I-1). The graphs show these percentile values for each month, along with the average storage for each month. For Trinity Reservoir, the maximum storage is held at about 1,800 taf from October through December. The reservoir is normally filled to the highest storage level in April–June, and then is drawn down through the end of September. The probability that Trinity Reservoir carryover storage will be between 250 taf and 2,000 taf is described by the distribution of the 10-percentile lines at the right-hand side of the graph.

Figure 5.1-3 shows the monthly cumulative distribution of Trinity River flows as simulated with CALSIM for the 2001 and 2020 baseline conditions for 1922–1994 (see Table I-2). The Trinity River fisheries restoration flows have been partially implemented in the 2001 simulation. The minimum annual fish flow releases are about 350 taf in the winter. The flows are held at 450 cfs in the summer months, with higher flows in April, May (peak flushing flows), and June. Only rarely are there additional spills from Trinity Dam. The full recommended restoration river flows that are implemented in the 2020 baseline increase the required flows in May and June of above normal and wet years. The increased 2020 baseline river flows will average 144 taf/yr. More than 150 taf will be required in 45 of the 73 years.

Figure 5.1-4 shows the monthly cumulative distribution of CALSIM-simulated exports from the Trinity River to the Sacramento River (see Table I-3). The 2001 baseline exports average about 730 taf/yr, with a range of 210 taf/yr to 1,553 taf/yr. The months of highest export are June–October, corresponding to temperature control requirements in the Sacramento River and CVP water supply demands in the Sacramento River and San Joaquin River basins. These months also correspond with the highest demands for the hydroelectric energy produced by these exports through Carr and Spring Creek power plants. The Trinity exports are reduced by an average of 144 taf/yr, the same amount that is used for increased Trinity River flows in the 2020 baseline.

Shasta Reservoir

Runoff from the upper Sacramento River and tributaries are regulated by the CVP Shasta Dam (Photograph 5.1-4) and re-regulated downstream at Keswick Dam. The watershed above Shasta Dam drains approximately 6,650 square miles and produces an average annual inflow of about 6 maf. Inflows generally increase from November through March with peak flows generally occurring in March. As snowmelt is not the dominant component of Shasta inflows, runoff generally decreases in April and May and inflow is less than 5,000 cfs from June through October.

Figure 5.1-5 shows the monthly cumulative distribution of the CALSIM-simulated Shasta storage for 1922–1994 under the 2001 and 2020 baseline conditions (see Table I-4). Maximum Shasta Reservoir storage of about 4.5 maf occurs in April–June. About 1.3 maf of storage space is reserved for flood control with the full amount of this flood control reserve available in December. From January to June 15 the flood control space depends on a wetness parameter calculated from the antecedent inflow. The objective is to allow filling of the reservoir, recognizing the need to maintain sufficient space consistent with basin wetness. The flood control management is the responsibility of the Corps. Storage usually increases from January through April and decreases from June through October. The Shasta carryover storage is reduced by an average of 94 taf in the 2020 baseline. The annual reductions in carryover storage are generally less than 15% of the 2001 carryover storage values.

Figure 5.1-6 shows the Shasta carryover storage is generally held above 2 maf for water temperature control purposes, but is simulated to be less than 2 maf in about 20% of the years. The NOAA Fisheries 2004 biological opinion for OCAP recognizes that in the driest 10% of hydrologic conditions, Shasta storage may be less than 1.9 maf, and requires reconsultation under those conditions. The simulated carryover storage is less than 1,500 taf in about eight of the years. The carryover storage is held between 2,500 taf and 3,500 taf in more than half of the years. The 2020 Baseline conditions are simulated to be very similar by CALSIM, although the 2020 baseline has lower Trinity exports.

Figure 5.1-7 shows the monthly cumulative distribution of the Keswick Dam release flows simulated by CALSIM for the 2001 and 2020 baseline conditions (see Table I-5). The highest releases occur in the months of June–September. The minimum fish flows vary by month and with water-year type. Flood control spills occur in some months of most years. The Keswick flows are managed to meet minimum fish flows, temperature control requirements for special-status species, flood control requirements, and the navigation control point flow requirements, in addition to downstream water supply demands of CVP contractors along the Sacramento River and south of the Delta. More details of the operational constraints and objectives for the Shasta Division facilities are described in the OCAP BA (Bureau of Reclamation 2003b).

Photograph 5.1-5 shows the Keswick Dam and powerhouse. Photograph 5.1-6 shows the Red Bluff Diversion Dam (RBDD) and the intake channel for the Tehama-Colusa Canal. The Keswick flows represent the combination of CVP water supply from Shasta and CVP supply exported from Trinity. The annual releases range from less than 4 maf in 5 years to more than 10 maf in 4 years. The reduction of 143 taf in the 2020 baseline (because of reduced Trinity exports) is about 2% of the 2001 baseline average Keswick release volume of 6,263 taf/yr.

Oroville Reservoir

Oroville Reservoir was completed in 1968. It is the major SWP storage reservoir with a maximum capacity of about 3.5 maf (Photograph 5.1-7). Other facilities include the Feather River Fish Hatchery ladder, raceway, and barrier (Photographs 5.1-8 and 5.1-11); the Thermalito Forebay and Afterbay (Photograph 5.1-9); and the Thermalito powerhouse (Photograph 5.1-10), which allows power generation and pumped-storage operations between the afterbay and forebay. However, the Hyatt power plant inlets (i.e., selective withdrawal for temperature control) are located at an elevation that provides a minimum storage volume of about 1 maf for hydropower purposes. The CALSIM model simulates drawdown of Oroville Reservoir below the 1-maf minimum in a few years by assuming that releases would bypass the Hyatt powerhouse (using river outlets). The effective seasonal and year-to-year drawdown is therefore limited to 2.5 maf. The average annual inflow to Oroville Reservoir is about 4 maf, and is a combination of rainfall runoff and snowmelt. Monthly flows are greater than 2,000 cfs (80% exceedance) from January through June. Summer flows are well sustained at above 1,000 cfs (80% exceedance) because of snowmelt and springs from the high-elevation watershed. Releases from Oroville flow into the Thermalito Reservoir complex, that provides a storage facility (i.e., afterbay) to allow pumped-storage operations at the Hyatt Power Plant and diversions to supply the 915 taf of water rights held by Feather River water districts. A release of 600 cfs is made to the river in all months to provide spawning and attracting flows for the Feather River hatchery. More details of the operational constraints and objectives for SWP Feather River facilities are described in the OCAP BA (Bureau of Reclamation 2003b).

Figure 5.1-9 shows the monthly cumulative distribution of the CALSIM-simulated Oroville storage for 1922–1994 under the 2001 and 2020 baseline conditions (see Table I-7). Maximum Oroville Reservoir storage occurs in April–June. About 700 taf of the maximum storage is reserved for flood control space between December and March. Storage usually increases from January through April and decreases from June through October. The 2020 baseline Oroville carryover storage is reduced by an average of 52 taf from the 2001 baseline values. These annual reductions are generally less than 10% of the CALSIM 2001 carryover storage values.

Figure 5.1-8 shows the Oroville Reservoir carryover storage simulated by CALSIM for the 2001 baseline conditions for the 1922–1994 hydrology. The carryover storage is highly variable, from a low carryover storage of about 1 maf (except 1977 with a simulated carryover storage of less than 500 taf) to a maximum carryover storage of more than 3 maf in about 20% of the years. The 2020 carryover storage pattern is very similar to the 2001 carryover storage pattern.

Figure 5.1-10 shows the monthly cumulative distribution of the Feather River flows below the Thermalito release simulated by CALSIM for the 2001 and 2020 baseline conditions (see Table I-8). The Feather River flows below Thermalito are generally regulated by the minimum fish flows (of about 1,000 cfs) and the downstream water supply demands of SWP for Delta export pumping. The summer flows average more than 5,000 cfs in June–August, and the average September flow is less than 2,000 cfs. Flow volumes vary with runoff conditions, and the average annual release volume is about 3 maf, with a minimum volume of 1 maf in several dry years, and a maximum release volume of 8 maf in 1983 (Table I-8). The CALSIM 2020 annual release volumes are slightly increased by an average of 28 taf/yr compared to the CALSIM 2001 baseline values. These annual changes are generally less than 10% of the 2001 baseline values.

Folsom Reservoir

Folsom Reservoir was constructed by the Corps between 1948 and 1956 and is operated as a unit of the CVP by Reclamation. Folsom Dam impounds a maximum of about 1 maf and is a multi-purpose reservoir that provides flood control and seasonal water storage for recreation, power, water supply, and minimum fish protection flows in the American River and the Delta. Several major reservoirs upstream in the Sierra Nevada have been constructed by other agencies with a total of 1,000 taf of storage that provide flood control and seasonal storage and power benefits. Nimbus Dam, located 7 miles downstream, provides re-regulation of the Folsom releases and diversion to the Folsom South Canal. Photograph 5.1-12 shows the Nimbus Dam and Folsom South Canal and Nimbus Fish hatchery. Total diversions from the American River are estimated in the 2001 CALSIM baseline model to be about 400 taf/yr.

Figure 5.1-11 shows the monthly cumulative distribution of CALSIM-simulated Folsom storage for 1922–1994 under the 2001 and 2020 baseline conditions (see Table I-9). Maximum Folsom Reservoir storage of 975 taf usually occurs in May–June. About 400 taf of the maximum storage is reserved for flood control space between December and March. Storage usually increases from January through May and decreases from July through November. More details of the operational constraints and objectives for the American River Division facilities are described in the OCAP BA (Bureau of Reclamation 2003b).

The average Folsom carryover storage under the 2001 CALSIM baseline was 489 taf. The Folsom carryover storage under the 2020 CALSIM baseline conditions was reduced by an average of 22 taf because of the increased deliveries from Folsom to satisfy the increased demands.

Photograph 5.1-13 shows the Folsom Dam and powerhouse with the spillway operating. Figure 5.1-12 shows the Folsom Reservoir carryover storage at the end of September. The reservoir storage is always less than 650 taf in preparation for rainfall flood control storage reservation in November–March. Carryover storage is above 600 taf in about 40% of the years and storage is less than 200 taf in the driest 10% of the years (Table I-9).

Figure 5.1-13 shows the monthly cumulative distribution of Nimbus Dam releases for 1922–1994 under the 2001 and 2020 baseline conditions (see Table I-9). Water supply diversions of about 400 taf/yr are taken from Folsom Reservoir and the Folsom South Canal in the 2001 CALSIM baseline simulations. These diversions are increased to supply the increased demands in the 2020 baseline simulation. The average reduction in Nimbus release for the 2020 CALSIM baseline was about 150 taf/yr, representing an average decrease in Nimbus releases of 6% from the 2001 baseline flows.

New Melones Reservoir

Figure 5.1-14 shows the monthly cumulative distribution of New Melones Reservoir storage values simulated with CALSIM for 1922-1994 under the 2001 and 2020 baseline conditions (see Table I-13). Operation of New Melones is governed by the interim operations plan, and includes higher-than-historical releases for anadromous fish in April and May as part of the CVPIA (b)(2) water management program. Maximum storage of about 2,500 taf is achieved only in a few sequences of relatively wet years. Oakdale and South San Joaquin Irrigation Districts have exchange contracts for 600 taf from New Melones Reservoir, which provides considerable year-to-year storage protection for these water-right holders. New Melones usually reaches seasonal maximum storage in June or

July from snowmelt. More details of the operational constraints and objectives for the Stanislaus River Division facilities are described in the OCAP BA (Bureau of Reclamation 2003b).

Photograph 5.1-14 shows the New Melones Dam and powerhouse. Figure 5.1-15 shows the New Melones Reservoir carryover storage simulated as the 2001 baseline conditions by CALSIM for the 1922–1994 hydrology. The carryover storage is highly variable, dependent on the sequence of hydrology. Storage is above 2,000 taf in about 10% of the years. Storage normally declines in subsequent years and may drop below 1,000 taf in drought sequences. The storage was simulated to drop to about 500 taf in the 1931–1934 drought sequence and the 1990–1992 sequence. The 2020 baseline simulation of New Melones carryover storage is similar. The maximum difference between 2020 carryover values and 2001 carryover values was 12 taf (Table I-13). The CALSIM model does not indicate many changes in the San Joaquin River Basin between the 2001 and 2020 baseline simulations, because the reservoir operations assumptions remain the same for 2001 and 2020 conditions.

Figure 5.1-16 shows the monthly cumulative distribution of Stanislaus River releases from Goodwin Dam simulated with CALSIM for 1922–1994 under the 2001 and 2020 baseline conditions (see Table I-14). Goodwin Dam is the location of irrigation diversions for the South San Joaquin and Oakdale Irrigation Districts (i.e., total of 600 taf/yr). These CVP release flows provide required minimum fisheries flows, provide additional flushing flows during the spring period of Chinook salmon outmigration (i.e., during April and May; included as part of the (b)(2) water allocation), and help control salinity on the San Joaquin River at Vernalis. The average release is 626 taf/yr, but ranges from only about 300 taf/yr in dry years to more than 2,000 taf/yr in a few wet years (as a result of reservoir flood control spills). The largest change between 2001 CALSIM annual flow volumes and 2020 CALSIM annual flow volumes was 8 taf/yr.

Sacramento River Flows at Freeport

Figure 5.1-17 shows the CALSIM-simulated monthly cumulative distribution of Sacramento River flows at Freeport for the 2001 and 2020 baseline conditions for the 1922–1994 hydrology with existing reservoirs and regulatory limits (see Table I-11).

The CALSIM 2001 baseline annual flow volumes for the Sacramento River at Freeport ranged from a minimum of 6,667 taf in 1977 to a maximum of 35,345 taf in 1983, with an average of 16,106 taf/yr. The CALSIM 2020 annual values ranged from 6,409 taf in 1977 to 34,973 taf in 1983, with an average of 16,072 taf/yr. Very high flows bypass the Sacramento River channel at Freeport and enter the Delta through the Yolo Bypass (see Table I-12).

On a year-by-year basis, the changes from 2001 baseline to the 2020 baseline values ranged from a decrease of 533 taf in 1958 to an increase of 519 taf in 1978. The average annual change was a decrease of 34 taf/yr. This represents a decrease of 0.1% of the long-term 2001 baseline Sacramento River Delta inflow volume. The CALSIM 2020 annual values were reduced by a maximum of 3.9% in 1977 and increased by a maximum of 2.7% in 1978 compared to the CALSIM 2001 baseline values.

The individual monthly differences between 2001 and 2020 baseline values are likely to be more variable than the annual values or the long-term (i.e., 73-year) average value. A reservoir may spill slightly earlier if the carryover storage is slightly more and increase the Sacramento River flow. A higher storage may trigger a slightly higher AFRP release flow and (b)(2) action at Shasta or Folsom that would increase the Sacramento River flow. The SWP delivery logic may change the monthly release from Oroville and change the Freeport flows. The CVP delivery logic may change the monthly pattern of releases from Shasta or Folsom and change the Freeport flows. Monthly changes of more than 10% of the average Freeport flow (i.e., 2,246 cfs) were simulated in 58 of the 876 simulated months (7%). Monthly changes of more than 5% of the long-term average flow (i.e., 1,123 cfs) were simulated in 161 (18%) of the 876 simulated months (see Table I-11c). This indicates the tendency for the CALSIM model to make many small changes in the monthly flow values within each year, without substantially changing the annual or long-term results. Although there may be a considerable number of months with changes, the annual values that characterize the CVP and SWP water supply conditions in the Delta are similar for the CALSIM 2001 and the CALSIM 2020 results.

San Joaquin River Flows at Vernalis

Figure 5.1-18 shows the CALSIM simulated monthly cumulative distribution of San Joaquin River flows at Vernalis for the 2001 and 2020 baseline conditions for the 1922–1994 hydrology (see Table I-19). 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 generally regulated to minimum required flows during the summer and fall period. The great majority of the San Joaquin River flows are less than 5,000 cfs. The simulated flows for 2001 and 2020 baselines are similar because the reservoir operation assumptions for these San Joaquin River reservoirs are the same for the 2001 and 2020 CALSIM simulations.

Because the Vernalis flows are adjusted for the VAMP period (April 15 to May 15), the CALSIM model calculates flows and corresponding CVP and SWP exports using two calculation periods (i.e., cycles) for each month. The first half of April and the second half of May indicate the San Joaquin River flows without the VAMP pulse flow. The additional flow in the second half of April and first half of May is assumed to be supplied by upstream water districts as part of the VAMP program. The target pulse flows during VAMP range from 2,000 cfs to 7,000 cfs. No VAMP flows are required in some dry year sequences. Tables I-

14a and I-14b include the annual flow volumes (taf) and the annual variation between the 2001 values and the 2020 values.

The CALSIM 2001 baseline annual flow volumes for the San Joaquin River at Vernalis ranged from a minimum of 833 taf to a maximum of 13,927 taf, with an average of 2,660 taf/yr (3,674 cfs). The CALSIM 2020 annual values ranged from 832 taf to 13,854 taf, with an average of 2,587 taf/yr (3,573 cfs). The average change was a decrease of 73 taf/yr. Some of this reduction can be attributed to the lower initial storage value for New Don Pedro Reservoir used in the 2020 CALSIM simulations. This represents a decrease of 2.7% of the long-term 2001 baseline value. The CALSIM 2020 annual values were changed by more than 5% of the annual baseline value in 9 years. Table I-14c shows the differences in Vernalis monthly flow (cfs) between the 2020 baseline and the 2001 baseline values.

Although there may be a considerable number of months with changes of more than 10% of the 2001 baseline monthly flow, and a few years with more than a 5% change from the 2001 baseline flow, the long-term CALSIM 2020 Vernalis flow was reduced by just 2% (adjusted for the different initial New Don Pedro storage value) from the CALSIM 2001 results.

The total inflow to the Delta, represented by the Freeport and Vernalis flows, is just 0.5% less than the 2001 baseline. This suggests that the 2020 CALSIM-simulated Delta inflow future no action conditions are similar to the 2001 CALSIM-simulated baseline existing conditions.

Water Transfers

The passage of the CVPIA in 1992 changed the operating rules of the CVP contractors to allow water transfers among users in prescribed situations. In 1996, the SWP negotiated the “Monterey Agreement” which changed the operating rules of the SWP to allow banking and limited water transfers among SWP contractors. These changes allow a limited water market within these projects.

The California Legislature passed several laws in the 1980s and 1990s making it easier to transfer water beyond the boundaries of historical water service areas. These laws are aimed at protecting water users who are not a party to the transfer and also protect fish and wildlife from being “injured” or “unreasonably affected” by the transfer. These laws developed an expedited process for the State Water Board to expand the water rights (i.e., place of use) of those conducting a short-term (i.e., 1-year) water transfer.

In recent years, extensive water transfers across the Delta have occurred. Almost 800 taf were purchased for transfer in 1991 as a part of DWR’s Drought Water Bank, still the largest water transfer year of record. Beginning in 1995, California experienced a series of higher-than-normal runoff years, and the need for water transfers decreased substantially. In 2001 (a dry year) EWA transferred

105 taf, and other parties transferred 360 taf for other beneficial uses, making use of the CVP and SWP pumping plants for diversion and conveyance from the Delta. In 2002, EWA transferred 142 taf from upstream of the Delta, and other parties transferred additional water through the Delta (California Department of Water Resources 2000b).

Although some additional water transfers could occur without the SDIP, the SDIP 8,500 cfs alternatives are expected to increase the ability of CVP and SWP contractors to transfer water across the Delta and convey the water in the California aqueduct to the place of beneficial use within the water district purchasing the water. A preliminary analysis of the water transfer capacity with the 8,500 cfs SDIP alternatives compared with the transfer capacity under existing conditions is included in this water supply evaluation. Figure 4-2 depicts the potential increase in transfers that could occur under each of the SDIP alternatives.

Central Valley Project and State Water Project Water Demands and Deliveries

Understanding the CVP and SWP water supply demands is important for evaluating the water supply effect from the SDIP alternatives.

Bulletin 160-98 indicates that the M&I water use in California was about 9 maf in 1995. The projected M&I water use is expected to rise to about 12 maf by 2020. This forecast of future M&I water use is based on population information and per capita water use estimates, and includes an expected demand reduction of 10% from water conservation programs.

Bulletin 160-98 also indicates that the current (1995) agricultural water use in California is about 34 maf. The projected agricultural water use is expected to decline slightly to about 32 maf by 2020 (a 6% reduction). This forecast of future agricultural water use is based on cropland projections that indicate irrigated cropland will decline from 9.5 million acres to about 9.2 million acres (a 3% reduction). The remaining reduction in agricultural water use will presumably be the result of more intensive water conservation and recycling efforts and changes in cropping.

For evaluating water supply conditions, there are different types of “years.” The WY begins on October 1 and runs through September 30. The WY is often used in California to divide the rainfall and runoff sequence at a time when rainfall and runoff is lowest. The WY is also convenient for reservoir operations studies because most reservoirs are drawn down to near their lowest levels near the end of September. The SWP uses the calendar year period of January–December for the delivery contract year, but the CVP delivery contract year runs from March through the following February.

The CALSIM model uses the WY as the basic modeling interval, and currently simulates WY1922 through WY1994 (73 water years). Therefore, only 71 full SWP delivery or CVP contract years are simulated in the 1922–1994 WY simulation period. Water year delivery patterns in CALSIM depend on the previous contract year's delivery allocation for the October–December SWP delivery values and the October–February CVP delivery values. However, CALSIM results for both SWP and CVP deliveries are reported by water years.

2001 and 2020 CALSIM Water Demands

The CALSIM monthly CVP and SWP operations model uses local inflows (runoff below major CVP and SWP reservoirs) that are based on the historical tributary flows and the changes from historical conditions that are expected based on the current (2001) or projected future (2020) land use and corresponding water use within the tributary basins. The assumptions used for land use result from historical survey and projected data developed for Bulletin 160-98.

Demands in the Sacramento River Basin, including the Feather River, are determined based on land use for each depletion study area (DSA), together with the various water rights, exchange contracts and other agreements. Total demands are divided into CVP, SWP, and non-project demands. Non-project demands may be partially satisfied from sources other than the CVP and SWP facilities. Nevertheless, non-project demands are assumed to be riparian or higher priority appropriative water rights, and they are always satisfied in CALSIM. Only SWP and CVP project demands are subject to reduced water allocations, and only SWP and CVP demands may not be satisfied if the water supply is limited in the CALSIM model. Non-project demands or excess local supplies are the only source for water transfers to CVP or SWP contractors that are facing a delivery deficit in drier years. CVP contracts in the Sacramento Valley, excluding the American River Basin, consist of Settlement contracts (approximately 2.2 maf) and agricultural service contracts (approximately 460 taf). Feather River Service Area (FRSA) demands are approximately 1 maf and are supplied by diversions from the Feather River at the Thermalito forebay and afterbay reservoirs.

Surface water deliveries are expected to increase substantially in the American River basin. The Water Forum Agreement provides for some surface diversion reductions from the American River in low runoff years. The CALSIM model assumes that American River basin demands will increase from about 300 taf in 2001 to about 600 taf in 2020.

Demands in the San Joaquin River Basin are generally set to fixed annual amounts and are assumed to be fully satisfied by the reservoir operations in CALSIM. This surface water supply from the San Joaquin River and tributaries (total of about 4.5 maf) is assumed to be taken upstream of the San Joaquin River inflow to the Delta at Vernalis. Although the Friant Dam and the Friant-Kern and Friant-Madera canals are a unit of the CVP, the CALSIM model does not link the San Joaquin reservoir operations to any CVP or SWP operations in the Delta or south of the Delta.

Central Valley Project Water Supply Demands

South-of-Delta CVP demands include agricultural and M&I needs served from the San Luis Reservoir and San Felipe Unit, the Cross Valley Canal, the DMC and Mendota Pool. 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 are estimated in the CALSIM model based on reservoir storage and projected hydrologic conditions. These CVP demands also contain exchange contractors, refuge water supplies, and operational losses. Monthly demand patterns are determined based on recent historical CVP deliveries.

The CALFED 2002 Water Supply Benchmark studies using the CALSIM model provides a detailed description of the components of the CVP demand that must be supplied from the CVP Tracy facility. The total CVP water supply demand at the CVP Tracy facility is about 3,045 taf/yr. There is an additional Cross Valley Canal demand of 128 taf/yr that the SWP has agreed to “wheel” (pumps for CVP at the SWP Banks facility) to allow an exchange of CVP Friant water. There is now a requirement under the CVPIA for CVP to deliver Level 2 wildlife refuge supplies. The Level 2 water supplies, including conveyance losses, total about 300 taf/yr for refuges located in the San Joaquin River and Tulare River basins that must be supplied from CVP Tracy pumping. The CVP losses are assumed to be about 185 taf/yr (about 5% of demands) in the CALSIM benchmark studies.

These combined CVP demands are approximately 3,350 taf/yr. Almost all of the CVP Tracy water supply is for agricultural uses, representing about 10% of the total California agricultural water supply. With the implementation of the CVPIA, CVP demand exceeds permissible CVP Tracy pumping capacity and full CVP deliveries must rely on SWP wheeling of some of these CVP Tracy demands.

State Water Project Water Supply Demands

The 29 SWP contractors that divert from the Delta have a total Table A amount of 4,133 taf/yr (California Department of Water Resources 2002b). This is the maximum demand that the SWP is obligated to meet. Additional SWP pumping can occur under Article 21 of the contracts when there is surplus Delta flow and the SWP portion of San Luis Reservoir is full. These additional Article 21 deliveries can typically be made in the wet months of December–March once the SWP portion of San Luis Reservoir is full.

Metropolitan is the largest SWP contractor, with a Table A amount of 2 maf. There are 12 other contractors in southern California, with Table A entitlements that total 580 taf, whose water must also be pumped over the Tehachapi

Mountains through the Edmonston Pumping Plant (maximum capacity of 3,250 taf/yr). The Edmonston Pumping Plant therefore provides a limit for the SWP deliveries to southern California, since a maximum of 3.25 maf can be pumped. When operating all 14 units, the plant can pump 320 cfs per unit, or 4,480 cfs, each day of the year. One unit is normally held in reserve, so the maximum delivery over the Tehachapi Mountains to Southern California contractors is limited to about 3 maf. Delivery of the maximum Table A entitlements of 2.58 maf would require operating the Edmonston pumping units at about 85% of capacity.

The San Joaquin Valley agricultural contractors have a combined entitlement of about 1.2 maf (the Kern County Water Authority has an entitlement of 1 maf). The South Bay aqueduct has a total entitlement demand of 220 taf. The North Bay aqueduct supplies an entitlement demand of about 76 taf, but this is not pumped at the SWP Banks facility.

The highest annual delivery made by the SWP (through 2002) was about 3.5 maf in 2000 (California Department of Water Resources 2002b). As the SWP contractor requests for the full Table A amount increase with population growth, the need to use the SWP facilities at their full design capacity will also increase. The SDIP will increase the operating flexibility of the SWP Banks facility and allow a greater fraction of the SWP Table A entitlements to be delivered to SWP contractors (i.e., increased water supply reliability).

The SDIP is expected to make some improvements in SWP water supply reliability, without having any major impacts on the CVP or on local water supplies, including the water diversions that supply agricultural water needs in the south Delta. This water supply section presents information to document the magnitude of the expected improvement in water supply reliability (based on the CVP and SWP planning model CALSIM II results), and describe the potential effects of increased SWP pumping on CVP exports and local south Delta diversions.

Example of Central Valley Project and State Water Project Delivery Patterns for Water Year 1994

CVP and SWP Delta operations and deliveries for WY 1994 are shown to illustrate the actual daily patterns of CVP and SWP operations. WY 1994 is the last in the CALSIM hydrology sequence, but was prior to the 1995 WQCP and D-1641 that changed the Delta objectives substantially. The 1994 pumping and delivery patterns illustrate the typical variations that occur within each water year. WY 1994 was classified as a critical year, and the SWP allocations were 50% of Table A contract amounts. The CVP allocations were also quite limited for 1994.

CVP Tracy is unable to directly supply the CVP demands of about 3,300 taf/yr because the CVP demands occur predominantly in the summer irrigation season. Because CVP Tracy can supply a maximum of about 275 taf each month, pumping must be sustained for all 12 months to meet the simulated demands. However, the CVP monthly demands are much higher than 275 taf during the irrigation season. Therefore, the CVP portion of the San Luis Reservoir (about 1,000 taf) is needed to satisfy the CVP monthly demands during the summer months.

Figure 5.1-19 shows the historical CVP Tracy pumping during WY1994 (the final year of the CALSIM simulation period). The historical CVP pumping was much lower than the 4,600 cfs capacity for several months in the spring and summer months, because CVP San Luis Reservoir filled in early January, and water supply conditions were relatively dry during the spring. The total pumping at CVP Tracy was about 2,025 taf for the year. The deliveries reached 10,000 cfs for some days in July, with a July average delivery of about 480 taf (7,800 cfs average). The total historical CVP deliveries for WY1994 were 2,300 taf.

Figure 5.1-20 shows the historical CVP San Luis storage, which began at a moderately high carryover storage of 350 taf and filled to the CVP maximum of 966 taf by the first week in January. The highest releases from storage of about 7,000 cfs were made in June and July to satisfy the peak summer CVP demands (i.e., limited water supply allocation). The CVP storage at the end of WY1994 was about 85 taf. Part of the annual CVP deliveries during WY1994 came from the 265-taf drawdown of CVP San Luis Reservoir storage during the year, from 350 taf to 85 taf.

Figure 5.1-21 shows the historical SWP Banks pumping and SWP deliveries during WY1994. The seasonal SWP deliveries were higher than the SWP Banks pumping during the summer irrigation season. The historical WY1994 SWP Banks pumping was about 2,000 taf, and the historical SWP deliveries were 2,525 taf. This is much less than the SWP full Table A contractual demands of 4,200 taf. Maximum permitted SWP pumping at 6,680 cfs did occur during October and in December. Very little SWP pumping was allowed in the April–June period of 1994.

Figure 5.1-22 shows the historical SWP San Luis Reservoir storage that began almost filled at 950 taf and was still about 400 taf at the end of WY1994. Part of the annual SWP deliveries during WY1994 was supplied by this drawdown of about 550 taf. SWP deliveries during WY1994 were less than the full SWP Table A amount, and the high initial carryover storage in San Luis Reservoir from WY1993 reduced the need for SWP Banks pumping. As the SWP demands increase towards the full SWP entitlement of 4,200 taf, the need for full SWP Banks pumping will also increase. The SDIP would increase the flexibility of SWP operations and make full SWP deliveries more reliable.

Central Valley Project and State Water Project Delta Facilities and Operations

The following description of CVP and SWP facilities and operational constraints in the Delta is provided to establish current operational conditions needed to evaluate project alternatives for water supply conditions.

Central Valley Project Delta Facilities

The CVP Tracy facility, about 5 miles north of Tracy, consists of six pumps including one rated at 800 cfs, two at 850 cfs, and three at 950 cfs (Photograph 5.1-15). Maximum pumping capacity is about 5,100 cfs. The CVP Tracy facility is located at the end of an earth-lined intake channel about 2.5 miles long. At the head of the intake channel, “louver” screens that are part of the CVP Tracy Fish Collection Facility intercept fish, which are then collected and transported by tanker truck to release sites away from the pumps. Photograph 5.2-16 shows the CVP DMC at mile post 4.0, conveying water south toward the O’Neil Forebay and Mendota Pool.

Other CVP facilities in the Delta include the Delta Cross Channel (DCC) and the Contra Costa Canal (CCC). The DCC is a gated diversion channel, just over a mile long, connecting the Sacramento River near Walnut Grove with Snodgrass Slough. Flows into the DCC from the Sacramento River are controlled by two 60-foot by 30-foot radial gates. When the gates are open, water flows from the Sacramento River through the DCC to natural channels of the lower Mokelumne and San Joaquin Rivers and toward the interior Delta to supply the CCC and the CVP Tracy facility in the south Delta and improve water quality by reducing saltwater intrusion from Antioch.

The CCC originates at Rock Slough, about 4 miles southeast of Oakley, and supplies the CCWD. The canal and associated facilities are part of the CVP, but are operated and maintained by the CCWD. CCWD now also operates a diversion on Old River just south of the SR 4 Bridge that provides the intake for Los Vaqueros Reservoir and connects with the CCC; however, this intake and Los Vaqueros Reservoir are not CVP facilities.

Central Valley Project Delta Pumping Capacity

The CVP Tracy facility has an authorized capacity of 4,600 cfs. This is equivalent to 9,125 acre-feet per day (af/day). Table 5.1-2 compares the CVP monthly demands to the maximum possible CVP Tracy 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 typical CVP demands.

If the CVP Tracy pumps were at maximum capacity for the entire year, they could deliver about 3,330 taf/yr 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 DMC capacity generally declines to about 4,200 cfs. CVP Tracy pumping is limited during the October–June period when diversions from the upper DMC (near CVP Tracy) are low. A CVP delivery of 3,000 taf would require CVP Tracy pumping at an average of more than 90% capacity for the entire year. This is a very high “load factor” for a pumping facility. The demand for water pumped at the CVP Tracy facility is currently greater than 3,000 taf/yr. The CVP, therefore, depends on wheeling capacity at SWP Banks to deliver some of this water each year.

The CVPIA has introduced additional constraints on the CVP Tracy pumping capacity. A portion of the Section (b)(2) water that is dedicated to anadromous fish restoration purposes (maximum of 800 taf) is normally allocated by USFWS to reduced 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 Tracy facility to supply the full CVP demands. During some wet years, flows from the upper San Joaquin River (i.e., Friant Dam) and the Kings River can meet San Joaquin River Exchange Contractor demands at the Mendota Pool and allow CVP Tracy pumping to supply other CVP contractor demands.

Table 5.1-2. CVP Tracy Pumping Plant Demands and Pumping Capacity

Month	Monthly CVP Tracy Demand (taf)	Maximum Volume at 4,600 cfs Tracy Capacity (taf)	Additional Needed from San Luis Reservoir (taf)
October	204	283	–
November	123	274	–
December	107	283	–
January	137	283	–
February	166	255	–
March	192	283	–
April	236	274	–
May	344	283	61
June	502	274	228
July	583	283	300
August	476	283	193
September	262	274	–
Total	**3,332**	**3,330**	**784**

cfs = cubic feet per second.
taf = thousand acre-feet.

State Water Project Delta Pumping Capacity

SWP Banks 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 is theoretically capable of pumping 7,493 taf each year. Photograph 5.1-17 shows SWP Banks. Photograph 5.1-18 shows the SWP California Aqueduct just south of the SWP Banks facility conveying water south along the I-5 (toward O'Neil Forebay) with the DMC on the right.

The current permitted CCF diversion capacity of 6,680 cfs would provide a maximum of about 4,836 taf/yr if the full diversion could be maintained every day of the year. Additional permitted diversions of one-third of the San Joaquin River at Vernalis is 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. This additional increment of permitted diversions (i.e., 3,670 cfs) could yield a maximum of 655 taf/yr (for a total of 5,490 taf) if the San Joaquin River flow at Vernalis was higher than about 11,000 cfs for the entire 90-day period (an unlikely hydrologic condition). For reference, diversion and pumping at 8,500 cfs for each day of the year (16,860 af/day), if it were possible, would yield a potential water supply of about 6,154 taf/yr.

The monthly pumping capacity of SWP Banks for these different pumping limits are given in Table 5.1-3. 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 often needed during these months because SWP Banks pumping is limited during April–June by a combination of VAMP and the 35% export/inflow ratio that is specified in D-1641 from February through June.

Table 5.1-3. SWP Harvey O. Banks Pumping Plant Demands and Maximum Pumping Capacity

Month	Monthly SWP Banks Demand (taf)	Maximum Volume at 6,680 cfs Banks Capacity (taf)	Additional Needed from San Luis Reservoir (taf)	Maximum Volume at 8,500 cfs Banks Capacity (taf)
October	295	411	–	523
November	261	397	–	506
December	245	411	–	523
January	173	411	–	523
February	203	371	–	472
March	235	411	–	523
April	302	397	–	506
May	407	411	–	523
June	520	397	123	506
July	541	411	130	523
August	532	411	121	523
September	404	397	7	506
Total	**4,118**	**4,836**	**381**	**6,154**

taf = thousand acre-feet.

The SDIP would increase the available SWP Delta supply and increase the reliability of the delivery of the full SWP south-of the-Delta entitlement demand of 4,118 taf. There are normal aqueduct and reservoir storage losses (i.e., evaporation and seepage) that are simulated by CALSIM to be about 170 taf/yr, so SWP Banks pumping for full SWP delivery must be about 4,300 taf. Only in a few years will there be sufficient Delta inflow each month to satisfy the in-Delta water diversions, meet the required Delta outflow for water quality and fisheries protection, supply the full CVP Tracy pumping, and also allow SWP Banks pumping of 4,300 taf.

Central Valley Project and State Water Project Delta Pumping Regulatory Limits

The limits on SWP Banks and CVP Tracy pumping are important to understanding Delta water management because these regulatory limits collectively restrict supply of full CVP and SWP demands for Delta exports. These regulatory limits may result from Delta outflow requirements, Delta salinity objectives, export/inflow limits, and permitted or physical export pumping capacity. The SDIP would increase diversion limits into CCF for export pumping beyond the threshold identified in the Corps' Public Notice 5820A, issued on October 13, 1981 concerning the Rivers and Harbor Act Section 10 permit requirements.

Delta Outflow Requirements

The minimum monthly Delta outflow objectives protect the salinity range for the estuarine aquatic habitat, and are included in D-1641. The monthly minimum depends on the WY type, which is calculated as the Sacramento Valley Index (slightly different from the Four-River Index used in the previous D-1485 objectives) from the unimpaired runoff of the Sacramento, Feather, Yuba, and American Rivers. The monthly outflows from February to June are calculated on a daily basis to satisfy the X2 objective. Minimum monthly flows for July range from 4,000 cfs in critical years to 8,000 cfs in wet years. The August outflows range from 3,000 cfs in critical years to 4,000 cfs in below normal years or higher. The September minimum outflow is 3,000 cfs in all year types. The October minimum outflows are 3,000 in critical and 4,000 cfs in all other year types. The November and December required outflows are 3,500 cfs in critical and 4,500 cfs in all other year types.

Although these D-1641 outflow objectives specify the minimum outflows during these months, a water supply and water quality tradeoff is involved in the actual operation of the Delta. A slightly higher outflow would reduce the salinity intrusion of Suisun Bay water into the Central Delta and reduce the salinity (i.e., electrical conductivity, chloride, bromide) of the CVP and SWP exports. The CVP and SWP operations may sometimes reduce pumping during these fall months to reduce the salinity of the exports, even though this would also reduce the water supply volume pumped during these months.

Delta Salinity Objectives

There are several Delta locations with 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 protect 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 during the irrigation season from April through August. The compliance values as well as the period of compliance change with WY type.

X2 Objective

The location of the estuarine salinity gradient is regulated during the months of February–June by the X2 (i.e., the position of the 2 parts per thousand [ppt] salinity gradient) objective in the 1995 WQCP (D-1641). The X2 position must remain downstream of Collinsville (kilometer 81 upstream from the Golden Gate Bridge) for the entire 5-month period. This requires a minimum outflow of about 7,100 cfs. The X2 objective specifies the number of days each month when the location of X2 must be downstream of Chipps Island (kilometer 75) or downstream of the Port Chicago EC monitoring station (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. Meeting the X2 objectives can require a relatively large volume of water for outflow during dry months that follow months with large storms.

Maximum Export/Inflow Ratios

D-1641 includes a maximum export/inflow (E/I) ratio objective to limit the fraction of Delta inflows that are exported. This objective was developed to protect fish species and to reduce entrainment losses. Delta exports are considered to be CVP Tracy and SWP Banks. Delta inflows are the gaged or estimated river inflows (does not include rainfall runoff in the Delta). The maximum E/I ratio is 0.35 for February through June and 0.65 for the remainder of the year. If the January eight-river runoff index is less than 1 maf, the February E/I ratio is increased to 0.45. CVP and SWP have agreed to share the allowable exports equally if the E/I ratio is limiting exports.

Delta Cross Channel Operations

Reclamation operates the DCC to improve the transfer of water from the Sacramento River to the export facilities at the CVP Tracy facility, and to improve water quality in the south Delta by reducing saltwater intrusion from Antioch. The gates, however, are closed when flows in the Sacramento River at Freeport reach about 25,000 cfs, to reduce scour on the downstream side of the gates and to reduce potential flooding on the Mokelumne River channels.

D-1641 provides for closure of the DCC gates from February 1 through May 20 for fish protection. From November through January, the DCC may be closed for up to an additional 45 days. The gates may also be closed for 14 days during the period of May 21 through June 15. Reclamation shall determine the timing and duration of the closures after consultation with USFWS, DFG, and NOAA Fisheries. Monitoring for fish presence and movement in the Sacramento River and Delta, the salvage of salmon at the Tracy and Skinner facilities, and hydrologic “cues” (i.e., storm events) are used to determine the timing of DCC closures, subject to water quality conditions.

San Luis Reservoir

San Luis Dam and Reservoir is located near Los Banos (Photograph 5.1-19). The reservoir, with a capacity of about 2 maf, is a pumped-storage reservoir primarily used to provide seasonal storage for both CVP and SWP water exported from the Delta. The CVP share of the San Luis Reservoir storage is 966 taf. The SWP share of the San Luis Reservoir storage is 1,062 taf.

O'Neill Dam and Forebay are located downstream of San Luis Dam along the California Aqueduct. The forebay is used as a hydraulic junction point for state and federal waters. The O’Neill Pumping-Generating Plant lifts CVP water from the DMC to the O’Neill Forebay. The joint CVP/SWP William R. Giannelli Pumping-Generating Plant lifts CVP/SWP water from O’Neill Forebay to San Luis Reservoir. The forebay provides re-regulation storage necessary to permit off-peak pumping and on-peak power generation by the Giannelli plant. When CVP water is released from O'Neill Forebay to the DMC, the units at the O'Neill Pumping-Generating Plant operate as hydroelectric generators.

The San Luis Canal, the joint federal and state (CVP/SWP) portion of the California Aqueduct, conveys water southeasterly from O’Neill Forebay along the west side of the San Joaquin Valley for delivery to CVP and SWP contractors. The Coalinga Canal conveys water from the San Luis Canal to the Coalinga area, where it serves the southern San Joaquin River Region. The California Aqueduct continues south to the Edmonston Pumping Plant and over the Tehachapi mountains to Metropolitan and other SWP contractors.

Figure 5.1-23 shows the CALSIM-simulated San Luis Reservoir carryover CVP storage and total (CVP plus SWP) San Luis Reservoir storage for 1922–1994 under the 2001 baseline conditions. The September carryover storage fluctuates from year to year with water supply conditions. The CVP San Luis carryover storage was as low as 200 taf in about 50% of the years and was as low as 100 taf in about 15% of the years. The SWP San Luis Reservoir storage was as low as 200 taf in about 40% of the years and was as low as 125 taf in about 20% of the years. The simulated CVP and SWP San Luis Reservoir carryover storage under 2020 conditions was similar to the 2001 carryover storage conditions.

Figure 5.1-24 shows the CALSIM-simulated CVP San Luis Reservoir monthly cumulative distribution of storage values for 1922–1994 under the 2001 and 2020 baseline conditions (see Table I-20). The CVP San Luis storage reaches the maximum annual storage in the months of February or March, and generally declines in April through September as water supply demands are satisfied during the summer. The CVP San Luis storage is greater than 900 taf (i.e., 90% of the maximum of 972 taf CVP storage) in about 25% of the years by the end of February. The CVP San Luis storage is greater than 900 taf in about 40% of the years by the end of March. The 2020 CVP San Luis Reservoir storage patterns are similar to the 2001 patterns, although the average storage in the summer is slightly higher under 2020 conditions. The average 2020 CVP San Luis Reservoir carryover storage is identical to the 2001 carryover.

Figure 5.1-25 shows the CALSIM-simulated monthly cumulative distribution of SWP San Luis Reservoir storage values for 1922–1994 under the 2001 baseline conditions (see Table I-21). 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 water supply demands are satisfied during the summer. The SWP San Luis storage is greater than 1,000 taf (i.e., 95% of the maximum of 1,067 taf SWP storage) in about 20% of the years by the end of February. The SWP San Luis storage is greater than 1,000 taf in about 35% of the years by the end of March. The 2020 SWP San Luis Reservoir storage patterns are similar to the 2001 patterns, although the average storage in the summer is slightly lower under 2020 conditions. The average 2020 SWP San Luis Reservoir carryover storage is about 25 taf lower than the average 2001 carryover.

Environmental Water Account Operations

The EWA is a cooperative management program that provides protection for at-risk fish species in the Bay-Delta system through environmentally beneficial changes in SWP/CVP operations at no uncompensated water cost to water users (Bureau of Reclamation 2003b). Unless renewed by agreement, the EWA will expire on December 31, 2007. The EWA acquires water assets through purchases or operational flexibility that are used to replace deliveries interrupted by actions taken to benefit fish. EWA aids the protection and recovery of at-risk species by temporarily adjusting CVP/SWP operations with no water loss to the project's water users. Water supply (asset) acquisition is the responsibility of the two Project Agencies (PAs): Reclamation and DWR. Pumping reduction actions taken to benefit fish are recommended by the three Management Agencies (MAs): NOAA Fisheries, USFWS, and DFG.

EWA assets are used to replace the water that would otherwise have been delivered to export service area contractors when fish actions are taken to protect and enhance fish species recovery. Fish actions recommended by the EWA MAs may include:

- decreasing export pumping from the Delta when at risk fish species are determined to be within the vicinity of the SWP and CVP pumping stations;
- closing the DCC gates (longer than D-1641 specifies) to restore natural flow patterns and to encourage fish to migrate through the most suitable water channels away from the SWP and CVP pumping stations;
- increasing the streamflow of rivers below reservoirs with purchased EWA water supply to improve spawning, migration, and rearing habitats; and
- increasing Delta outflow (usually with pumping reductions) to improve the water quality of Delta habitats or to improve fish outmigration.

The water supply acquisition measures available to the EWA PAs include:

- purchasing surface water stored in reservoirs (but not CVP or SWP reservoirs);
- purchasing surface water (typically stored in a reservoir) while the water users forego their surface water deliveries and pump an equivalent amount of groundwater as an alternative supply;
- purchasing water from agricultural diverters who then idle land that would otherwise have been in production or shift to less-water-intensive crops;

- purchasing groundwater assets that were previously stored by the selling agency to be used as collateral or to be pumped and delivered as replacement supply; and
- obtaining water through a regulatory variance in the Delta that allows water to be diverted from the Delta specifically for the EWA (this has usually been accomplished by temporarily increasing the E/I ratio).

In addition to obtaining new water, the EWA PAs may use several asset shifting measures to manage the EWA water assets. Delaying water deliveries to a Project contractor would “borrow” water for a fee and return the water at a later date. (This option has been used to prevent San Luis Reservoir storage low point impacts due to EWA actions.) The EWA may borrow CVP or SWP water, if the water can be “repaid” without affecting deliveries to CVP or SWP contractors. The EWA may also borrow CVP or SWP storage space if the storage space is not needed for other designated uses. The PAs may exchange EWA asset locations that are more suitable for accomplishing EWA purposes.

The SDIP assumes that the EWA operations as generally described in the CALFED ROD will continue to be implemented. The EWA implementation is assumed in the CALSIM modeling of the SDIP operational scenarios, including the No-Action. The actual EWA operations in 2001, 2002, and 2003 have differed somewhat from the ROD description as the MAs and PAs work together to implement a successful EWA. The CALSIM model includes calculations of monthly changes in exports for the EWA actions that generally follow the ROD. Actual EWA operations are adaptive and cannot be accurately described within CALSIM. The simulated EWA actions were held constant in CALSIM to provide an indication of the likely effects of the SDIP operations on the need for increased EWA assets.

CALSIM Implementation of Environmental Water Account Fish Protection and Water Purchases

The CALSIM monthly model contains an assumed operation of EWA that generally provides the same “level of entrainment protection” as the baseline simulation for each SDIP operational scenario. The CALSIM model general EWA assumptions are described in Appendix H of the Benchmark Study Report (California Department of Water Resources 2002a). The assumed upstream and south-of-Delta EWA water purchases and the assumed export reduction actions at SWP Banks are simulated in the CALSIM model during the fifth simulation “layer” of calculations.

The EWA simulations with the monthly CALSIM model are somewhat complex because the assumed EWA actions cover periods of 1 or 2 weeks each month, while the CALSIM results are calculated as monthly averages. For example, one of the EWA fish protection actions occurs in the months of December–March. The assumed action is a 1-week pumping reduction to a combined pumping of about 4,000 cfs. Assuming that the CVP pumping was 4,000 cfs and the SWP pumping was 6,680 cfs, this action would represent a water cost of about 92 taf for each 1-week reduction. If the SWP pumping was 8,500 cfs under one of the alternatives, the water cost for the same action would be about 118 taf, an increase of 26 taf per week of protection. If a 1-week protection was scheduled in each month, and the baseline pumping was 6,680 cfs and increased to 8,500 cfs during each month of EWA actions, the additional EWA assets needed to provide the same level of protection would be 100 taf. However, it is unlikely that each of the four protection periods would correspond to periods of maximum pumping, so the increase in EWA (pumping reductions) necessary to provide the same fish protection would likely be less than 100 taf. The simulated EWA fish protection actions during VAMP will be the same with or without the SDIP, because the reduction is from SWP pumping half of the San Joaquin River flow to the designated VAMP export target of either 700 cfs or 1,500 cfs. In some years the EWA will hold the SWP pumping at the VAMP target for the first 2 weeks of April and the second half of May. The maximum increase in pumping during these periods would be 1,820 cfs (from 6,680 cfs to 8,500 cfs). If this change in pumping were allowed for both 2-week periods, the additional EWA cost would be 112 taf.

The simulated EWA reductions in SWP and CVP pumping for fish protection under the 2001 baseline conditions averaged about 210 taf/yr. The annual protection ranged from a low of just 55 taf in 1924, to a high of 590 taf in 1984. The EWA protections were always used during VAMP in April and May. The CALSIM model simulated monthly EWA export of upstream purchases and other EWA assets that the model determined were available (i.e., 50% of SWP gain from upstream (b)(2) actions). The average EWA export was 117 taf, with a range of 31 taf to 362 taf. These EWA exports are larger than the upstream EWA purchases, which averaged 54 taf with a range of 0 taf to 135 taf.

The CALSIM assumed south-of-Delta purchases averaged 123 taf/yr. The maximum total EWA purchase was 185 taf in a single year. More of the total EWA water was assumed to be purchased from south-of-Delta contractors in wetter years. More of the 185 taf total was assumed to be purchased from upstream sources in the drier years. The CALSIM simulation of EWA actions included an average of about 210 taf/yr of reductions.

An interagency EWA exercise using an interactive daily simulation model to simulate weekly EWA actions suggested that the EWA might come out about even with the 8,500 cfs pumping limit. These results from recent years (1981–1994) are described in Appendix B, “Simulation of Environmental Water Account Actions to Reduce Fish Entrainment Losses (Interactive Daily EWA Gaming Evaluations),” of this EIS/EIR document.

Environmental Consequences

Assessment Methods

Evaluation of the CVP and SWP water supply conditions that may be affected by the SDIP alternatives uses the CALSIM model results that provide monthly simulations of CVP and SWP reservoir operations, Delta export pumping and water delivery patterns for the 1922–1994 historical period of hydrology (runoff and estimated local water uses). The interpretation of a series of comparative simulations of a baseline (existing conditions for CEQA or future no action for NEPA) and alternative cases is the basis for identifying changes and potential impacts to water supply conditions.

Because increased SWP and CVP water delivery reliability is a SDIP project purpose, water supply changes are only considered to be potential environmental impacts if the SDIP alternative interferes with or limits water supply conditions for other riparian or appropriative water right holders. Water supply changes for other in-Delta users (i.e., SDWA, CCWD) would be considered potential water supply impacts.

The water supply evaluation using the CALSIM model allows a quantitative approach for comparing the water delivery reliability of the SDIP alternatives. A discussion of the CALSIM results for the various operational alternatives for the SDIP increased pumping capacity is presented in this section. Changes in water supply conditions for other water users (SDWA, CCWD) are evaluated as potential water supply impacts.

The results from the CALSIM simulations of the 2001 existing conditions will be emphasized in the water supply section. The results from the 2020 future no action conditions were compared to verify that the changes identified from the 2001 simulations were characteristic of the changes simulated for the 2020 conditions.

The 2020 CALSIM CVP and SWP exports for each of the operational scenarios will be shown along with the 2001 CALSIM CVP and SWP exports in this water supply section, because Delta exports can directly affect fish entrainment and water quality. Other hydrologic conditions have already been shown to be similar by comparison of the 2001 and 2020 baseline monthly distribution of values.

Potential Effects

Numerous environmental documents have been published over the past 10 years that have addressed hydrologic and water supply changes to the CVP and SWP potentially resulting from implementation of a project or program. Many of the documents reviewed do not consider changes in hydrological or water supply conditions resulting from project operations, in and of themselves, to be environmental effects. Rather, such changes are often considered to be the causative agents that may result in impacts on water quality, fish, recreation, groundwater, and agricultural resources.

Based on a review of these documents as well as review of the potential impacts of the SDIP alternatives analyzed in this EIS/EIR, the only potential water supply effects determined to be appropriate for this analysis were:

- a reduction in the ability of in-Delta water users (SDWA) to divert their full water supply because of lowered Delta channel water levels, and
- a reduction in the ability of in-Delta water users (CCWD) to divert their full water supply (i.e., Los Vaqueros storage) because of increased Delta salinity.

The potential effects of CVP and SWP pumping on water levels in the south Delta channels is described in Section 5.2, Tidal Hydraulics. Effects from CVP or SWP pumping on the ability of local water diverters to obtain sufficient water for all beneficial uses are not addressed in this section.

The potential effects of increased salinity on CCWD diversions to Los Vaqueros reservoir, and on subsequent deliveries of water within the CCWD delivery target of 65 mg/l chloride, are fully described in Section 5.3, Water Quality. Because there are no substantial effects from CVP or SWP pumping on the salinity of CCWD diversions (see Section 5.3), it is assumed that no water supply changes in CCWD are caused by SDIP changes in SWP and CVP pumping.

Simulated Water Supply Changes

The CALSIM results are used to evaluate potential water supply changes for CVP and SWP contractors. The simulated changes in SWP and CVP monthly exports are shown in the following tables to document the CALSIM changes that will be important for tidal hydraulic, water quality, and fish effects. The changes in annual CVP and SWP deliveries are the only values needed to evaluate potential CVP and SWP water supply changes. Figure 4-2 depicts the average annual changes in CVP and SWP Delta exports.

SDIP Stage 2 operational scenarios (i.e., A, B, or C) would each have the same water supply changes regardless of which Stage 1 physical/structural alternative it is paired with. The CALSIM results are not dependent on the SDIP Stage 1 physical/structural alternative selected for implementation. Each of the Stage 2 operational scenarios is compared directly with the 2001 Existing Conditions simulation that includes the presently permitted maximum SWP Banks capacity of 6,680 cfs with 500 cfs pumping of EWA transfer water in July–September (7,180 cfs total pumping). The operational scenarios may have slightly different water supply changes.

Based on tidal hydraulic evaluations described in Section 5.2, Tidal Hydraulics, there would not be a substantial change in the south Delta channel tidal water surface elevations that would affect the ability of modern agricultural diversion pumps within the SDWA boundaries to obtain sufficient water from these tidal channels. Therefore, no significant differences in water supply conditions in the south Delta are identified as dependent on the Stage 1 alternative physical/structural component. A few individual siphons or older pumps with an opening of higher than –2.0 feet msl may require modification to extend the pipe openings to below –5.0 feet msl (see Chapter 2, “Project Description”). These individual extensions are proposed by DWR as part of the project, but are not considered to be necessary for mitigation of significant water supply impacts.

Alternative 1 (No Action)

Stage 1 (Physical/Structural Component)

Under the No Action Alternative, no new south Delta structures would be constructed that would result in a change in south Delta water supply conditions. Installation of temporary barriers would continue as assumed under existing conditions but extension of agricultural diversion structures would not occur.

Stage 2 (Operational Component)

No changes in operations or pumping capacity limits at SWP Banks would occur under the No Action Alternative, and no substantial changes in the SWP, CVP, or south Delta water supply conditions would occur.

Future No Action

Under future no action conditions (2020 conditions), SDIP would not be implemented. It is expected that the temporary barriers program would continue. The CALSIM results for the future no action baseline have been shown previously in this section.

Alternative 2A

Stage 1 (Physical/Structural Component)

Under Stage 1 of Alternative 2A, the fish control gate at the head of Old River would be constructed and operated. All three proposed agricultural tidal gates would also be installed and operated: (1) in Old River just upstream of the CVP Tracy facility, (2) in Grant Line Canal just upstream of the CCF gates, and (3) in Middle River just upstream of Victoria Canal. Stage 1 would also include the dredging of some south Delta channels and the extension of up to 24 agricultural diversions. Construction and operation of the physical components under this alternative would not result in water supply impacts. Some agricultural siphons and pumps will be extended to provide a full capability for local diversions with the 0.0 feet msl target elevation.

2020 Conditions

2020 conditions in the south Delta under Stage 1 of Alternative 2A are expected to be the same as those described for 2001. Therefore, construction and operation of the physical components under this alternative would not result in water supply impacts.

Stage 2 (Operational Component)

Stage 2 of Alternative 2A includes an operations scenario that incorporates operational assumptions that further integrate CVP and SWP operations. The SWP Banks pumping limits are generally 8,500 cfs for most of the year. The VAMP period from April 15 to May 15 generally requires additional restrictions in CVP and SWP pumping that are held constant among all SDIP operational scenarios. The general pumping rules that are associated with this alternative are described in Chapter 2, “Project Description,” and summarized in Table 2-2. The CVP and SWP pumping patterns are shown separately. Stage 2 of Alternative 2A does not change any operating rule for the CVP Tracy facility. Any changes in CVP pumping are the direct or indirect result of changes from SWP Banks pumping patterns or from new agreements to integrate the CVP and SWP operations. Total monthly CVP and SWP export pumping values are used in the evaluation of fish entrainment impacts. The range of monthly combined export pumping for the 2001 baseline and for Alternative 2A is shown in Figure 6.1-9.

Change WS-1: Change in CVP Water Supply Pumping and Deliveries. Figure 5.1-26 shows the monthly cumulative distribution of simulated CVP Tracy pumping for Alternative 2A compared with the 2001 and 2020 baseline pumping. The CVP pumping is reduced substantially during the VAMP period of April 15 through May 15 for both the baseline and Alternative 2A. CVP Tracy pumping is generally limited in the post-Vamp portion of May and June. CVP Tracy pumping of greater than 4,000 cfs is simulated in more than 50% of the years for each month other than April, May, and June. The simulated CVP Tracy pumping for Alternative 2A is very similar to the 2001 baseline conditions.

Table 5.1-4 gives the monthly cumulative distribution of simulated CVP Tracy pumping flows for the 2001 baseline (existing conditions) and the 2020 baseline (future no action) compared to the Alternative 2A operational scenario pumping for 2001 and 2020 conditions. The tabular values allow the simulated changes in CVP Tracy pumping to be identified. For the baseline simulation during October, there was a 50% probability that the CVP Tracy pumping would be close to the maximum capacity of 4,600 cfs. The simulation of Alternative 2A indicates that the October CVP Tracy pumping would be similar to the 2001 baseline values, with the minimum pumping slightly lower at 1,566 cfs, the median slightly lower at 4,098 cfs, and the maximum the same at 4,391 cfs. The October pumping would be at this maximum value of 4,391 in 20% of the years under Alternative 2A, while CVP pumping in October was simulated at this high value in less than 10% of the years under the baseline. On average, the October CVP Tracy pumping would be reduced by 63 cfs. The other months reveal a similar pattern, with very small changes in simulated CVP Tracy pumping. The simulated CVP Tracy pumping in the August–February period was slightly reduced under Alternative 2A.

CVP Tracy pumping was slightly increased in March under this alternative. The CALSIM simulated April and May pumping is complicated by the VAMP period conditions that are assumed to occur from April 15 to May 15. The CALSIM model therefore simulates the months with two periods each. The CVP pumping during the VAMP period is a maximum of 1,500 cfs whenever the San Joaquin River inflow is greater than 7,000 cfs. This occurred in about 20% of the years (i.e., 80% and higher pumping distribution). CVP pumping in the first half of April was at the maximum pumping of 4,600 cfs in only about 20% of the years (i.e., pumping greater than 4,500). CVP Tracy pumping in the second half of May and all of June is limited to 3,000 cfs by the CALSIM-assumed (b)(2) allocation of CVP water supply yield for fish protection. This represents a potential reduction of about 45 taf in May and about 95 taf in June if CVP pumping would otherwise have been 4,600 cfs. The CVP Tracy pumping in April and May was identical for the baseline and Alternative 2A. CVP Tracy pumping in June was slightly increased in some of the lower pumping years. CVP Tracy pumping in the summer months was not substantially changed with Alternative 2A. The Alternative 2A operational scenario for CVP Tracy annual pumping was similar to the 2001 baseline pumping, with an average decrease of 8 taf/yr (0.3% of the average annual baseline pumping).

Table I-28 gives the simulated monthly CVP Tracy pumping for 2001 Alternative 2A and the 2001 baseline conditions for the 73-year period of CALSIM simulation. The monthly and annual differences are given. The CVP Tracy monthly pumping is given in units of flow (cfs). To convert monthly average flow to a monthly water supply volume, the approximate conversion of 60 taf for each 1,000 cfs of monthly pumping can be used. The 2001 baseline annual (water year) CVP Tracy pumping ranged from a minimum of 872 taf/yr to a maximum of 2,838 taf/yr.

Table 5.1-5a gives the simulated annual (water year) CVP south-of-Delta deliveries for the 2001 baseline simulation and each of the alternative operational scenarios. The annual changes in the CVP deliveries for each of the operational scenarios is also given in Table 5.1-5a. The average CVP delivery was 2,645 taf for the baseline 2001 simulation. The 1922–1994 sequence of simulated CVP south of Delta deliveries is shown in Figure 5.1-27 for the 2001 baseline conditions. The CVP water supply was greater than 3,000 taf (90% of demand) in about 30% of the years. The CVP delivery dropped below 2,000 taf (60% of demand) in about 20% of the years. The CVP delivery was less than 1,500 taf (45% of demand) in about 10% of the years. There are four drought sequences in the historic record, 1924–1926, 1929–1935, 1976–1977, and 1987–1992. All of these years have CVP deliveries of less than 2,000 taf. The average change in CVP deliveries under Alternative 2A was an increase of 106 taf from the 2001

Table 5.1-4. CALSIM–Simulated Scenario A CVP Tracy Pumping Monthly Distribution, for 2001 and 2020 Conditions (cfs)

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A. 2001 Baseline

Per-centile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post-VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	1,616	800	351	691	641	800	800	800	800	800	800	800	868	1,410	
10	2,585	1,251	1,193	2,389	1,389	1,240	800	800	800	800	1,220	857	2,048	2,912	
20	2,998	2,431	2,889	2,999	2,877	1,865	800	800	800	800	1,734	2,571	3,718	4,275	
30	3,309	3,412	3,002	3,007	3,137	2,403	1,125	800	800	800	2,012	3,745	4,467	4,366	
40	3,914	4,217	3,212	3,026	3,679	2,772	1,500	800	800	800	2,339	4,536	4,505	4,448	
50	4,315	4,247	4,209	4,122	4,020	3,352	2,919	800	800	1,125	2,540	4,570	4,531	4,468	
60	4,344	4,250	4,221	4,222	4,224	3,685	3,564	1,125	800	1,500	2,852	4,577	4,535	4,470	
70	4,355	4,253	4,222	4,226	4,237	4,230	4,200	1,125	1,125	1,500	3,000	4,588	4,543	4,475	
80	4,365	4,256	4,224	4,228	4,245	4,274	4,544	1,500	1,500	2,692	3,000	4,600	4,553	4,481	
90	4,374	4,260	4,225	4,229	4,247	4,286	4,600	1,500	1,500	3,000	3,000	4,600	4,562	4,485	
Max	4,391	4,265	4,227	4,232	4,254	4,308	4,600	1,500	1,500	3,001	3,000	4,600	4,578	4,494	
Avg	3,781	3,541	3,415	3,504	3,479	3,088	2,737	1,019	1,011	1,507	2,365	3,790	4,021	4,183	2,312

B. 2001 Scenario A

Per-centile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post-VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	1,566	800	184	596	641	800	800	800	800	800	800	800	800	1,397	
10	2,537	1,401	1,090	2,372	1,384	867	800	800	800	800	1,251	1,271	2,049	2,912	
20	3,005	2,345	2,690	2,991	2,670	1,930	800	800	800	800	1,762	2,553	3,541	3,991	
30	3,157	2,999	2,997	3,001	3,209	2,421	1,125	800	800	800	2,027	4,006	4,381	4,352	
40	3,556	3,941	3,007	3,010	3,641	2,870	1,500	800	800	800	2,338	4,539	4,497	4,417	
50	4,098	4,237	4,215	4,056	4,152	3,467	2,842	800	800	1,125	2,562	4,574	4,532	4,468	
60	4,368	4,258	4,222	4,222	4,229	4,217	3,564	1,125	800	1,500	2,923	4,600	4,557	4,482	
70	4,377	4,261	4,226	4,229	4,236	4,275	4,451	1,125	1,125	1,500	3,000	4,600	4,565	4,487	
80	4,391	4,265	4,226	4,231	4,249	4,292	4,544	1,500	1,500	2,692	3,000	4,600	4,578	4,494	
90	4,391	4,265	4,227	4,232	4,252	4,302	4,600	1,500	1,500	3,000	3,000	4,600	4,578	4,494	
Max	4,391	4,265	4,227	4,232	4,254	4,321	4,600	1,500	1,500	3,001	3,000	4,600	4,578	4,494	
Avg	3,718	3,456	3,389	3,470	3,476	3,156	2,748	1,019	1,011	1,509	2,385	3,827	4,010	4,140	2,304

C. 2001 Scenario A Changes (A – B)

Per-centile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post-VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	-50	0	-167	-95	0	0	0	0	0	0	0	0	-68	-13	
10	-48	150	-103	-17	-5	-373	0	0	0	0	31	414	1	0	
20	7	-86	-199	-8	-207	65	0	0	0	0	28	-18	-177	-284	
30	-152	-413	-5	-6	72	18	0	0	0	0	15	261	-86	-14	
40	-358	-276	-205	-16	-38	98	0	0	0	0	-1	3	-8	-31	
50	-217	-10	6	-66	132	115	-77	0	0	0	22	4	1	0	
60	24	8	1	0	5	532	0	0	0	0	71	23	22	12	
70	22	8	4	3	-1	45	251	0	0	0	0	12	22	12	
80	26	9	2	3	4	18	0	0	0	0	0	0	25	13	
90	17	5	2	3	5	16	0	0	0	0	0	0	16	9	
Max	0	0	0	0	0	13	0	0	0	0	0	0	0	0	
Avg	-63	-85	-26	-34	-3	68	10	0	0	2	20	37	-11	-43	-8

Table 5.1-4. Continued

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D. 2020 Baseline

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post-VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	1,664	800	723	715	641	800	800	800	800	800	800	800	898	1,198	
10	2,401	1,333	1,353	2,183	1,417	1,194	800	800	800	800	1,179	1,244	2,345	2,867	
20	3,016	2,233	2,755	2,998	2,594	2,064	800	800	800	800	1,541	2,449	3,577	4,080	
30	3,154	3,301	2,999	3,004	3,289	2,576	1,297	800	800	800	2,008	3,434	4,290	4,349	
40	3,679	3,728	3,079	3,008	3,904	2,929	2,561	800	800	800	2,260	4,533	4,503	4,442	
50	4,259	4,225	4,211	4,214	4,218	3,424	3,127	800	800	1,125	2,523	4,561	4,523	4,463	
60	4,339	4,249	4,220	4,224	4,232	3,980	3,817	1,125	800	1,500	2,908	4,578	4,535	4,471	
70	4,353	4,253	4,223	4,226	4,242	4,240	4,544	1,125	1,125	1,620	3,000	4,587	4,542	4,475	
80	4,359	4,255	4,223	4,228	4,245	4,274	4,544	1,500	1,500	2,859	3,000	4,594	4,547	4,477	
90	4,370	4,259	4,225	4,229	4,248	4,287	4,600	1,500	1,500	3,000	3,000	4,600	4,558	4,483	
Max	4,391	4,265	4,227	4,232	4,254	4,308	4,600	1,500	1,500	3,001	3,000	4,600	4,578	4,494	
Avg	3,723	3,487	3,417	3,498	3,487	3,152	2,895	1,021	1,011	1,543	2,326	3,720	3,990	4,152	2,305

E. 2020 Scenario A

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post-VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	1,803	800	741	706	641	800	800	800	800	800	800	800	898	1,185	
10	2,235	1,287	1,241	1,653	1,388	1,167	800	800	800	800	1,123	1,121	1,821	2,880	
20	2,921	2,208	2,719	2,995	2,397	2,017	800	800	800	800	1,548	2,559	3,061	3,939	
30	3,186	3,016	2,995	3,000	3,375	2,435	1,125	800	800	800	1,977	3,302	4,358	4,341	
40	3,588	3,769	3,007	3,008	3,715	3,216	2,561	800	800	800	2,256	4,465	4,504	4,382	
50	3,903	4,167	4,209	3,900	4,188	3,516	3,131	800	800	1,125	2,522	4,569	4,528	4,467	
60	4,339	4,238	4,221	4,223	4,231	3,979	3,931	1,125	800	1,500	2,911	4,598	4,550	4,478	
70	4,370	4,257	4,224	4,228	4,241	4,265	4,544	1,125	1,125	1,647	3,000	4,600	4,559	4,484	
80	4,384	4,263	4,226	4,231	4,248	4,291	4,544	1,500	1,500	2,807	3,000	4,600	4,571	4,490	
90	4,391	4,265	4,227	4,232	4,252	4,300	4,600	1,500	1,500	3,000	3,000	4,600	4,578	4,494	
Max	4,391	4,265	4,227	4,232	4,254	4,315	4,600	1,500	1,500	3,001	3,000	4,600	4,578	4,494	
Avg	3,667	3,441	3,387	3,417	3,467	3,183	2,883	1,021	1,011	1,543	2,343	3,705	3,914	4,124	2,286

F. 2020 Scenario A Changes (D – E)

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post-VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	139	0	18	-9	0	0	0	0	0	0	0	0	0	-13	
10	-166	-46	-112	-530	-29	-27	0	0	0	0	-56	-123	-524	13	
20	-95	-25	-36	-3	-197	-47	0	0	0	0	7	110	-516	-141	
30	32	-285	-4	-4	86	-141	-172	0	0	0	-31	-132	68	-8	
40	-91	41	-72	0	-189	287	0	0	0	0	-4	-68	1	-60	
50	-356	-58	-2	-314	-30	92	4	0	0	0	-1	8	5	4	
60	0	-11	1	-1	-1	-1	114	0	0	0	3	20	15	7	
70	17	4	1	2	-1	25	0	0	0	27	0	13	17	9	
80	25	8	3	3	3	17	0	0	0	-52	0	6	24	13	
90	21	6	2	3	4	13	0	0	0	0	0	0	20	11	
Max	0	0	0	0	0	7	0	0	0	0	0	0	0	0	
Avg	-56	-46	-30	-81	-20	31	-12	0	0	0	17	-15	-76	-28	-19

Table 5.1-5a. CVP South of Delta Water Supply Deliveries for 2001 Conditions

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		Delivery				Change from 2001 Baseline Delivery		
			Operational Scenario			Operational Scenario		
	Demand (taf)	2001 Baseline (taf)	A (taf)	B (taf)	C (taf)	A (taf)	B (taf)	C (taf)
A. Annual Values								
1922	3,332	3,311	3,564	3,359	3,359	253	48	48
1923	3,332	2,959	2,950	2,960	2,961	-9	1	2
1924	3,332	1,551	1,508	1,537	1,538	-43	-14	-13
1925	3,332	2,044	2,063	2,063	2,063	19	19	19
1926	3,332	1,898	1,948	1,924	1,949	50	26	51
1927	3,332	2,775	3,063	2,820	2,831	288	45	56
1928	3,332	2,985	2,931	2,987	2,985	-54	2	0
1929	3,332	1,980	2,025	1,983	1,980	45	3	0
1930	3,332	2,011	2,043	2,012	2,013	32	1	2
1931	3,332	1,391	1,393	1,391	1,391	2	0	0
1932	3,332	1,404	1,317	1,313	1,323	-87	-91	-81
1933	3,332	1,229	1,200	1,198	1,202	-29	-31	-27
1934	3,332	1,278	1,295	1,292	1,289	17	14	11
1935	3,332	1,910	1,917	1,917	1,915	7	7	5
1936	3,332	2,333	2,341	2,324	2,325	8	-9	-8
1937	3,332	2,226	2,243	2,227	2,227	17	1	1
1938	3,332	3,115	3,206	3,152	3,115	91	37	0
1939	3,332	2,744	2,703	2,667	2,626	-41	-77	-118
1940	3,332	2,485	2,730	2,511	2,495	245	26	10
1941	3,332	2,958	3,286	2,963	2,967	328	5	9
1942	3,332	3,187	3,473	3,207	3,207	286	20	20
1943	3,332	3,135	3,530	3,270	3,270	395	135	135
1944	3,332	2,723	2,693	2,688	2,686	-30	-35	-37
1945	3,332	2,888	3,035	2,985	2,881	147	97	-7
1946	3,332	2,955	3,156	2,967	2,971	201	12	16
1947	3,332	2,714	2,679	2,788	2,802	-35	74	88
1948	3,332	2,720	2,816	2,858	2,915	96	138	195
1949	3,332	2,769	2,798	2,769	2,777	29	0	8
1950	3,332	2,340	2,321	2,348	2,342	-19	8	2
1951	3,332	2,722	2,918	2,746	2,717	196	24	-5
1952	3,332	3,378	3,460	3,368	3,386	82	-10	8
1953	3,332	3,198	3,409	3,185	3,198	211	-13	0
1954	3,332	3,074	3,444	3,185	3,212	370	111	138
1955	3,332	2,769	2,643	2,714	2,704	-126	-55	-65
1956	3,332	3,010	3,163	3,006	3,010	153	-4	0
1957	3,332	3,300	3,450	3,301	3,282	150	1	-18
1958	3,332	3,228	3,435	3,314	3,294	207	86	66
1959	3,332	3,147	3,319	3,212	3,222	172	65	75
1960	3,332	2,100	2,024	2,092	2,098	-76	-8	-2
1961	3,332	2,736	2,700	2,726	2,724	-36	-10	-12
1962	3,332	2,999	3,111	3,016	2,984	112	17	-15
1963	3,332	2,896	3,307	3,043	3,050	411	147	154

Table 5.1-5a. Continued

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		Delivery				Change from 2001 Baseline Delivery		
			Operational Scenario			Operational Scenario		
	Demand (taf)	2001 Baseline (taf)	A (taf)	B (taf)	C (taf)	A (taf)	B (taf)	C (taf)
1964	3,332	2,669	2,651	2,721	2,741	-18	52	72
1965	3,332	3,035	3,184	3,110	3,110	149	75	75
1966	3,332	3,031	3,294	3,101	3,099	263	70	68
1967	3,332	3,017	3,303	3,053	3,084	286	36	67
1968	3,332	3,164	3,340	3,162	3,171	176	-2	7
1969	3,332	3,420	3,458	3,414	3,418	38	-6	-2
1970	3,332	3,122	3,355	3,126	3,126	233	4	4
1971	3,332	2,961	3,227	2,957	2,957	266	-4	-4
1972	3,332	2,997	3,147	3,098	3,120	150	101	123
1973	3,332	3,082	3,352	3,137	3,145	270	55	63
1974	3,332	3,050	3,315	3,039	3,044	265	-11	-6
1975	3,332	3,050	3,369	3,078	3,079	319	28	29
1976	3,332	2,050	2,114	2,094	2,104	64	44	54
1977	3,332	1,311	1,282	1,307	1,304	-29	-4	-7
1978	3,332	2,760	2,969	2,807	2,811	209	47	51
1979	3,332	3,236	3,402	3,237	3,244	166	1	8
1980	3,332	3,214	3,483	3,265	3,271	269	51	57
1981	3,332	3,224	3,121	3,218	3,218	-103	-6	-6
1982	3,332	3,222	3,353	3,169	3,315	131	-53	93
1983	3,332	3,434	3,484	3,521	3,561	50	87	127
1984	3,332	3,291	3,513	3,318	3,318	222	27	27
1985	3,332	2,559	2,795	2,695	2,697	236	136	138
1986	3,332	2,929	2,723	2,877	2,881	-206	-52	-48
1987	3,332	2,374	2,323	2,356	2,351	-51	-18	-23
1988	3,332	1,851	1,840	1,851	1,846	-11	0	-5
1989	3,332	2,068	2,033	2,061	2,057	-35	-7	-11
1990	3,332	1,606	1,577	1,602	1,588	-29	-4	-18
1991	3,332	1,424	1,424	1,424	1,424	0	0	0
1992	3,332	1,847	1,717	1,805	1,765	-130	-42	-82
1993	3,332	2,647	2,993	2,626	2,692	346	-21	45
1994	3,332	2,890	3,131	3,017	3,050	241	127	160
Avg	3,332	2,645	2,752	2,666	2,670	106	21	24
B. Cumulative Distribution								
100%		3,434	3,564	3,521	3,561	411	147	195
90%		3,227	3,456	3,269	3,280	286	95	117
80%		3,142	3,354	3,179	3,203	250	54	67
70%		3,041	3,298	3,099	3,103	208	36	49
60%		2,966	3,149	3,008	2,990	151	19	12
50%		2,888	2,969	2,877	2,881	91	4	5
40%		2,723	2,729	2,725	2,723	31	1	0
30%		2,441	2,522	2,449	2,437	1	-4	-3
20%		2,046	2,037	2,062	2,059	-29	-10	-8
10%		1,654	1,605	1,643	1,623	-49	-29	-22
0%		1,229	1,200	1,198	1,202	-206	-91	-118

Table 5.1-5b. CVP South of Delta Water Supply Deliveries for 2020 Conditions

		Delivery				Change from 2001 Baseline Delivery		
			Operational Scenario			Operational Scenario		
	Demand (taf)	2001 Baseline (taf)	A (taf)	B (taf)	C (taf)	A (taf)	B (taf)	C (taf)
A. Annual Values								
1922	3,332	3,184	3,408	3,184	3,184	224	0	0
1923	3,332	3,033	2,928	2,979	2,996	-105	-54	-37
1924	3,332	1,550	1,474	1,524	1,570	-76	-26	20
1925	3,332	1,938	2,009	1,974	1,945	71	36	7
1926	3,332	1,929	1,939	1,941	1,931	10	12	2
1927	3,332	2,710	2,947	2,710	2,719	237	0	9
1928	3,332	2,877	2,860	2,949	2,893	-17	72	16
1929	3,332	1,983	1,928	1,972	1,934	-55	-11	-49
1930	3,332	1,990	1,993	1,979	1,969	3	-11	-21
1931	3,332	1,380	1,382	1,379	1,378	2	-1	-2
1932	3,332	1,438	1,420	1,444	1,430	-18	6	-8
1933	3,332	1,240	1,234	1,242	1,238	-6	2	-2
1934	3,332	1,306	1,311	1,306	1,304	5	0	-2
1935	3,332	1,907	1,910	1,906	1,907	3	-1	0
1936	3,332	2,269	2,267	2,298	2,266	-2	29	-3
1937	3,332	2,091	2,123	2,107	2,138	32	16	47
1938	3,332	3,036	3,103	3,092	3,088	67	56	52
1939	3,332	2,606	2,820	2,710	2,754	214	104	148
1940	3,332	2,471	2,713	2,483	2,488	242	12	17
1941	3,332	3,019	3,294	3,008	3,051	275	-11	32
1942	3,332	3,224	3,600	3,319	3,285	376	95	61
1943	3,332	3,221	3,322	3,235	3,309	101	14	88
1944	3,332	2,470	2,510	2,501	2,506	40	31	36
1945	3,332	2,591	2,718	2,597	2,580	127	6	-11
1946	3,332	2,923	3,157	3,035	3,028	234	112	105
1947	3,332	2,548	2,464	2,595	2,600	-84	47	52
1948	3,332	2,668	2,820	2,755	2,757	152	87	89
1949	3,332	2,741	2,746	2,718	2,722	5	-23	-19
1950	3,332	2,219	2,200	2,222	2,224	-19	3	5
1951	3,332	2,652	2,885	2,690	2,667	233	38	15
1952	3,332	3,376	3,459	3,372	3,385	83	-4	9
1953	3,332	3,086	3,283	3,105	3,093	197	19	7
1954	3,332	3,004	3,350	2,997	3,100	346	-7	96
1955	3,332	2,571	2,546	2,584	2,560	-25	13	-11
1956	3,332	2,929	3,115	2,956	2,922	186	27	-7
1957	3,332	3,224	3,337	3,251	3,234	113	27	10
1958	3,332	3,114	3,360	3,197	3,213	246	83	99
1959	3,332	3,239	3,309	3,223	3,194	70	-16	-45
1960	3,332	2,012	2,006	2,016	1,999	-6	4	-13
1961	3,332	2,610	2,561	2,610	2,610	-49	0	0
1962	3,332	2,982	3,083	3,002	2,968	101	20	-14
1963	3,332	2,971	3,273	2,999	3,068	302	28	97

Table 5.1-5b. Continued

		Delivery				Change from 2001 Baseline Delivery		
			Operational Scenario			Operational Scenario		
	Demand (taf)	2001 Baseline (taf)	A (taf)	B (taf)	C (taf)	A (taf)	B (taf)	C (taf)
1964	3,332	2,488	2,600	2,601	2,582	112	113	94
1965	3,332	3,019	3,095	3,065	3,055	76	46	36
1966	3,332	2,898	3,224	2,970	3,089	326	72	191
1967	3,332	2,948	3,162	2,950	2,954	214	2	6
1968	3,332	3,167	3,417	3,221	3,214	250	54	47
1969	3,332	3,372	3,488	3,335	3,438	116	-37	66
1970	3,332	3,050	3,241	3,035	3,098	191	-15	48
1971	3,332	2,937	3,189	2,952	2,952	252	15	15
1972	3,332	2,913	3,032	2,991	2,976	119	78	63
1973	3,332	3,035	3,264	3,049	3,066	229	14	31
1974	3,332	3,002	3,246	2,897	3,006	244	-105	4
1975	3,332	3,044	3,328	3,041	3,069	284	-3	25
1976	3,332	2,037	2,086	2,062	2,045	49	25	8
1977	3,332	1,331	1,290	1,305	1,294	-41	-26	-37
1978	3,332	2,486	2,713	2,508	2,508	227	22	22
1979	3,332	3,109	3,035	3,093	3,092	-74	-16	-17
1980	3,332	3,169	3,356	3,205	3,217	187	36	48
1981	3,332	3,132	3,135	3,182	3,186	3	50	54
1982	3,332	3,036	3,260	3,030	3,089	224	-6	53
1983	3,332	3,401	3,460	3,451	3,485	59	50	84
1984	3,332	3,169	3,413	3,183	3,183	244	14	14
1985	3,332	2,674	2,851	2,721	2,759	177	47	85
1986	3,332	2,668	2,598	2,631	2,589	-70	-37	-79
1987	3,332	2,197	2,140	2,218	2,209	-57	21	12
1988	3,332	1,908	1,894	1,893	1,888	-14	-15	-20
1989	3,332	2,044	2,037	2,019	2,033	-7	-25	-11
1990	3,332	1,589	1,558	1,572	1,573	-31	-17	-16
1991	3,332	1,436	1,436	1,436	1,436	0	0	0
1992	3,332	1,847	1,776	1,809	1,816	-71	-38	-31
1993	3,332	2,528	2,740	2,476	2,504	212	-52	-24
1994	3,332	2,955	3,071	2,942	2,957	116	-13	2
Avg	3,332	2,588	2,689	2,603	2,611	101	15	23
B. Cumulative Distribution								
100%		3,401	3,600	3,451	3,485	376	113	191
90%		3,181	3,359	3,218	3,214	249	72	89
80%		3,072	3,290	3,093	3,096	231	47	54
70%		3,019	3,203	3,017	3,067	203	27	40
60%		2,939	3,085	2,959	2,970	121	17	18
50%		2,710	2,860	2,721	2,757	83	12	9
40%		2,587	2,713	2,600	2,588	38	0	4
30%		2,390	2,385	2,405	2,399	3	-3	-2
20%		1,999	2,007	1,994	1,981	-16	-14	-11
10%		1,641	1,602	1,619	1,622	-54	-26	-21
0%		1,240	1,234	1,242	1,238	-105	-105	-79

baseline CVP deliveries. The maximum annual change was 411 taf. The changes in CVP deliveries were greater than 150 taf in 40% of the years. This simulated increase in CVP deliveries is an average of about 4% of the average CVP deliveries.

Change WS-2: Change in SWP Water Supply Pumping and Deliveries. Figure 5.1-28 shows the monthly cumulative distribution of simulated SWP Banks pumping for Alternative 2A compared with the 2001 and 2020 baseline pumping. The 2001 baseline SWP Banks pumping is greater than 7,000 cfs in about 30% of the years in the months of December–March because of the allowable increased pumping (i.e., 1/3 of the San Joaquin River flow) from December 15 to March 15. The SWP Banks pumping is reduced substantially during the VAMP period of April 15 through May 15. SWP Banks pumping of more than 5,000 cfs is simulated in at least 50% of the years for each month other than April, May, and June.

The simulated SWP Banks pumping for Alternative 2A is higher in about 10% to 30% of the years from October to March and during July–September. The SWP Banks pumping is at the 8,500-cfs limit in only about 10% of the years for each month.

Table 5.1-6 shows the monthly cumulative distribution of simulated SWP Banks pumping for Alternative 2A compared to the 2001 baseline (existing conditions) and the 2020 baseline (future no action). The minimum October SWP pumping value was 723 cfs, the median (50%) value was 4,984 cfs, and the maximum value was 6,680 cfs for Alternative 2A. For the 2001 baseline simulation during October there was a 20% probability that the SWP Banks pumping would be close to the maximum capacity of 6,680 cfs. The simulation of Alternative 2A operations indicates that the October SWP Banks pumping would be higher than 6,680 cfs in only about 20% of the years. The maximum increment in SWP pumping of 1,820 cfs would occur during October in about 10% of the years, and the October SWP pumping would be 8,500 cfs in about 10% of the years. The increased SWP Banks pumping in November is similar, with about 20% of the years at 6,680 cfs capacity in the baseline simulation increasing to the new 8,500 cfs pumping capacity under Alternative 2A in at least 10% of the years.

The changes in SWP Banks pumping under Alternative 2A in December would increase SWP pumping to 8,500 cfs in about 20% of the years. The January pumping was simulated at 8,500 cfs in about 10% of the years under the 2001 baseline because of the allowable increased SWP pumping during the December 15–March 15 period. The January SWP pumping would be 8,500 cfs in about 30% of the years. Baseline 2001 February pumping was 8,500 cfs in about 20% of the years and Alternative 2A February SWP pumping would be 8,500 cfs in 30% of the years. Baseline 2001 March SWP pumping was a maximum of 7,561 cfs in 20% of the years and Alternative 2A March pumping was 8,500 cfs in about 20% of the years.

The simulated SWP Banks pumping was not changed during the VAMP period in April and May because SWP pumping conditions are completely determined by the San Joaquin River inflow and the VAMP reductions that are simulated as part of the EWA actions. Alternative 2A operations would allow increased pumping in the first half of April and the second half of May in about 20% of the years.

Baseline 2001 June SWP pumping was at the 6,680 cfs maximum in about 10% of the years. Less than 10% of the Alternative 2A June pumping values would be at 8,500 cfs. The allowance of 500 cfs of EWA wheeling in July–September was included in the baseline assumptions, but was simulated in only about 20% of the years. The full increase in SWP Banks pumping of 1,320 cfs during these summer months that would be allowed under Alternative 2A operations was simulated in only about 10% of the years.

The Alternative 2A CALSIM simulation of SWP Banks pumping suggests that the increased SWP Banks pumping capacity may be used in relatively few years during the summer period of peak demands. The additional export pumping capacity may be available for water transfers, as will be described and evaluated in a later section. Alternative 2A would result in an average increase in SWP Banks pumping of approximately 519 cfs in July, 703 cfs in August, and 329 cfs in September (Table 5.1-6). The average annual increase of 202 taf (6% of baseline) is considered an improvement in water supply reliability for SWP or CVP (depending on deliveries). A portion of this overall increase in pumping (59 taf/yr) would be SWP Article 21 deliveries.

Table I-30 gives the monthly SWP Banks pumping for Alternative 2A and the 2001 baseline pumping for each of the 73 years. The monthly and annual differences are given. The Alternative 2A SWP Banks pumping was higher in many months because of the allowable 8,500 cfs pumping limit.

Table 5.1-7a shows the annual (water year) SWP south-of-Delta CALSIM-simulated demands and Table A (firm) deliveries for the baseline and the alternative operational scenarios. The average simulated SWP water supply demand was 3,712 taf/yr for the 2001 baseline CALSIM simulation (the maximum of 4,100 taf/yr was reduced as assumed in the variable demands for Metropolitan and Kern County). The average simulated SWP Table A delivery for the 2001 baseline was 3,107 taf/yr. An average of 148 taf/yr of Article 21 (surplus) deliveries was simulated for the 2001 baseline. The Article 21 deliveries were increased to 207 taf/yr for Alternative 2A (see Table 5.1-12).

The 1922–1994 sequence of simulated SWP south of Delta deliveries is shown in Figure 5.1-29. The variable SWP demands assumed in CALSIM are also shown to indicate that in some years the demands were fully satisfied even though the deliveries were less than the 4,100 taf maximum contractual demand. For example, Table 5.1-7a indicates that the maximum SWP water supply delivery was 3,834 taf (in 1954) under the 2001 baseline, and this delivery fully satisfied the 1954 demands. The variable SWP demands were almost fully satisfied (less than 100 taf deficit) in about 40% of the years, and the SWP water supply deliveries were greater than 3,500 taf in about 40% of the years (generally the same years), while SWP delivery dropped below 3 maf (about 75% of the total

Table 5.1-6. CALSIM–Simulated Scenario A SWP Exports Monthly Distribution, for 2001 and 2020 Conditions (cfs)

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A. 2001 Baseline

Per-centile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post-VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	723	300	300	1,246	762	300	300	300	300	300	300	1,445	300	837	
10	1,235	980	2,643	2,645	1,674	1,121	304	304	606	606	842	3,367	1,639	1,658	
20	2,666	2,255	3,135	3,893	3,016	2,570	700	700	700	1,125	2,271	3,829	5,480	3,881	
30	3,675	2,571	3,966	4,556	3,482	3,175	1,500	700	700	1,868	2,886	4,123	5,819	4,851	
40	4,210	3,229	4,472	5,272	4,111	4,234	2,904	700	700	2,692	3,475	4,745	6,524	5,782	
50	4,984	4,208	5,193	5,967	5,176	5,260	3,679	700	700	2,976	4,112	5,418	6,680	6,209	
60	5,467	5,022	5,705	6,775	6,668	6,914	4,527	700	700	3,926	4,347	6,083	6,680	6,630	
70	6,371	6,588	7,001	7,296	7,735	7,228	5,500	1,125	1,125	4,521	5,266	6,658	6,749	6,680	
80	6,680	6,680	7,047	7,465	8,437	7,561	5,640	1,500	1,500	5,639	6,072	7,180	7,003	7,180	
90	6,680	6,680	7,195	8,493	8,500	7,561	5,697	1,500	1,500	5,640	6,680	7,180	7,180	7,180	
Max	6,680	6,680	7,678	8,500	8,500	7,561	5,697	1,500	1,500	5,687	6,680	7,180	7,180	7,180	
Avg	4,583	4,172	5,110	5,769	5,409	5,006	3,413	905	916	3,214	3,991	5,350	5,767	5,457	3,312

B. 2001 Scenario A

Per-centile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post-VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	349	300	300	1,247	652	300	300	300	300	300	300	1,493	300	909	
10	1,163	1,216	2,525	2,630	1,850	1,004	300	300	425	425	1,247	3,276	2,071	1,669	
20	2,552	2,012	2,888	3,988	3,023	2,570	700	700	700	899	2,354	4,423	5,160	3,974	
30	3,593	2,378	3,715	4,810	3,476	3,174	1,500	700	700	1,868	2,982	4,756	6,301	4,938	
40	4,065	2,837	4,343	4,971	4,146	4,232	2,851	700	700	2,676	3,485	5,251	7,049	5,422	
50	4,983	4,002	5,170	6,003	5,596	6,049	3,679	700	700	2,984	4,015	6,160	7,379	6,208	
60	5,478	4,909	6,319	6,341	6,368	6,922	4,523	700	700	3,945	4,361	6,559	7,648	6,840	
70	5,959	5,620	7,239	8,500	8,500	8,234	5,500	1,125	1,125	4,521	5,263	6,978	7,858	7,019	
80	7,721	7,021	8,500	8,500	8,500	8,500	6,274	1,500	1,500	5,817	6,048	7,713	8,032	7,533	
90	8,500	8,500	8,500	8,500	8,500	8,500	6,551	1,500	1,500	6,549	7,116	8,500	8,310	8,500	
Max	8,500	8,500	8,500	8,500	8,500	8,500	6,608	1,500	1,500	6,598	8,500	8,500	8,500	8,500	
Avg	4,843	4,301	5,457	5,960	5,571	5,384	3,578	894	910	3,338	4,162	5,869	6,470	5,786	3,514

C. 2001 Scenario A Changes (A – B)

Per-centile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post-VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	-374	0	0	1	-110	0	0	0	0	0	0	48	0	72	
10	-72	236	-118	-15	176	-117	-4	-4	-181	-181	405	-91	432	11	
20	-114	-243	-247	95	7	0	0	0	0	-226	83	594	-320	93	
30	-82	-193	-251	254	-6	-1	0	0	0	0	96	633	482	87	
40	-145	-392	-129	-301	35	-2	-52	0	0	-16	10	506	525	-360	
50	-1	-206	-23	36	420	789	0	0	0	8	-97	742	699	-1	
60	11	-113	614	-434	-300	8	-4	0	0	19	14	476	968	210	
70	-412	-968	238	1,204	765	1,006	0	0	0	0	-3	320	1,109	339	
80	1,041	341	1,453	1,035	63	939	634	0	0	178	-24	533	1,029	353	
90	1,820	1,820	1,305	7	0	939	854	0	0	909	436	1,320	1,130	1,320	
Max	1,820	1,820	822	0	0	939	911	0	0	911	1,820	1,320	1,320	1,320	
Avg	260	129	347	191	162	378	165	-11	-6	124	171	519	703	329	202

Table 5.1-6. Continued

D. 2020 Baseline

Per-centile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post-VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	586	301	1,065	1,358	778	300	300	300	300	300	300	1,781	302	801	
10	1,141	1,188	2,599	2,890	1,994	1,182	320	320	700	700	333	2,740	1,859	1,532	
20	2,362	1,957	3,562	4,160	3,104	2,823	1,560	700	700	700	2,292	3,856	4,842	3,983	
30	3,083	2,666	4,125	4,625	3,867	3,555	2,749	700	700	1,799	3,038	4,111	6,102	4,884	
40	4,003	3,192	4,326	4,929	4,478	4,476	3,450	700	700	2,653	3,717	4,691	6,594	5,380	
50	4,624	4,234	5,131	6,354	5,686	6,135	4,172	700	700	3,033	3,973	5,768	6,680	5,946	
60	5,394	5,354	5,501	7,296	7,431	7,060	4,964	700	700	3,804	4,538	6,680	6,749	6,380	
70	6,464	6,357	6,713	7,405	8,171	7,254	5,640	1,125	1,125	4,416	5,302	7,180	7,026	6,550	
80	6,680	6,680	7,032	8,070	8,437	7,561	5,640	1,500	1,500	5,639	5,969	7,180	7,180	6,686	
90	6,680	6,680	7,157	8,500	8,500	7,561	5,697	1,500	1,500	5,640	6,680	7,180	7,180	7,180	
Max	6,680	6,680	7,678	8,500	8,500	7,561	5,697	1,500	1,500	5,687	6,680	7,180	7,180	7,180	
Avg	4,436	4,220	5,122	5,987	5,692	5,201	3,763	914	920	3,160	3,981	5,433	5,861	5,290	3,357

E. 2020 Scenario A

Per-centile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post-VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	300	300	300	1,358	778	300	300	300	300	300	300	1,592	300	776	
10	1,130	1,263	2,772	3,069	1,782	1,174	525	525	300	300	828	2,901	1,977	1,532	
20	2,293	1,904	3,477	4,296	3,113	2,805	1,650	700	700	700	2,348	4,196	4,422	3,879	
30	3,316	2,609	4,274	4,809	3,893	3,420	2,704	700	700	1,500	3,107	4,752	6,310	4,775	
40	3,801	3,336	4,814	5,115	5,166	4,477	3,450	700	700	2,696	3,723	5,053	6,870	5,353	
50	4,522	3,817	5,535	6,322	6,117	6,315	4,171	700	700	3,035	3,989	6,009	7,441	5,858	
60	5,397	4,563	5,984	7,874	7,793	7,600	4,964	700	700	3,804	4,688	6,446	7,716	6,420	
70	6,120	5,381	6,610	8,500	8,500	8,500	5,903	1,125	1,125	4,418	5,307	7,326	7,961	6,905	
80	7,963	6,788	8,239	8,500	8,500	8,500	6,551	1,500	1,500	5,798	5,958	8,473	8,129	7,282	
90	8,500	8,500	8,500	8,500	8,500	8,500	6,551	1,500	1,500	6,549	6,960	8,500	8,467	8,500	
Max	8,500	8,500	8,500	8,500	8,500	8,500	6,608	1,500	1,500	6,598	8,500	8,500	8,500	8,500	
Avg	4,831	4,335	5,535	6,253	5,762	5,639	4,045	921	891	3,263	4,155	5,906	6,408	5,532	3,559

F. 2020 Scenario A Changes (D – E)

Per-centile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post-VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	-286	-1	-765	0	0	0	0	0	0	0	0	-189	-2	-25	
10	-11	75	173	179	-212	-8	205	205	-400	-400	495	161	118	0	
20	-69	-53	-85	136	9	-18	90	0	0	0	56	340	-420	-104	
30	233	-57	149	184	26	-135	-44	0	0	-299	69	641	208	-109	
40	-202	144	488	186	688	1	0	0	0	43	6	362	276	-27	
50	-102	-417	404	-32	431	180	-1	0	0	2	16	241	761	-88	
60	3	-791	483	578	362	540	0	0	0	0	150	-234	967	40	
70	-344	-976	-103	1,095	329	1,246	263	0	0	2	5	146	935	355	
80	1,283	108	1,207	430	63	939	911	0	0	158	-11	1,293	949	596	
90	1,820	1,820	1,343	0	0	939	854	0	0	909	280	1,320	1,287	1,320	
Max	1,820	1,820	822	0	0	939	911	0	0	911	1,820	1,320	1,320	1,320	
Avg	395	115	413	266	70	438	282	7	-29	104	174	473	547	242	202

Table 5.1-7a. SWP South of Delta Water Supply Table A Deliveries for 2001 Conditions

	Demand (taf)	2001 Baseline (taf)	Delivery			Change from Baseline Deliveries		
			Operational Scenario			Operational Scenario		
			A (taf)	B (taf)	C (taf)	A (taf)	B (taf)	C (taf)
A. Annual Values								
1922	3,486	3,477	3,463	3,477	3,480	-14	0	3
1923	3,643	3,658	3,673	3,659	3,656	15	1	-2
1924	3,903	1,512	1,512	1,503	1,501	0	-9	-11
1925	3,945	1,576	1,609	1,516	1,572	33	-60	-4
1926	3,816	2,772	2,825	2,668	2,779	53	-104	7
1927	3,599	3,506	3,526	3,495	3,516	20	-11	10
1928	3,813	3,381	3,369	3,374	3,395	-12	-7	14
1929	3,939	1,512	1,529	1,511	1,506	17	-1	-6
1930	3,929	2,389	2,491	2,371	2,388	102	-18	-1
1931	3,960	1,503	1,529	1,494	1,497	26	-9	-6
1932	3,744	1,677	1,617	1,562	1,515	-60	-115	-162
1933	3,875	1,604	1,578	1,485	1,457	-26	-119	-147
1934	3,971	1,631	1,700	1,606	1,589	69	-25	-42
1935	3,764	3,231	3,252	3,229	3,227	21	-2	-4
1936	3,752	3,793	3,793	3,793	3,794	0	0	1
1937	3,520	3,520	3,518	3,436	3,518	-2	-84	-2
1938	3,426	3,502	3,486	3,462	3,502	-16	-40	0
1939	3,619	3,541	3,505	3,505	3,482	-36	-36	-59
1940	3,703	3,508	3,510	3,492	3,494	2	-16	-14
1941	3,147	3,223	3,223	3,230	3,231	0	7	8
1942	3,481	3,496	3,476	3,498	3,495	-20	2	-1
1943	3,614	3,549	3,567	3,549	3,549	18	0	0
1944	3,587	3,520	3,431	3,492	3,536	-89	-28	16
1945	3,601	3,601	3,578	3,468	3,598	-23	-133	-3
1946	3,687	3,754	3,755	3,721	3,755	1	-33	1
1947	3,896	3,034	3,101	2,890	3,071	67	-144	37
1948	3,958	2,754	2,911	2,756	2,776	157	2	22
1949	3,887	2,548	2,444	2,434	2,428	-104	-114	-120
1950	3,824	3,084	3,164	3,031	3,167	80	-53	83
1951	3,787	3,769	3,799	3,765	3,798	30	-4	29
1952	3,212	3,231	3,231	3,231	3,231	0	0	0
1953	3,654	3,671	3,671	3,671	3,671	0	0	0
1954	3,823	3,834	3,831	3,835	3,834	-3	1	0
1955	3,778	2,132	2,403	2,157	2,361	271	25	229
1956	3,668	3,291	3,357	3,297	3,346	66	6	55
1957	3,730	3,471	3,478	3,483	3,484	7	12	13
1958	3,540	3,497	3,474	3,474	3,491	-23	-23	-6
1959	3,926	3,572	3,590	3,591	3,564	18	19	-8
1960	4,100	2,287	2,483	2,294	2,413	196	7	126
1961	4,114	2,639	2,639	2,604	2,574	0	-35	-65
1962	3,790	3,150	3,187	3,083	3,134	37	-67	-16
1963	3,647	3,663	3,674	3,650	3,667	11	-13	4

Table 5.1-7a. Continued

		Delivery				Change from Baseline Deliveries		
		2001 Baseline (taf)	Operational Scenario			Operational Scenario		
	Demand (taf)		A (taf)	B (taf)	C (taf)	A (taf)	B (taf)	C (taf)
1964	3,842	3,559	3,623	3,608	3,604	64	49	45
1965	3,662	3,334	3,356	3,200	3,352	22	-134	18
1966	3,690	3,645	3,643	3,614	3,643	-2	-31	-2
1967	3,499	3,501	3,486	3,484	3,486	-15	-17	-15
1968	3,715	3,528	3,543	3,545	3,543	15	17	15
1969	3,275	3,238	3,242	3,238	3,239	4	0	1
1970	3,614	3,637	3,633	3,636	3,636	-4	-1	-1
1971	3,808	3,823	3,823	3,823	3,823	0	0	0
1972	3,970	3,203	3,228	3,226	3,233	25	23	30
1973	3,706	3,506	3,510	3,508	3,510	4	2	4
1974	3,640	3,666	3,662	3,664	3,662	-4	-2	-4
1975	3,703	3,718	3,718	3,718	3,718	0	0	0
1976	3,944	3,280	3,271	3,272	3,272	-9	-8	-8
1977	3,963	1,134	1,128	1,132	1,132	-6	-2	-2
1978	3,288	2,627	2,625	2,626	2,629	-2	-1	2
1979	3,465	3,509	3,512	3,510	3,509	3	1	0
1980	3,243	3,257	3,257	3,257	3,257	0	0	0
1981	3,716	3,485	3,521	3,516	3,515	36	31	30
1982	3,535	3,509	3,508	3,514	3,514	-1	5	5
1983	3,087	3,104	3,110	3,104	3,104	6	0	0
1984	3,562	3,571	3,571	3,571	3,571	0	0	0
1985	3,738	3,719	3,750	3,750	3,753	31	31	34
1986	3,409	3,229	3,232	3,230	3,230	3	1	1
1987	3,804	3,152	3,228	3,039	3,177	76	-113	25
1988	3,997	1,354	1,373	1,262	1,353	19	-92	-1
1989	4,080	2,628	2,717	2,631	2,692	89	3	64
1990	3,994	1,527	1,551	1,522	1,533	24	-5	6
1991	3,958	984	1,000	977	990	16	-7	6
1992	3,898	1,201	1,334	1,182	1,287	133	-19	86
1993	3,635	3,134	3,170	3,128	3,157	36	-6	23
1994	3,696	3,402	3,457	3,488	3,494	55	86	92
Avg	3,712	3,017	3,037	2,998	3,023	21	-19	6
B. Cumulative Distribution								
100%	4,114	3,834	3,831	3,835	3,834	271	86	229
90%	3,962	3,670	3,674	3,670	3,670	75	16	43
80%	3,928	3,572	3,585	3,583	3,587	37	2	23
70%	3,831	3,513	3,514	3,506	3,515	24	0	9
60%	3,788	3,498	3,480	3,483	3,494	17	0	3
50%	3,716	3,334	3,357	3,297	3,352	4	-2	0
40%	3,683	3,228	3,230	3,228	3,231	0	-8	0
30%	3,629	3,064	3,106	2,975	3,091	0	-18	-2
20%	3,549	2,453	2,486	2,396	2,419	-4	-36	-5
10%	3,434	1,537	1,556	1,512	1,508	-19	-102	-15
0%	3,087	984	1,000	977	940	-104	-144	-162

Table 5.1-7b. SWP South of Delta Water Supply Table A Deliveries for 2020 Conditions

			Delivery			Change from Baseline Deliveries		
			Operational Scenario			Operational Scenario		
	2020 Demand (taf)	2020 Baseline (taf)	A (taf)	B (taf)	C (taf)	A (taf)	B (taf)	C (taf)
A. Annual Values								
1922	4,133	4,089	4,093	4,088	4,093	4	-1	4
1923	4,133	3,908	4,022	3,950	4,173	114	42	265
1924	4,015	1,526	1,547	1,545	1,578	21	19	52
1925	4,098	1,439	1,521	1,455	1,492	82	16	53
1926	4,133	2,557	2,643	2,567	2,687	86	10	130
1927	4,133	3,917	3,941	3,923	3,949	24	6	32
1928	4,133	3,535	3,594	3,552	3,586	59	17	51
1929	4,008	1,537	1,516	1,550	1,545	-21	13	8
1930	4,096	2,482	2,536	2,500	2,511	54	18	29
1931	4,133	1,551	1,557	1,555	1,551	6	4	0
1932	4,120	1,560	1,539	1,558	1,569	-21	-2	9
1933	4,129	1,512	1,507	1,507	1,522	-5	-5	10
1934	4,133	1,618	1,620	1,613	1,630	2	-5	12
1935	3,958	3,358	3,358	3,352	3,364	0	-6	6
1936	4,082	3,882	3,987	3,788	4,006	105	-94	124
1937	4,133	3,561	3,515	3,458	3,517	-46	-103	-44
1938	4,133	4,106	4,086	4,083	4,089	-20	-23	-17
1939	3,990	3,498	3,643	3,686	3,685	145	188	187
1940	4,091	3,778	3,789	3,707	3,784	11	-71	6
1941	3,599	3,718	3,699	3,691	3,708	-19	-27	-10
1942	3,820	3,848	3,832	3,850	3,845	-16	2	-3
1943	4,065	3,733	3,749	3,733	3,733	16	0	0
1944	3,804	3,524	3,494	3,514	3,578	-30	-10	54
1945	3,894	3,843	3,808	3,758	3,814	-35	-85	-29
1946	3,964	3,875	3,897	3,848	3,903	22	-27	28
1947	3,972	2,897	2,950	2,913	2,935	53	16	38
1948	4,097	2,822	2,900	2,815	2,801	78	-7	-21
1949	4,027	2,489	2,482	2,502	2,502	-7	13	13
1950	4,102	3,118	3,251	3,100	3,217	133	-18	99
1951	4,103	4,045	4,080	4,041	4,069	35	-4	24
1952	3,612	3,629	3,628	3,628	3,628	-1	-1	-1
1953	3,967	3,980	3,980	3,980	3,980	0	0	0
1954	4,117	4,112	4,102	4,101	4,101	-10	-11	-11
1955	4,026	2,055	2,287	2,080	2,184	232	25	129
1956	4,102	3,638	3,692	3,642	3,667	54	4	29
1957	4,052	3,498	3,583	3,492	3,655	85	-6	157
1958	3,961	3,827	3,838	3,809	3,858	11	-18	31
1959	4,090	3,705	3,720	3,722	3,721	15	17	16
1960	4,133	2,390	2,586	2,405	2,509	196	15	119
1961	4,133	2,728	2,739	2,709	2,775	11	-19	47
1962	3,978	3,264	3,263	3,204	3,268	-1	-60	4
1963	4,087	4,068	4,082	4,061	4,080	14	-7	12

Table 5.1-7b. Continued

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		Delivery				Change from Baseline Deliveries		
	2020 Demand (taf)	2020 Baseline (taf)	Operational Scenario			Operational Scenario		
			A (taf)	B (taf)	C (taf)	A (taf)	B (taf)	C (taf)
1964	4,053	3,357	3,529	3,484	3,499	172	127	142
1965	3,980	3,262	3,335	3,144	3,335	73	-118	73
1966	4,027	3,835	3,842	3,797	3,843	7	-38	8
1967	4,036	3,998	4,001	3,998	4,000	3	0	2
1968	4,106	3,791	3,788	3,791	3,789	-3	0	-2
1969	3,676	3,567	3,569	3,566	3,569	2	-1	2
1970	3,938	3,963	3,961	3,964	3,961	-2	1	-2
1971	4,104	4,103	4,113	4,107	4,112	10	4	9
1972	4,133	3,147	3,375	3,286	3,377	228	139	230
1973	4,122	3,622	3,694	3,676	3,692	72	54	70
1974	4,096	4,068	4,065	4,067	4,066	-3	-1	-2
1975	4,107	4,106	4,105	4,107	4,107	-1	1	1
1976	4,051	3,222	3,454	3,515	3,528	232	293	306
1977	4,110	1,132	1,185	1,199	1,203	53	67	71
1978	3,921	3,183	3,190	3,180	3,180	7	-3	-3
1979	4,110	3,827	3,826	3,808	3,839	-1	-19	12
1980	3,808	3,625	3,627	3,619	3,629	2	-6	4
1981	4,077	3,676	3,688	3,665	3,666	12	-11	-10
1982	4,037	3,976	3,982	3,974	3,972	6	-2	-4
1983	3,464	3,480	3,480	3,480	3,480	0	0	0
1984	3,928	3,935	3,935	3,935	3,935	0	0	0
1985	3,940	3,685	3,791	3,767	3,829	106	82	144
1986	3,869	3,379	3,314	3,300	3,304	-65	-79	-75
1987	3,948	3,307	3,327	3,154	3,264	20	-153	-43
1988	4,017	1,395	1,446	1,330	1,400	51	-65	5
1989	4,113	2,666	2,790	2,708	2,729	124	42	63
1990	4,133	1,581	1,615	1,593	1,596	34	12	15
1991	4,133	1,005	1,036	997	1,021	31	-8	16
1992	4,133	1,267	1,401	1,239	1,361	134	-28	94
1993	4,133	3,581	3,616	3,572	3,606	35	-9	25
1994	4,133	3,193	3,284	3,280	3,309	91	87	116
Avg	4,026	3,180	3,219	3,183	3,220	39	3	40
B. Cumulative Distribution								
100%	4,133	4,112	4,113	4,107	4,173	232	293	306
90%	4,133	4,036	4,056	4,032	4,068	131	52	130
80%	4,133	3,898	3,939	3,894	3,943	84	17	72
70%	4,111	3,805	3,798	3,775	3,820	53	8	49
60%	4,102	3,646	3,692	3,678	3,686	25	0	26
50%	4,087	3,535	3,583	3,552	3,586	12	-1	12
40%	4,037	3,347	3,372	3,342	3,374	6	-5	6
30%	4,001	3,135	3,227	3,126	3,202	0	-8	2
20%	3,959	2,485	2,556	2,501	2,510	-2	-19	-2
10%	3,874	1,540	1,541	1,551	1,555	-18	-64	-10
0%	3,464	1,005	1,036	997	1,021	-65	-153	-82

Table A amount) in about 30% of the years. The SWP delivery was less than 2 maf (50% of the total Table A amount) in about 15% of the years. The drought sequences in the historic record produce substantial SWP delivery deficits that are similar to the reduced CVP delivery pattern, although the sequence of CVP and SWP delivery deficits is not identical.

The average change in SWP Table A deliveries under Alternative 2A would be an increase of 21 taf. The maximum annual reduction was 104 taf and the largest increase was 271 taf while in 40% of the years the change in SWP deliveries was less than 10 taf. Many of these unchanged years are the years with fully satisfied demands that do not require any additional SWP deliveries. The average increase in SWP Table A deliveries is less than 1% of the average simulated SWP Table A deliveries. However, Table 5.1-7a does not include Article 21 deliveries, which increased by an average of 59 taf with Alternative 2A. Article 21 water is available only when SWP San Luis Reservoir storage is filled. Article 21 SWP water deliveries can be used by contractors who have local storage or recharge facilities. This increase is considered to be one of the benefits of the SDIP for SWP contractors. There also may be substantial opportunity for increased water transfers to SWP contractors with Alternative 2A.

2020 Conditions

Figure 5.1-30 shows the average monthly changes in CVP and SWP pumping for Alternative 2A compared to the 2001 and 2020 baselines. The figure indicates that the average changes in monthly pumping are relatively small and that the simulated changes in SWP pumping are larger than those simulated for CVP pumping. The CVP Tracy and SWP Banks pumping changes under 2020 conditions were similar to the CVP Tracy and SWP Banks pumping changes under 2001 conditions (see Figures 5.1-26 and 5.1-28). Water supply changes associated with the Alternative 2A monthly changes simulated under 2020 conditions are similar to the impacts identified for 2001 conditions. Table 5.1-4 shows the 2020 CALSIM-simulated monthly cumulative distribution of CVP pumping for Alternative 2A compared to the 2020 baseline CVP pumping patterns. Table 5.1-6 shows the 2020 CALSIM-simulated monthly cumulative distribution of SWP pumping patterns for Alternative 2A compared to the 2020 baseline SWP pumping patterns. The monthly CVP Tracy pumping for 2020 Alternative 2A and the 2020 baseline conditions is given in Table I-29. The monthly and annual differences are given. The 2020 baseline and 2020 Alternative 2A combined pumping values used in the fish entrainment evaluations are shown in Figure 6.1-38.

Table 5.1-5b gives the simulated CVP deliveries under the 2020 baseline simulation and for each alternative operational scenario. The CVP delivery increases were similar for the 2020 and the 2001 baselines. The average increase in CVP deliveries was 101 taf/yr for 2020 (future no action) conditions with Alternative 2A. Table 5.1-7b shows the corresponding simulated SWP Table A demand and deliveries under the 2020 baseline and alternative operational scenarios. The average SWP water supply demand was increased in CALSIM from 3,712 taf for the 2001 simulations to 4,026 taf/yr for the 2020 simulations.

The average simulated SWP 2020 baseline Table A deliveries were 3,180 taf/yr, which is 73 taf/yr above the 2001 baseline deliveries. The average Table A delivery for Alternative 2A was increased by 39 taf/yr above the 2020 baseline delivery. The average Article 21 deliveries were about 92 taf/yr for the 2020 baseline and increased by an average of 50 taf to about 142 taf/yr for Alternative 2A (see Table 5.1-13). The monthly SWP Banks pumping for 2020 Alternative 2A and the 2020 baseline conditions is given in Table I-31. The monthly and annual differences are given.

Interim Operations

Structural/Physical Components

The temporary south Delta agricultural barriers and head of Old River fish control barrier would be installed each year while the permanent tidal gates are being constructed, just as they are in the existing conditions under Alternative 1 (No Action). There are no project impacts associated with these temporary barrier installations. As construction proceeds with the permanent tidal gates, the construction impacts as outlined for Stage 1 of Alternative 2A will occur.

Operational Components

The operational conditions that have been simulated with CALSIM are similar to the Alternative 1 simulations during the April–November period. The April and May VAMP protections remain the same, and the (b)(2) and EWA protections that may be applied during the May–June period will be governed by the AFRP and EWA staff through the CALFED operations group. The only interim operational changes are in the December–March period, when the 8,500 cfs SWP pumping limit is assumed, without the condition that the San Joaquin River flow is greater than 5,460 cfs (i.e., 6,680 cfs plus 1/3 of San Joaquin River flow of 5,460 cfs is 8,500 cfs). Because the E/I ratio and Delta outflow limits remain unchanged, there are only a few of these winter months when the SWP exports would be slightly higher than under the existing no action conditions. Simulated pumping could approach the simulated pumping under Alternative 2A conditions in these months, although the 8,500 cfs limit would be raised only between December 15 and March 15. Review of Table 5.1-4 indicates that there are no substantial changes in the long-term average or range of CVP pumping during these months. Review of Table 5.1-6 indicates that the SWP pumping would increase by more than 1,000 cfs during these months in only about 20% of the years. There are therefore no significant water supply changes under the interim operations.

Alternative 2B

Stage 1 (Physical/Structural Component)

Under Stage 1 of Alternative 2B, the fish control gate at the head of Old River would be constructed and operated. All three proposed agricultural tidal gates would also be installed and operated: (1) in Old River just upstream of the CVP Tracy facility, (2) in Grant Line Canal just upstream of the CCF gates, and (3) in Middle River just upstream of Victoria Canal. Stage 1 would also include the dredging of some south Delta channels and the extension of up to 24 agricultural diversions. Construction and operation of the physical components under this alternative would not result in water supply impacts.

2020 Conditions

2020 conditions in the south Delta under Stage 1 of Alternative 2B are expected to be the same as those described for 2001. Therefore, construction and operation of the physical components under this alternative would not result in water supply impacts.

Stage 2 (Operational Component)

Stage 2 of Alternative 2B represents the most restrictive operations for utilizing the 8,500 cfs pumping capacity of SWP Banks. Under this alternative SWP Banks pumping limits would be generally 8,500 cfs for only the summer months of July–September and the fall months of October and November when fish densities at the salvage facilities historically have been low. The general pumping rules that are associated with this scenario are described in Chapter 2, “Project Description,” and summarized in Table 2-2. The CVP and SWP pumping patterns are shown separately. Stage 2 of Alternative 2B does not change any operating rule for the CVP Tracy facility. Any changes in CVP pumping are the direct or indirect result of changes from SWP Banks pumping patterns. Wheeling of CVP water by the SWP may be changed under this alternative.

Change WS-1: Change in CVP Water Supply Pumping and Deliveries. Figure 5.1-31 shows the monthly cumulative distribution of simulated CVP Tracy pumping for Alternative 2B compared with the 2001 and 2020 baseline pumping. The simulated CVP Tracy pumping for Alternative 2B is similar to the 2001 baseline conditions.

Table 5.1-8 gives the simulated monthly average and cumulative distribution of CVP Tracy pumping for the 2001 baseline and the Alternative 2B operational conditions. Under Alternative 2B CVP Tracy pumping would be similar to the 2001 baseline.

The simulation of Alternative 2B operations indicates that the October CVP Tracy pumping would be similar to the baseline values, with the minimum pumping slightly higher at 1,958 cfs, the median slightly lower at 4,294 cfs, and the maximum the same at 4,391 cfs. On average, the October CVP Tracy pumping would be reduced by 29 cfs. The other months reveal a similar pattern, with very small changes in simulated CVP Tracy pumping. The simulated CVP Tracy pumping in the September–March period was slightly reduced under Alternative 2B. The lack of reliable access to SWP pumping for refuge deliveries causes a reduced CVP delivery benefit in these months.

The CALSIM simulated April and May CVP Tracy pumping was identical for the 2001 baseline and Alternative 2B. No substantial changes in CVP Tracy pumping were simulated during the summer months of June–September.

The CVP water supply that can be pumped at the CVP Tracy facility would not be substantially changed by the Alternative 2B operational assumptions. There may still be a gain or loss of CVP deliveries if the wheeling that is simulated at SWP Banks is increased or reduced by some of the Alternative 2B assumptions.

Table I-34 gives the simulated monthly CVP Tracy pumping for 2001 Alternative 2B and the 2001 baseline conditions for the 73-year period of CALSIM simulation. The monthly and annual differences are given.

Table 5.1-5a gives the simulated annual (water year) CVP south-of-Delta deliveries for the 2001 baseline and each of the alternative operational scenarios. The annual changes in the CVP deliveries for each of the operational scenarios are also given. The average CVP delivery was 2,645 taf for the 2001 baseline. The average change in CVP deliveries under Alternative 2B was an increase of 21 taf. The maximum annual change was 147 taf in 1963. The changes in CVP deliveries were greater than 54 taf in 20% of the years. This slight increase in CVP deliveries is an average of less than 1% of the average CVP deliveries.

Change WS-2: Change in SWP Water Supply Pumping and Deliveries. Figure 5.1-32 shows the monthly cumulative distribution of simulated SWP Banks pumping for Alternative 2B compared with the 2001 and 2020 baseline pumping. The simulated SWP Banks pumping for Alternative 2B is limited to 7,180 cfs from December through March. Higher pumping is simulated in about 10% to 30% of the years from July through November. The SWP Banks pumping is at the 8,500-cfs limit in only about 10% of the years during these months. Table I-36 gives the monthly SWP Banks pumping for Alternative 2B and the 2001 baseline pumping for each of the 73 years. The monthly and annual differences are given. The Alternative 2B SWP Banks pumping was higher in the months of July–November because of the allowable 8,500-cfs pumping limit.

Table 5.1-9 shows the monthly cumulative distribution of simulated SWP Banks pumping for the 2001 baseline (existing conditions) and for the Alternative 2B operational conditions. The simulation of Alternative 2B indicates that the October SWP Banks pumping would be higher than 6,680 cfs in about 20% of the years. The maximum increment in SWP pumping of 1,820 cfs would occur during October in about 10% of the years. The increased SWP Banks pumping in November is similar, with about 20% of the years at 6,680 cfs capacity in the baseline simulation increasing to the new 8,500 cfs pumping capacity under this alternative.

The changes in SWP Banks pumping under Alternative 2B in the December–March period reflects the changed maximum pumping limit of 7,180 cfs that is imposed for added fish protection. However, the simulated SWP pumping was

Table 5.1-8. CALSIM–Simulated Scenario B CVP Tracy Pumping Monthly Distribution, for 2001 and 2020 Conditions (cfs)

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A. 2001 Baseline

Per-centile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post-VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	1,616	800	351	691	641	800	800	800	800	800'	800	800	868	1,410	
10	2,585	1,251	1,193	2,389	1,389	1,240	800	800	800	800	1,220	857	2,048	2,912	
20	2,998	2,431	2,889	2,999	2,877	1,865	800	800	800	800	1,734	2,571	3,718	4,275	
30	3,309	3,412	3,002	3,007	3,137	2,403	1,125	800	800	800	2,012	3,745	4,467	4,366	
40	3,914	4,217	3,212	3,026	3,679	2,772	1,500	800	800	800	2,339	4,536	4,505	4,448	
50	4,315	4,247	4,209	4,122	4,020	3,352	2,919	800	800	1,125	2,540	4,570	4,531	4,468	
60	4,344	4,250	4,221	4,222	4,224	3,685	3,564	1,125	800	1,500	2,852	4,577	4,535	4,470	
70	4,355	4,253	4,222	4,226	4,237	4,230	4,200	1,125	1,125	1,500	3,000	4,588	4,543	4,475	
80	4,365	4,256	4,224	4,228	4,245	4,274	4,544	1,500	1,500	2,692	3,000	4,600	4,553	4,481	
90	4,374	4,260	4,225	4,229	4,247	4,286	4,600	1,500	1,500	3,000	3,000	4,600	4,562	4,485	
Max	4,391	4,265	4,227	4,232	4,254	4,308	4,600	1,500	1,500	3,001	3,000	4,600	4,578	4,494	
Avg	3,781	3,541	3,415	3,504	3,479	3,088	2,737	1,019	1,011	1,507	2,365	3,790	4,021	4,183	2,312

B. 2001 Scenario B

Per-centile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post-VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	1,958	800	17	592	641	800	800	800	800	800	800	800	800	1,402	
10	2,584	1,266	1,086	1,921	1,386	1,202	800	800	800	800	1,220	856	1,799	2,911	
20	2,980	2,385	2,352	2,991	2,208	2,035	800	800	800	800	1,784	2,554	3,513	4,259	
30	3,150	3,218	2,999	3,002	3,082	2,520	1,125	800	800	800	2,027	4,393	4,463	4,362	
40	3,622	3,819	3,005	3,008	3,426	2,643	1,500	800	800	800	2,326	4,539	4,511	4,448	
50	4,294	4,218	4,209	3,568	3,925	3,059	2,939	800	800	1,125	2,557	4,573	4,531	4,468	
60	4,342	4,250	4,222	4,220	4,222	3,651	3,564	1,125	800	1,500	2,885	4,582	4,538	4,472	
70	4,355	4,253	4,222	4,226	4,236	4,245	4,202	1,125	1,125	1,500	3,000	4,590	4,544	4,476	
80	4,366	4,257	4,224	4,228	4,245	4,276	4,544	1,500	1,500	2,692	3,000	4,600	4,553	4,481	
90	4,372	4,259	4,225	4,229	4,247	4,284	4,600	1,500	1,500	3,000	3,000	4,600	4,559	4,484	
Max	4,391	4,265	4,227	4,232	4,254	4,308	4,600	1,500	1,500	3,001	3,000	4,600	4,578	4,494	
Avg	3,752	3,482	3,344	3,434	3,366	3,060	2,736	1,019	1,011	1,510	2,379	3,816	4,020	4,165	2,291

C. 2001 Scenario B Changes (A – B)

Per-centile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Pos-t VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	342	0	-334	-99	0	0	0	0	0	0	0	0	-68	-8	
10	-1	15	-107	-468	-3	-38	0	0	0	0	0	-1	-249	-1	
20	-18	-46	-537	-8	-669	170	0	0	0	0	50	-17	-205	-16	
30	-159	-194	-3	-5	-55	117	0	0	0	0	15	648	-4	-4	
40	-292	-398	-207	-18	-253	-129	0	0	0	0	-13	3	6	0	
50	-21	-29	0	-554	-95	-293	19	0	0	0	17	3	0	0	
60	-2	0	1	-2	-2	-34	0	0	0	0	33	5	3	2	
70	0	0	0	0	-1	15	2	0	0	0	0	2	1	1	
80	1	1	0	0	0	2	0	0	0	0	0	0	0	0	
90	-2	-1	0	0	0	-2	0	0	0	0	0	0	-3	-1	
Max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Avg	-29	-59	-71	-70	-113	-28	-1	0	0	3	14	26	-1	-18	-21

Table 5.1-8. Continued

D. 2020 Baseline

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post-VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	1,664	800	723	715	641	800	800	800	800	800	800	800	898	1,198	
10	2,401	1,333	1,353	2,183	1,417	1,194	800	800	800	800	1,179	1,244	2,345	2,867	
20	3,016	2,233	2,755	2,998	2,594	2,064	800	800	800	800	1,541	2,449	3,577	4,080	
30	3,154	3,301	2,999	3,004	3,289	2,576	1,297	800	800	800	2,008	3,434	4,290	4,349	
40	3,679	3,728	3,079	3,008	3,904	2,929	2,561	800	800	800	2,260	4,533	4,503	4,442	
50	4,259	4,225	4,211	4,214	4,218	3,424	3,127	800	800	1,125	2,523	4,561	4,523	4,463	
60	4,339	4,249	4,220	4,224	4,232	3,980	3,817	1,125	800	1,500	2,908	4,578	4,535	4,471	
70	4,353	4,253	4,223	4,226	4,242	4,240	4,544	1,125	1,125	1,620	3,000	4,587	4,542	4,475	
80	4,359	4,255	4,223	4,228	4,245	4,274	4,544	1,500	1,500	2,859	3,000	4,594	4,547	4,477	
90	4,370	4,259	4,225	4,229	4,248	4,287	4,600	1,500	1,500	3,000	3,000	4,600	4,558	4,483	
Max	4,391	4,265	4,227	4,232	4,254	4,308	4,600	1,500	1,500	3,001	3,000	4,600	4,578	4,494	
Avg	3,723	3,487	3,417	3,498	3,487	3,152	2,895	1,021	1,011	1,543	2,326	3,720	3,990	4,152	2,305

E. 2020 Scenario B

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post-VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	1,693	800	682	735	641	800	800	800	800	800	800	800	898	1,193	
10	2,313	1,262	1,366	2,169	1,060	1,197	800	800	800	800	1,164	910	2,308	2,860	
20	3,024	2,199	2,656	2,998	2,575	1,792	800	800	800	800	1,502	2,559	3,119	4,031	
30	3,062	2,939	2,992	3,004	2,997	2,561	1,500	800	800	800	1,860	3,537	4,370	4,346	
40	3,564	3,731	3,004	3,008	3,580	2,849	2,601	800	800	800	2,261	4,531	4,500	4,419	
50	4,220	4,217	4,209	4,002	3,943	3,293	3,127	800	800	1,125	2,523	4,561	4,523	4,464	
60	4,334	4,247	4,220	4,220	4,231	3,952	3,856	1,125	800	1,500	2,908	4,578	4,535	4,470	
70	4,352	4,253	4,223	4,225	4,235	4,242	4,544	1,125	1,125	1,666	3,000	4,587	4,542	4,475	
80	4,361	4,255	4,223	4,228	4,245	4,274	4,544	1,500	1,500	2,846	3,000	4,597	4,549	4,478	
90	4,370	4,259	4,225	4,229	4,248	4,281	4,600	1,500	1,500	3,000	3,000	4,600	4,558	4,483	
Max	4,391	4,265	4,227	4,232	4,254	4,305	4,600	1,500	1,500	3,001	3,000	4,600	4,578	4,494	
Avg	3,684	3,403	3,368	3,470	3,404	3,095	2,911	1,021	1,011	1,543	2,324	3,750	3,991	4,138	2,286

F. 2020 Scenario B Changes (D – E)

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-Vamp 4/1–4/15	Vamp 4/16–4/30	Vamp 5/1–5/15	Post-Vamp 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	29	0	-41	20	0	0	0	0	0	0	0	0	0	-5	
10	-88	-71	13	-14	-357	3	0	0	0	0	-15	-334	-37	-7	
20	8	-34	-99	0	-19	-272	0	0	0	0	-39	110	-458	-49	
30	-92	-362	-7	0	-292	-15	203	0	0	0	-148	103	80	-3	
40	-115	3	-75	0	-324	-80	40	0	0	0	1	-2	-3	-23	
50	-39	-8	-2	-212	-275	-131	0	0	0	0	0	0	0	1	
60	-5	-2	0	-4	-1	-28	39	0	0	0	0	0	0	-1	
70	-1	0	0	-1	-7	2	0	0	0	47	0	0	0	0	
80	2	0	0	0	0	0	0	0	0	-14	0	3	2	1	
90	0	0	0	0	0	-6	0	0	0	0	0	0	0	0	
Max	0	0	0	0	0	-3	0	0	0	0	0	0	0	0	
Avg	-39	-84	-49	-28	-83	-57	16	0	0	1	-2	30	1	-14	-19

Table 5.1-9. CALSIM–Simulated Scenario B SWP Exports Monthly Distribution, for 2001 and 2020 Conditions (cfs)

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A. 2001 Baseline

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post-VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	723	300	300	1,246	762	300	300	300	300	300	300	1,445	300	837	
10	1,235	980	2,643	2,645	1,674	1,121	304	304	606	606	842	3,367	1,639	1,658	
20	2,666	2,255	3,135	3,893	3,016	2,570	700	700	700	1,125	2,271	3,829	5,480	3,881	
30	3,675	2,571	3,966	4,556	3,482	3,175	1,500	700	700	1,868	2,886	4,123	5,819	4,851	
40	4,210	3,229	4,472	5,272	4,111	4,234	2,904	700	700	2,692	3,475	4,745	6,524	5,782	
50	4,984	4,208	5,193	5,967	5,176	5,260	3,679	700	700	2,976	4,112	5,418	6,680	6,209	
60	5,467	5,022	5,705	6,775	6,668	6,914	4,527	700	700	3,926	4,347	6,083	6,680	6,630	
70	6,371	6,588	7,001	7,296	7,735	7,228	5,500	1,125	1,125	4,521	5,266	6,658	6,749	6,680	
80	6,680	6,680	7,047	7,465	8,437	7,561	5,640	1,500	1,500	5,639	6,072	7,180	7,003	7,180	
90	6,680	6,680	7,195	8,493	8,500	7,561	5,697	1,500	1,500	5,640	6,680	7,180	7,180	7,180	
Max	6,680	6,680	7,678	8,500	8,500	7,561	5,697	1,500	1,500	5,687	6,680	7,180	7,180	7,180	
Avg	4,583	4,172	5,110	5,769	5,409	5,006	3,413	905	916	3,214	3,991	5,350	5,767	5,457	3,312

B. 2001 Scenario B

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post-VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	300	300	300	1,246	328	300	300	300	300	300	300	1,929	300	1,150	
10	1,180	921	2,211	2,622	1,672	1,122	316	316	486	486	612	3,083	1,810	1,656	
20	2,563	2,051	2,856	3,492	3,012	2,720	700	700	700	903	2,138	4,226	5,162	3,846	
30	3,363	2,394	3,769	4,316	3,481	3,174	1,500	700	700	1,868	2,849	4,775	6,418	4,787	
40	3,904	3,014	4,314	4,972	4,111	4,375	2,849	700	700	2,682	3,481	5,480	6,848	5,413	
50	4,874	3,820	5,218	5,372	5,296	5,327	3,679	700	700	2,978	4,112	6,146	7,080	6,232	
60	5,260	4,744	5,330	6,531	6,368	6,468	4,527	700	700	3,926	4,440	6,611	7,334	6,568	
70	5,979	5,673	6,726	7,180	7,180	7,180	5,502	1,125	1,125	4,519	5,266	6,899	8,055	6,832	
80	7,713	6,788	7,180	7,180	7,180	7,180	5,891	1,500	1,500	5,827	6,072	7,748	8,307	7,448	
90	8,500	8,500	7,180	7,180	7,180	7,180	5,891	1,500	1,500	5,890	7,111	8,186	8,310	8,500	
Max	8,500	8,500	7,180	7,180	7,180	7,180	5,948	1,500	1,500	5,937	7,180	8,500	8,500	8,500	
Avg	4,816	4,252	4,892	5,401	4,934	4,890	3,455	903	912	3,221	4,002	5,877	6,373	5,660	3,345

C. 2001 Scenario B Changes (A – B)

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post-VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	-423	0	0	0	-434	0	0	0	0	0	0	484	0	313	
10	-55	-59	-432	-23	-2	1	12	12	-120	-120	-230	-284	171	-2	
20	-103	-204	-279	-401	-4	150	0	0	0	-222	-133	397	-318	-35	
30	-312	-177	-197	-240	-1	-1	0	0	0	0	-37	652	599	-64	
40	-306	-215	-158	-300	0	141	-54	0	0	-10	6	735	324	-369	
50	-110	-388	25	-595	120	67	0	0	0	2	0	728	400	23	
60	-207	-278	-375	-244	-300	-446	0	0	0	0	93	528	654	-62	
70	-392	-915	-275	-116	-555	-48	2	0	0	-2	0	241	1,306	152	
80	1,033	108	133	-285	-1,257	-381	251	0	0	187	0	568	1,304	268	
90	1,820	1,820	-15	-1,313	-1,320	-381	194	0	0	250	431	1,006	1,130	1,320	
Max	1,820	1,820	-498	-1,320	-1,320	-381	251	0	0	250	500	1,320	1,320	1,320	
Avg	233	80	-218	-368	-475	-116	42	-2	-4	7	11	527	606	203	33

Table 5.1-9. Continued

D. 2020 Baseline

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post-VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	586	301	1,065	1,358	778	300	300	300	300	300	300	1,781	302	801	
10	1,141	1,188	2,599	2,890	1,994	1,182	320	320	700	700	333	2,740	1,859	1,532	
20	2,362	1,957	3,562	4,160	3,104	2,823	1,560	700	700	700	2,292	3,856	4,842	3,983	
30	3,083	2,666	4,125	4,625	3,867	3,555	2,749	700	700	1,799	3,038	4,111	6,102	4,884	
40	4,003	3,192	4,326	4,929	4,478	4,476	3,450	700	700	2,653	3,717	4,691	6,594	5,380	
50	4,624	4,234	5,131	6,354	5,686	6,135	4,172	700	700	3,033	3,973	5,768	6,680	5,946	
60	5,394	5,354	5,501	7,296	7,431	7,060	4,964	700	700	3,804	4,538	6,680	6,749	6,380	
70	6,464	6,357	6,713	7,405	8,171	7,254	5,640	1,125	1,125	4,416	5,302	7,180	7,026	6,550	
80	6,680	6,680	7,032	8,070	8,437	7,561	5,640	1,500	1,500	5,639	5,969	7,180	7,180	6,686	
90	6,680	6,680	7,157	8,500	8,500	7,561	5,697	1,500	1,500	5,640	6,680	7,180	7,180	7,180	
Max	6,680	6,680	7,678	8,500	8,500	7,561	5,697	1,500	1,500	5,687	6,680	7,180	7,180	7,180	
Avg	4,436	4,220	5,122	5,987	5,692	5,201	3,763	914	920	3,160	3,981	5,433	5,861	5,290	3,357

E. 2020 Scenario B

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post-VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	300	300	300	1,359	778	300	300	300	300	300	300	2,060	302	817	
10	1,109	1,166	2,509	3,002	1,838	1,238	700	700	700	700	546	2,779	1,525	1,523	
20	2,426	1,998	3,138	4,009	3,194	2,827	1,541	700	700	700	2,262	4,420	4,699	3,674	
30	3,135	2,676	3,957	4,321	3,765	3,368	2,749	700	700	1,799	2,887	4,752	6,227	4,843	
40	3,705	3,289	4,316	4,931	4,309	4,476	3,450	700	700	2,686	3,734	5,129	6,978	5,331	
50	4,480	3,928	5,233	6,077	5,329	5,900	4,171	700	700	3,031	3,963	6,242	7,441	5,865	
60	5,335	4,490	5,332	7,180	7,180	7,180	4,973	700	700	3,804	4,533	6,687	7,688	6,156	
70	6,147	5,342	6,138	7,180	7,180	7,180	5,772	1,125	1,125	4,416	5,305	7,443	7,988	6,724	
80	8,003	6,745	7,180	7,180	7,180	7,180	5,891	1,500	1,500	5,805	5,969	8,214	8,189	7,229	
90	8,500	8,500	7,180	7,180	7,180	7,180	5,948	1,500	1,500	5,890	7,029	8,500	8,310	8,500	
Max	8,500	8,500	7,180	7,180	7,180	7,180	5,948	1,500	1,500	5,937	7,180	8,500	8,500	8,500	
Avg	4,749	4,244	4,957	5,622	5,167	5,092	3,854	923	918	3,212	4,024	5,997	6,372	5,477	3,393

F. 2020 Scenario B Changes (D – E)

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post-VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	-286	-1	-765	1	0	0	0	0	0	0	0	279	0	16	
10	-32	-22	-90	112	-156	56	380	380	0	0	213	39	-334	-9	
20	64	41	-424	-151	90	4	-19	0	0	0	-30	564	-143	-309	
30	52	10	-168	-304	-102	-187	0	0	0	0	-151	641	125	-41	
40	-298	97	-10	2	-169	0	0	0	0	33	17	438	384	-49	
50	-144	-306	102	-277	-357	-235	-1	0	0	-2	-10	474	761	-81	
60	-59	-864	-169	-116	-251	120	9	0	0	0	-5	7	939	-224	
70	-317	-1,015	-575	-225	-991	-74	132	0	0	0	3	263	962	174	
80	1,323	65	148	-890	-1,257	-381	251	0	0	166	0	1,034	1,009	543	
90	1,820	1,820	23	-1,320	-1,320	-381	251	0	0	250	349	1,320	1,130	1,320	
Max	1,820	1,820	-498	-1,320	-1,320	-381	251	0	0	250	500	1,320	1,320	1,320	
Avg	313	24	-165	-365	-525	-109	92	9	-1	52	43	564	511	187	37

reduced in almost all years (even when baseline pumping was less than 6,680 cfs) during these winter months.

The allowance of 500 cfs of EWA wheeling in July–September was included in the baseline assumptions, and was simulated in about 20% of the years. The full increase in SWP Banks pumping of 1,320 cfs during these summer months that is allowed under Alternative 2B was simulated in only about 10% of the years. The SWP exports for contractors are allowed above 6,680 cfs in these months under Alternative 2B once all necessary EWA wheeling is accomplished. There was an average increase in SWP Banks pumping of about 527 cfs in July, 606 cfs in August, and 203 cfs in September. Alternative 2B SWP Banks pumping would be similar to 2001 baseline conditions, with a slight average increase of 33 taf (1% of the average annual baseline SWP pumping). The average annual increase of 33 taf is not large enough to be considered an improvement in SWP water supply reliability.

Table 5.1-7a shows the simulated annual (water year) SWP south-of-Delta Table A deliveries for Alternative 2B compared to the 2001 baseline values. The average change in SWP deliveries under Alternative 2B would be a reduction of 19 taf/year. The maximum annul reduction was 144 taf in 1947, and the largest increase was 86 taf in 1994. In half the years, the change in SWP deliveries was less than 10 taf. The slight average decrease in SWP deliveries was less than 0.5% of the average simulated SWP baseline deliveries. No substantial change in SWP deliveries would occur under Alternative 2B. The SWP Article 21 deliveries would be increased by an average of 27 taf under Alternative 2B compared with the 2001 baseline value of 148 taf (see Table 5.1-12).

2020 Conditions

Figure 5.1-33 shows the average monthly changes in CVP and SWP pumping for Alternative 2B compared to the 2001 and 2020 baselines. The figure indicates that the average changes in monthly pumping are relatively small and that the simulated changes in SWP pumping are larger than those simulated for CVP pumping. The simulated CVP Tracy and SWP Banks pumping changes for Alternative 2B under 2020 conditions were similar to the CVP Tracy and SWP Banks pumping changes under 2001 conditions (see Figures 5.1-31 and 5.1-32). Table 5.1-8 compares 2020 CVP pumping patterns for Alternative 2B. Table 5.1-9 shows the simulated 2020 SWP pumping patterns for Alternative 2B. They are similar in all months to the 2001 Alternative 2B pumping patterns. The monthly CVP Tracy pumping for 2020 Alternative 2B and the 2020 baseline conditions is given in Table I-35. The monthly and annual differences are given.

Table 5.1-5b indicates that the CVP deliveries for 2020 simulations were similar to the 2001 results for Alternative 2B, with an average increase of 15 taf/yr.

Table 5.1-9 indicates that the average change in SWP deliveries under Alternative 2B would be an increase of 3 taf/yr for 2020 conditions. The monthly SWP Banks pumping for 2020 Alternative 2B and the 2020 baseline conditions are given in Table I-37. The SWP Article 21 deliveries would be increased by an average of 11 taf under Alternative 2B compared with the 2020 baseline value of 92 taf (see Table 5.1-13).

Alternative 2C

Stage 1 (Physical/Structural Component)

Under Stage 1 of Alternative 2C, the fish control gate at the head of Old River would be constructed and operated. All three proposed agricultural tidal gates would also be installed and operated: (1) in Old River just upstream of the CVP Tracy facility, (2) in Grant Line Canal just upstream of the CCF gates, and (3) in Middle River just upstream of Victoria Canal. Stage 1 would also include the dredging of some south Delta channels and the extension of up to 24 agricultural diversions. Construction and operation of the physical components under this alternative would not result in water supply impacts.

2020 Conditions

2020 conditions in the south Delta under Stage 1 of Alternative 2C are expected to be the same as those described for 2001. Therefore, construction and operation of the physical components under this alternative would not result in water supply impacts.

Stage 2 (Operational Component)

Stage 2 of Alternative 2C operational scenario represents a moderate set of maximum SWP Banks pumping limits for the 8,500 cfs pumping capacity. The general rules that are associated with this Alternative are described in Chapter 2, “Project Description,” and summarized in Table 2-2. Alternative 2C imposes no new rules on the CVP Tracy pumping. The 8,500 cfs limit on SWP Banks pumping is allowed from June through February. The March limits remain the same as under the current permit, with pumping until March 15 increased by one-third of the San Joaquin River inflow, with an assumed March maximum of 7,560 cfs (average of 6,680 cfs and 8,500 cfs), just as in the baseline simulation.

Change WS-1: Change in CVP Water Supply Pumping and Deliveries. Figure 5.1-34 shows the monthly cumulative distribution of simulated CVP Tracy pumping for Alternative 2C compared with the 2001 and 2020 baseline pumping. The simulated CVP Tracy pumping for Alternative 2C is very similar to the 2001 baseline conditions.

Table 5.1-10 gives the simulated monthly cumulative distribution of CVP Tracy pumping for the 73-year period of CALSIM simulation of Alternative 2C compared to the baseline monthly cumulative distribution for the 2001 conditions. The simulation of Alternative 2C indicates that the October CVP Tracy pumping will be similar, with the minimum pumping slightly higher at 1,751 cfs, the median slightly lower at 4,294 cfs, and the maximum the same at

Table 5.1-10. CALSIM–Simulated Scenario C CVP Tracy Pumping Monthly Distribution, for 2001 and 2020 Conditions (cfs)

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A. 2001 Baseline

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post-VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	1,616	800	351	691	641	800	800	800	800	800	800	800	868	1,410	
10	2,585	1,251	1,193	2,389	1,389	1,240	800	800	800	800	1,220	857	2,048	2,912	
20	2,998	2,431	2,889	2,999	2,877	1,865	800	800	800	800	1,734	2,571	3,718	4,275	
30	3,309	3,412	3,002	3,007	3,137	2,403	1,125	800	800	800	2,012	3,745	4,467	4,366	
40	3,914	4,217	3,212	3,026	3,679	2,772	1,500	800	800	800	2,339	4,536	4,505	4,448	
50	4,315	4,247	4,209	4,122	4,020	3,352	2,919	800	800	1,125	2,540	4,570	4,531	4,468	
60	4,344	4,250	4,221	4,222	4,224	3,685	3,564	1,125	800	1,500	2,852	4,577	4,535	4,470	
70	4,355	4,253	4,222	4,226	4,237	4,230	4,200	1,125	1,125	1,500	3,000	4,588	4,543	4,475	
80	4,365	4,256	4,224	4,228	4,245	4,274	4,544	1,500	1,500	2,692	3,000	4,600	4,553	4,481	
90	4,374	4,260	4,225	4,229	4,247	4,286	4,600	1,500	1,500	3,000	3,000	4,600	4,562	4,485	
Max	4,391	4,265	4,227	4,232	4,254	4,308	4,600	1,500	1,500	3,001	3,000	4,600	4,578	4,494	
Avg	3,781	3,541	3,415	3,504	3,479	3,088	2,737	1,019	1,011	1,507	2,365	3,790	4,021	4,183	2,312

B. 2001 Scenario C

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post-VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	1,751	800	16	603	641	800	800	800	800	800	800	800	800	1,394	
10	2,623	1,280	1,087	1,921	1,014	872	800	800	800	800	1,220	859	1,753	2,911	
20	2,989	2,380	2,426	2,993	2,445	1,990	800	800	800	800	1,779	2,556	3,517	4,262	
30	3,157	3,005	2,999	3,004	3,096	2,325	1,125	800	800	800	2,027	3,985	4,463	4,362	
40	3,638	3,819	3,083	3,009	3,426	2,635	1,500	800	800	800	2,327	4,540	4,508	4,455	
50	4,294	4,203	4,209	4,042	3,941	2,867	2,939	800	800	1,125	2,557	4,573	4,531	4,469	
60	4,343	4,250	4,222	4,222	4,225	3,509	3,564	1,125	800	1,500	2,921	4,583	4,539	4,473	
70	4,355	4,253	4,223	4,226	4,237	4,230	4,202	1,125	1,125	1,500	3,000	4,588	4,543	4,475	
80	4,366	4,255	4,224	4,228	4,245	4,276	4,544	1,500	1,500	2,596	3,000	4,600	4,553	4,481	
90	4,374	4,260	4,225	4,229	4,247	4,291	4,600	1,500	1,500	3,000	3,000	4,600	4,562	4,486	
Max	4,391	4,265	4,227	4,232	4,254	4,307	4,600	1,500	1,500	3,001	3,000	4,600	4,578	4,494	
Avg	3,751	3,465	3,364	3,450	3,383	3,003	2,737	1,019	1,011	1,505	2,385	3,809	4,012	4,165	2,289

C. 2001 Scenario C Changes (A – B)

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post-VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	135	0	-335	-88	0	0	0	0	0	0	0	0	-68	-16	
10	38	29	-106	-468	-375	-368	0	0	0	0	0	2	-295	-1	
20	-9	-51	-463	-6	-432	125	0	0	0	0	45	-15	-201	-13	
30	-152	-407	-3	-3	-41	-78	0	0	0	0	15	240	-4	-4	
40	-276	-398	-129	-17	-253	-137	0	0	0	0	-12	4	3	7	
50	-21	-44	0	-80	-79	-485	19	0	0	0	17	3	0	1	
60	-1	0	1	0	1	-176	0	0	0	0	69	6	4	3	
70	0	0	1	0	0	0	2	0	0	0	0	0	0	0	
80	1	-1	0	0	0	2	0	0	0	-96	0	0	0	0	
90	0	0	0	0	0	5	0	0	0	0	0	0	0	1	
Max	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	
Avg	-30	-76	-51	-54	-96	-85	0	0	0	-2	20	19	-9	-18	-23

Table 5.1-10. Continued

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D. 2020 Baseline

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post-VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	1,664	800	723	715	641	800	800	800	800	800	800	800	898	1,198	
10	2,401	1,333	1,353	2,183	1,417	1,194	800	800	800	800	1,179	1,244	2,345	2,867	
20	3,016	2,233	2,755	2,998	2,594	2,064	800	800	800	800	1,541	2,449	3,577	4,080	
30	3,154	3,301	2,999	3,004	3,289	2,576	1,297	800	800	800	2,008	3,434	4,290	4,349	
40	3,679	3,728	3,079	3,008	3,904	2,929	2,561	800	800	800	2,260	4,533	4,503	4,442	
50	4,259	4,225	4,211	4,214	4,218	3,424	3,127	800	800	1,125	2,523	4,561	4,523	4,463	
60	4,339	4,249	4,220	4,224	4,232	3,980	3,817	1,125	800	1,500	2,908	4,578	4,535	4,471	
70	4,353	4,253	4,223	4,226	4,242	4,240	4,544	1,125	1,125	1,620	3,000	4,587	4,542	4,475	
80	4,359	4,255	4,223	4,228	4,245	4,274	4,544	1,500	1,500	2,859	3,000	4,594	4,547	4,477	
90	4,370	4,259	4,225	4,229	4,248	4,287	4,600	1,500	1,500	3,000	3,000	4,600	4,558	4,483	
Max	4,391	4,265	4,227	4,232	4,254	4,308	4,600	1,500	1,500	3,001	3,000	4,600	4,578	4,494	
Avg	3,723	3,487	3,417	3,498	3,487	3,152	2,895	1,021	1,011	1,543	2,326	3,720	3,990	4,152	2,305

E. 2020 Scenario C

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post-VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	1,661	800	740	720	641	800	800	800	800	800	800	800	898	1,187	
10	2,341	1,295	1,285	1,818	1,063	1,166	800	800	800	800	1,113	856	1,986	2,803	
20	2,921	2,181	2,690	2,995	2,252	1,762	800	800	800	800	1,577	2,248	3,486	4,018	
30	3,053	3,196	2,992	3,000	2,993	2,457	1,500	800	800	800	1,833	3,491	4,149	4,350	
40	3,619	3,694	3,004	3,008	3,562	2,644	2,608	800	800	800	2,261	4,529	4,500	4,436	
50	4,234	4,007	4,209	3,780	3,943	3,284	3,129	800	800	1,125	2,523	4,562	4,523	4,465	
60	4,326	4,240	4,220	4,218	4,229	3,963	3,843	1,125	800	1,500	2,908	4,579	4,536	4,472	
70	4,353	4,253	4,223	4,226	4,235	4,249	4,544	1,125	1,125	1,589	3,000	4,588	4,542	4,475	
80	4,359	4,255	4,223	4,228	4,245	4,277	4,544	1,500	1,500	2,813	3,000	4,598	4,551	4,479	
90	4,370	4,259	4,225	4,229	4,247	4,287	4,600	1,500	1,500	3,000	3,000	4,600	4,558	4,483	
Max	4,391	4,265	4,227	4,232	4,254	4,308	4,600	1,500	1,500	3,001	3,000	4,600	4,578	4,494	
Avg	3,677	3,407	3,380	3,417	3,385	3,083	2,910	1,021	1,011	1,542	2,316	3,695	3,971	4,134	2,276

F. 2020 Scenario C Changes (D – E)

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post-VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	-3	0	17	5	0	0	0	0	0	0	0	0	0	-11	
10	-60	-38	-68	-365	-354	-28	0	0	0	0	-66	-388	-359	-64	
20	-95	-52	-65	-3	-342	-302	0	0	0	0	36	-201	-91	-62	
30	-101	-105	-7	-4	-296	-119	203	0	0	0	-175	57	-141	1	
40	-60	-34	-75	0	-342	-285	46	0	0	0	1	-4	-3	-6	
50	-25	-218	-2	-434	-275	-140	2	0	0	0	0	1	0	2	
60	-13	-9	0	-6	-3	-17	26	0	0	0	0	1	1	1	
70	0	0	0	0	-7	9	0	0	0	-31	0	1	0	0	
80	0	0	0	0	0	3	0	0	0	-47	0	4	4	2	
90	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	
Max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Avg	-46	-80	-37	-81	-102	-69	15	0	0	-1	-10	-25	-19	-18	-29

4,391 cfs. On average, the October CVP Tracy pumping will be reduced by 30 cfs. The other months reveal a similar pattern, with very small changes in simulated CVP Tracy pumping. The simulated CVP Tracy pumping in the August–March period was slightly reduced under Alternative 2C. CVP Tracy pumping in April and May was identical for the baseline and Alternative 2C.

Table I-40 gives the simulated monthly CVP Tracy pumping for 2001 Alternative 2C and the 2001 baseline conditions for the 73-year period of CALSIM simulation. The monthly and annual differences are given.

The CVP water supply that can be pumped at the CVP Tracy facility would not be significantly changed by the Alternative 2C assumptions. There may still be a gain or loss of CVP deliveries if the wheeling that is simulated at SWP Banks is increased or reduced by some of the Alternative 2C assumptions. The actual shifts in the simulated annual (water year) CVP deliveries for each of the operational alternatives is given in Table 5.1-5a. The average change in CVP deliveries with Operational Scenario C was an increase of 24 taf, about 1% of the baseline average delivery. The maximum annual change under Operational Scenario C was 195 taf in 1948. The largest reduction in annual delivery was 118 taf in 1939. This slight shift in average CVP deliveries under Operational Scenario C is about 1% of the average baseline CVP deliveries.

Change WS-2: Change in SWP Water Supply Pumping and Deliveries. Figure 5.1-35 shows the monthly cumulative distribution of simulated SWP Banks pumping for Alternative 2C compared with the 2001 and 2020 baseline pumping. The SWP Banks pumping is at the 8,500-cfs limit in only about 10% of the years during the months of July through March. Table I-42 gives the monthly SWP Banks pumping for Alternative 2C and the 2001 baseline pumping for each of the 73 years. The monthly and annual differences are given. The Alternative 2C SWP Banks pumping was higher in the months of July–November because of the allowable 8,500-cfs pumping limit. Table 5.1-11 gives the simulated monthly cumulative distribution of SWP Banks pumping for the 73-year period of CALSIM simulation of Alternative 2C compared to the monthly cumulative distributions for the 2001 baseline conditions. The Alternative 2C SWP Banks pumping was similar, with an average increase of 126 taf (4% of the average annual baseline SWP pumping). This change in simulated total SWP pumping is considered a substantial improvement in water supply reliability.

For the baseline simulation during October, there was a 20% probability that SWP Banks pumping would be close to the maximum capacity of 6,680 cfs. The simulation of Alternative 2C indicates that the October SWP Banks pumping will be higher than 6,680 cfs in about 20% of the years (the same years that the baseline was at 6,680 cfs). The maximum increment in SWP pumping of 1,820 cfs will occur during October in about 10% of the years. The increased SWP Banks pumping in November is similar, with about 20% of the years at 6,680 cfs capacity in the baseline simulation increasing to the new 8,500 cfs pumping capacity in about 10% of the years under Alternative 2C.

The changes in SWP Banks pumping under Alternative 2C in the December–March period reflects the increased maximum pumping limit of 8,500 cfs that is allowed regardless of the San Joaquin River inflow. Although SWP Banks pumping increases to 8,500 cfs in more of these months than under the baseline, there are some reductions in SWP Banks pumping during these months in other years of the simulation. The maximum December pumping was 7,678 cfs under the baseline, and 20% of the years are pumping at 8,500 cfs under Alternative 2C. The changes in January are smaller, with about 10% more years at 8,500 cfs. The simulated changes in February are smaller yet, presumably because SWP San Luis Reservoir is simulated to fill earlier with the increased SWP Banks pumping limits.

The simulated SWP Banks pumping was not changed during March because the pumping limits do not change under Alternative 2C. SWP pumping was not changed in April or May because conditions are almost completely determined by the E/I ratio and the VAMP reductions. Alternative 2C allows no increase in SWP Banks pumping limits during April or May.

The full increase in SWP Banks pumping of 1,320 cfs during July–September that is allowed under Alternative 2C was simulated in only about 10% of the years. There was an average increase in SWP Banks pumping of about 508 cfs in July, 532 cfs in August, and 223 cfs in September under Alternative 2C. The average annual increase of 126 taf is certainly large enough to consider as an improvement in SWP water supply reliability.

Table 5.1-7a shows the annual (water year) SWP south-of-Delta deliveries for the baseline and Alternative 2C for 2001 conditions. The average change was 6 taf, and the increased SWP deliveries were more than 20 taf in about 20% of the years. There were also reductions of more than 20 taf in 10% of the years. There was an increase in SWP Article 21 deliveries from the baseline average of 148 taf to 203 taf under Alternative 2C. This is an improvement in water supply conditions for some SWP contractors.

2020 Conditions

Figure 5.1-36 shows the average monthly changes in CVP and SWP pumping for Alternative 2C compared to the 2001 and 2020 baselines. The figure indicates that the average changes in monthly pumping are relatively small and that the simulated changes in SWP pumping are larger than those simulated for CVP pumping. The CVP Tracy and SWP Banks pumping changes under 2020 conditions were similar to the CVP Tracy and SWP Banks pumping changes under 2001 conditions. Water supply changes associated with the Alternative 2C simulated under 2020 conditions are similar to the changes identified for the 2001 conditions. Table 5.1-10 shows the 2020 monthly cumulative distribution of CVP pumping for Alternative 2C compared to the 2020 baseline conditions. Table 5.1-11 shows the simulated 2020 monthly cumulative distribution of SWP pumping patterns for Alternative 2C compared to the 2020 baseline conditions. They are similar in all months to the simulated pumping patterns for Alternative 2C under 2001 conditions. The monthly CVP Tracy pumping for 2020 Alternative 2C and the 2020 baseline conditions is given in Table I-41.

Table 5.1-11. CALSIM–Simulated Scenario C SWP Exports Monthly Distribution, for 2001 and 2020 Conditions (cfs)

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A. 2001 Baseline

Per-centile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post-VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	723	300	300	1,246	762	300	300	300	300	300	300	1,445	300	837	
10	1,235	980	2,643	2,645	1,674	1,121	304	304	606	606	842	3,367	1,639	1,658	
20	2,666	2,255	3,135	3,893	3,016	2,570	700	700	700	1,125	2,271	3,829	5,480	3,881	
30	3,675	2,571	3,966	4,556	3,482	3,175	1,500	700	700	1,868	2,886	4,123	5,819	4,851	
40	4,210	3,229	4,472	5,272	4,111	4,234	2,904	700	700	2,692	3,475	4,745	6,524	5,782	
50	4,984	4,208	5,193	5,967	5,176	5,260	3,679	700	700	2,976	4,112	5,418	6,680	6,209	
60	5,467	5,022	5,705	6,775	6,668	6,914	4,527	700	700	3,926	4,347	6,083	6,680	6,630	
70	6,371	6,588	7,001	7,296	7,735	7,228	5,500	1,125	1,125	4,521	5,266	6,658	6,749	6,680	
80	6,680	6,680	7,047	7,465	8,437	7,561	5,640	1,500	1,500	5,639	6,072	7,180	7,003	7,180	
90	6,680	6,680	7,195	8,493	8,500	7,561	5,697	1,500	1,500	5,640	6,680	7,180	7,180	7,180	
Max	6,680	6,680	7,678	8,500	8,500	7,561	5,697	1,500	1,500	5,687	6,680	7,180	7,180	7,180	
Avg	4,583	4,172	5,110	5,769	5,409	5,006	3,413	905	916	3,214	3,991	5,350	5,767	5,457	3,312

B. 2001 Scenario C

Per-centile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post-VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	300	300	300	1,248	752	300	300	300	300	300	300	1,483	300	915	
10	1,289	924	2,174	2,630	1,669	1,124	300	300	609	609	559	2,882	1,448	1,655	
20	2,425	1,867	2,820	3,682	2,984	2,570	700	700	700	1,125	2,456	4,182	5,134	3,351	
30	3,471	2,474	3,761	4,809	3,481	3,174	1,500	700	700	1,882	2,994	4,673	6,145	4,851	
40	3,727	3,014	4,348	4,958	4,148	4,375	2,849	700	700	2,690	3,590	5,253	6,621	5,278	
50	4,787	3,919	5,191	5,685	5,597	5,613	3,679	700	700	2,973	4,062	6,131	7,022	6,277	
60	5,338	5,000	6,319	6,391	6,320	6,442	4,527	700	700	3,926	4,338	6,565	7,266	6,563	
70	5,969	5,778	6,912	8,500	8,500	7,561	5,502	1,125	1,125	4,521	5,262	6,822	7,699	6,924	
80	8,190	6,748	8,500	8,500	8,500	7,561	5,640	1,500	1,500	5,639	6,071	7,741	8,308	7,433	
90	8,500	8,500	8,500	8,500	8,500	7,561	5,697	1,500	1,500	5,640	6,680	8,500	8,310	8,500	
Max	8,500	8,500	8,500	8,500	8,500	7,561	5,697	1,500	1,500	5,687	6,680	8,500	8,500	8,500	
Avg	4,815	4,269	5,338	5,927	5,477	5,003	3,390	900	916	3,201	4,029	5,858	6,299	5,680	3,437

C. 2001 Scenario C Changes (A – B)

Per-centile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post-VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	-423	0	0	2	-10	0	0	0	0	0	0	38	0	78	
10	54	-56	-469	-15	-5	3	-4	-4	3	3	-283	-485	-191	-3	
20	-241	-388	-315	-211	-32	0	0	0	0	0	185	353	-346	-530	
30	-204	-97	-205	253	-1	-1	0	0	0	14	108	550	326	0	
40	-483	-215	-124	-314	37	141	-54	0	0	-3	115	508	97	-504	
50	-197	-289	-2	-282	421	353	0	0	0	-4	-50	713	342	68	
60	-129	-22	614	-384	-348	-472	0	0	0	0	-9	482	586	-67	
70	-402	-810	-89	1,204	765	333	2	0	0	0	-4	164	950	244	
80	1,510	68	1,453	1,035	63	0	0	0	0	0	-1	561	1,305	253	
90	1,820	1,820	1,305	7	0	0	0	0	0	0	0	1,320	1,130	1,320	
Max	1,820	1,820	822	0	0	0	0	0	0	0	0	1,320	1,320	1,320	
Avg	232	97	228	158	68	-3	-23	-5	0	-13	38	508	532	223	126

Table 5.1-11. Continued

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D. 2020 Baseline

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post-VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	586	301	1,065	1,358	778	300	300	300	300	300	300	1,781	302	801	
10	1,141	1,188	2,599	2,890	1,994	1,182	320	320	700	700	333	2,740	1,859	1,532	
20	2,362	1,957	3,562	4,160	3,104	2,823	1,560	700	700	700	2,292	3,856	4,842	3,983	
30	3,083	2,666	4,125	4,625	3,867	3,555	2,749	700	700	1,799	3,038	4,111	6,102	4,884	
40	4,003	3,192	4,326	4,929	4,478	4,476	3,450	700	700	2,653	3,717	4,691	6,594	5,380	
50	4,624	4,234	5,131	6,354	5,686	6,135	4,172	700	700	3,033	3,973	5,768	6,680	5,946	
60	5,394	5,354	5,501	7,296	7,431	7,060	4,964	700	700	3,804	4,538	6,680	6,749	6,380	
70	6,464	6,357	6,713	7,405	8,171	7,254	5,640	1,125	1,125	4,416	5,302	7,180	7,026	6,550	
80	6,680	6,680	7,032	8,070	8,437	7,561	5,640	1,500	1,500	5,639	5,969	7,180	7,180	6,686	
90	6,680	6,680	7,157	8,500	8,500	7,561	5,697	1,500	1,500	5,640	6,680	7,180	7,180	7,180	
Max	6,680	6,680	7,678	8,500	8,500	7,561	5,697	1,500	1,500	5,687	6,680	7,180	7,180	7,180	
Avg	4,436	4,220	5,122	5,987	5,692	5,201	3,763	914	920	3,160	3,981	5,433	5,861	5,290	3,357

E. 2020 Scenario C

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Pre-VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post-VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	300	300	300	1,358	778	300	300	300	300	300	300	1,593	300	806	
10	1,148	1,096	2,585	3,061	1,963	1,174	700	700	700	700	749	3,163	976	1,596	
20	2,222	1,809	3,287	4,191	3,045	2,826	1,538	700	700	700	2,162	4,450	4,750	4,001	
30	3,289	2,633	3,970	4,812	3,809	3,527	2,749	700	700	1,799	3,107	4,843	6,418	4,697	
40	3,679	2,981	4,811	4,981	4,363	4,677	3,448	700	700	2,655	3,725	5,347	6,775	5,314	
50	4,488	3,927	5,341	6,320	6,319	6,168	4,172	700	700	3,031	3,975	6,176	7,302	5,846	
60	5,285	4,622	5,995	7,767	6,737	7,232	4,971	700	700	3,804	4,534	6,506	7,725	6,246	
70	6,103	5,368	6,322	8,500	8,500	7,561	5,640	1,125	1,125	4,416	5,305	7,326	8,064	6,669	
80	8,500	6,755	8,044	8,500	8,500	7,561	5,640	1,500	1,500	5,639	5,969	8,458	8,310	7,045	
90	8,500	8,500	8,500	8,500	8,500	7,561	5,697	1,500	1,500	5,640	6,680	8,500	8,390	8,500	
Max	8,500	8,500	8,500	8,500	8,500	7,561	5,697	1,500	1,500	5,687	6,680	8,500	8,500	8,500	
Avg	4,769	4,271	5,434	6,167	5,721	5,256	3,775	923	919	3,158	3,992	6,055	6,347	5,507	3,498

F. 2020 Scenario C Changes (D – E)

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Pre VAMP 4/1–4/15	VAMP 4/16–4/30	VAMP 5/1–5/15	Post VAMP 5/16–5/31	Jun	Jul	Aug	Sep	taf/yr
Min	-286	-1	-765	0	0	0	0	0	0	0	0	-188	-2	5	
10	7	-92	-14	171	-31	-8	380	380	0	0	416	423	-883	64	
20	-140	-148	-275	31	-59	3	-22	0	0	0	-130	594	-92	18	
30	206	-33	-155	187	-58	-28	0	0	0	0	69	732	316	-187	
40	-324	-211	485	52	-115	201	-2	0	0	2	8	656	181	-66	
50	-136	-307	210	-34	633	33	0	0	0	-2	2	408	622	-100	
60	-109	-732	494	471	-694	172	6	0	0	0	-4	-174	976	-134	
70	-361	-989	-391	1,095	329	307	0	0	0	0	3	146	1,038	119	
80	1,820	75	1,012	430	63	0	0	0	0	0	0	1,278	1,130	359	
90	1,820	1,820	1,343	0	0	0	0	0	0	0	0	1,320	1,210	1,320	
Max	1,820	1,820	822	0	0	0	0	0	0	0	0	1,320	1,320	1,320	
Avg	333	51	312	180	29	55	13	8	-1	-2	11	622	486	217	141

Table 5.1-5b indicates that the simulated 2020 CVP deliveries would be increased by 23 taf/year under Alternative 2C.

Table 5.1-7b indicates that the 2020 SWP deliveries were increased by 40 taf/yr under Alternative 2C. The monthly SWP Banks pumping for 2020 Alternative 2C and the 2020 baseline conditions is given in Table I-43. This change in SWP deliveries is not considered substantially different from the 2020 baseline SWP deliveries. SWP Article 21 deliveries were also increased from 92 taf/yr to 133 taf/yr for Alternative 2C under 2020 conditions.

Alternative 3B

Stage 1 (Physical/Structural Component)

Under Stage 1 of Alternative 3B, the fish control gate at the head of Old River would be constructed and operated. Two of the proposed agricultural tidal gates would also be installed and operated: (1) in Old River just upstream of the CVP Tracy facility, and (2) in Middle River just upstream of Victoria Canal. The extension of some additional agricultural siphons and pumps may be required to eliminate any potential impact on local water users from the increased pumping allowed in Alternative 3B. Construction and operation of the physical components under this alternative would not result in water supply impacts. Because water levels would not be maintained at 0 feet msl, some additional dredging may be required in the vicinity of some diversion siphons or pumps.

2020 Conditions

2020 conditions in the south Delta under Stage 1 of Alternative 3B are expected to be the same as those described for 2001. Therefore, construction and operation of the physical components under this alternative would not result in water supply impacts.

Stage 2 (Operational Component)

The operational conditions simulated for Stage 2 of Alternative 3B are identical to those for Stage 2 of Alternative 2B; therefore, changes in CVP and SWP water supply pumping and deliveries under this alternative would be the same as described for Stage 2 of Alternative 2B above. No substantial changes in CVP or SWP pumping or deliveries would occur under Alternative 3B.

2020 Conditions

The CVP Tracy and SWP Banks pumping changes under 2020 conditions were similar to the CVP Tracy and SWP Banks pumping changes under 2001 conditions. Water supply changes associated with the Alternative 3B monthly changes simulated under 2020 conditions are similar to the impacts identified for 2001 conditions. Effects under 2020 conditions would be the same as described for Alternative 2B for 2020 conditions.

Alternative 4B

Stage 1 (Physical/Structural Component)

Under Stage 1 of Alternative 4B, the fish control gate at the head of Old River would be constructed and operated. None of the three proposed agricultural tidal gates would be installed and operated. The extension of some additional agricultural siphons and pumps may be required to eliminate any potential impact on local water users from the increased pumping allowed in Alternative 4B. Construction and operation of the physical components under this alternative would not result in water supply impacts. Because water levels would not be maintained at 0 feet msl, some additional dredging may be required in the vicinity of some diversion siphons or pumps.

2020 Conditions

2020 conditions in the south Delta under Stage 1 of Alternative 4B are expected to be the same as those described for 2001. Therefore, construction and operation of the physical components under this alternative would not result in water supply impacts.

Stage 2 (Operational Component)

The operational conditions simulated for Stage 2 of Alternative 4B are identical to those for Stage 2 of Alternative 2B; therefore changes in CVP and SWP water supply pumping and deliveries under this alternative would be the same as described for Stage 2 of Alternative 2B above. No substantial changes in CVP or SWP pumping or deliveries would occur under Alternative 4B.

2020 Conditions

The CVP Tracy and SWP Banks pumping changes under 2020 conditions were similar to the CVP Tracy and SWP Banks pumping changes under 2001 conditions. Water supply changes associated with the Alternative 4B monthly changes simulated under 2020 conditions are similar to the impacts identified for 2001 conditions. Effects under 2020 conditions would be the same as described for Alternative 2B for 2020 conditions.

Summary of CALSIM Simulation Results

Table 5.1-12 gives a summary of the CALSIM results for the 2001 baseline simulation and each of the alternative operational scenarios that have been evaluated in this section. Because none of the alternatives would substantially change SWP water supply pumping or Table A deliveries (SWP Firm) above the 2001 baseline simulations, it may be helpful to review and understand the basic reasons for this result. During the above-normal and wet years (50% of the years) the SWP water supply Table A demands are often fully met under the 2001 baseline conditions with a 6,680 cfs SWP Banks pumping limit. During the drier 50% of the years, there are fewer opportunities for water to be exported from the Delta by increasing the SWP Banks pumping limit to 8,500 cfs, because the pumps are often not operating at the existing pumping limit of 6,680 cfs during these drier periods. The CALSIM estimates of SWP Article 21 deliveries for the baseline and alternatives are given in the second line of Table 5.1-12.

Table 5.1-13 provides a summary of the CALSIM results for the 2020 baseline simulation and each of the alternative operational scenarios that have been evaluated in this section. As demonstrated throughout this section, the 2020 CALSIM results are similar to the 2001 CALSIM results.

Effects of the South Delta Improvements Program on Environmental Water Account Assets

The average amount of EWA protection (i.e., reduced pumping) that is included in the 2001 CALSIM baseline simulation was 202 taf/yr. The CALSIM model included a constant purchase of 185 taf/yr; therefore the variable assets (i.e., half of the SWP gains from CVPIA (b)(2) releases) were 17 taf/yr. The CALSIM 2001 and 2020 baseline simulations are consistent with each other and represent a typical EWA protection pattern within the CALSIM monthly model.

The additional EWA debt that was simulated in the SDIP alternatives to provide the same pumping protections was relatively small compared to the baseline EWA protection. For example, the average increase in EWA assets needed to provide the same entrainment protection for Alternative 2A was about 5 taf/yr. If all EWA actions were made each year, the average increase in EWA uses (to reduce pumping for entrainment protection) for Alternative 2A would have been about 10 taf/yr. This represents 5% of the EWA assets (about 200 taf/yr) assumed in the ROD and simulated in CALSIM. Most of the EWA actions in April and May during VAMP would have the same water supply cost because the baseline pumping is less than 6,680 cfs. Only EWA actions during periods when allowable pumping was increased with the higher pumping limits would require more EWA assets to maintain the same entrainment protection.

An interagency EWA exercise using an interactive daily simulation model has been conducted, and the observed shifts in EWA assets generally correspond to relatively small shifts in necessary assets (see Appendix B). The daily gaming model allowed higher pumping with the 8,500 cfs in the weeks following the specified fish protection actions. The possible need for a 10% increase in the EWA assets to accommodate the increased SWP Banks pumping limits is a reasonable estimate based on these SDIP CALSIM results, and was generally confirmed by the daily gaming model results (see Appendix B).

Effects of the South Delta Improvements Program on Article 21 Deliveries

Tables 5.1-12 and 5.1-13 indicate that the simulated average SWP Article 21 deliveries were 148 taf/yr for the 2001 baseline, about 207 taf/yr under Operational Scenario A, 175 taf/yr under Operational Scenario B, and 203 taf/yr under Operational Scenario C. The 2020 baseline average Article 21 deliveries were 92 taf/yr and increased to 142 taf/yr under Operational Scenario A, 130 taf/yr under Operational Scenario B, and 133 taf/yr under Operational Scenario C. This increase in Article 21 deliveries was generally the result of the increased SWP Banks pumping capacity in the fall and winter that allowed SWP San Luis Reservoir to fill earlier, which is the trigger for allowing surplus water deliveries under Article 21 of the SWP contracts. The CALSIM model assumed a monthly maximum Article 21 delivery of 50 taf to Metropolitan Water District (i.e., pumping at Edmonston Pumping Plant) and an additional 84 taf for agricultural uses (i.e., groundwater recharge) in Kern County. A maximum Article 21 delivery flow of 2,180 cfs (2,400 cfs in February) was assumed for November through March, only if the end-of-month SWP San Luis Reservoir storage was full (i.e., 1,067 taf).

The maximum possible Article 21 deliveries are therefore 536 taf/yr, if full monthly deliveries were made in 4 of these 5 months. Article 21 deliveries were simulated in 94 months during the November–March period of the 73-year simulation (365 possible months). The 2020 baseline suggests that Article 21 deliveries were 92 taf/yr (17% of possible 4-month maximum). The average Article 21 deliveries for Operational Scenario A were 142 taf/yr (26% of possible 4-month maximum). If a higher monthly maximum Article 21 delivery is assumed, the potential Article 21 deliveries would be increased. The Article 21 deliveries would occur in the same months, but would be increased to the new maximum if this additional surplus water were available. Article 21 deliveries were limited by the maximum of 134 taf/month in only 12 of the 94 months with some Article 21 deliveries. Therefore, the additional Article 21 deliveries will increase by only a fraction of the increase in the monthly maximum Article 21 delivery rate. The Article 21 deliveries will require more EWA water to be used if the Article 21 pumping is being made during a week with fish entrainment protection action.

Water Transfers Analysis

There is some water transfer capacity available under existing conditions, and additional water transfer capacity would be provided in some years with the SDIP export alternatives. Although CALSIM was not used to simulate water transfers, the CALSIM modeling of the 2001 and 2020 baselines (existing conditions and future no action) indicates that in many years there will be unused pumping capacity during the July–September period that may be available for moving additional water transfers through the Delta. The July–September period is the major “window of opportunity” for water transfers because the allowable

Table 5.1-12. CALSIM–Simulated Summary, for 2001 Baseline Conditions

	2001 Base Study		2001 Scenario A				2001 Scenario B				2001 Scenario C			
	Dry Period Average (May ‘28–Oct ‘34)	73-Year Average (1922–1994)	Dry Period Average (May ‘28–Oct ‘34)	Dry Period Difference	73-Year Average (1922–1994)	73-Year Difference	Dry Period Average (May ‘28–Oct ‘34)	Dry Period Difference	73-Year Average (1922–1994)	73-Year Difference	Dry Period Average (May ‘28–Oct ‘34)	Dry Period Difference	73-Year Average (1922–1994)	73-Year Difference
South of Delta Delivery														
SWP Firm	1,898	3,017	1,919	21	3,038	21	1,854	-44	2,998	-19	1,843	-55	3,023	6
SWP Article 21	94	148	116	22	207	59	112	18	175	27	154	61	203	55
CVP Including CVC	1,744	2,645	1,726	-18	2,752	107	1,729	-15	2,666	21	1,730	-14	2,670	24
Total Delivery	3,736	5,810	3,761	25	5,996	186	3,695	-41	5,839	29	3,728	-8	5,895	85
Other Outflow/Adjustment:														
EWA San Luis Spill	0	18	6	6	38	20	6	6	19	0	6	6	44	26
SOD Reservoir Evaporation	113	105	113	0	105	0	113	1	106	1	113	1	106	2
DMC VAMP Release	4	4	4	0	4	0	4	0	4	0	4	0	4	0
SWP Channel Loss	66	65	66	0	65	0	66	0	65	0	66	0	65	0
North Bay Adjustment	-23	-40	-23	0	-40	0	-22	1	-39	0	-22	1	-40	0
Total Other Outflow/Adjust.	161	152	166	6	171	19	167	7	153	2	168	7	179	28
South of Delta Exports														
Banks SWP	1,732	3,040	1,779	47	3,105	65	1,718	-15	3,040	0	1,744	12	3,099	59
Banks CVP	74	151	74	0	279	128	65	-9	188	37	74	0	205	54
Tracy	1,573	2,310	1,542	-31	2,302	-8	1,563	-11	2,289	-21	1,553	-20	2,287	-23
Banks EWA	162	117	162	-1	126	9	160	-2	113	-4	161	-1	130	13
Total Exports	3,542	5,618	3,557	15	5,812	194	3,505	-37	5,630	12	3,533	-9	5,721	103
Other Inflow:														
EWA Unpaid Debt	46	66	56	10	77	12	51	5	84	18	54	8	75	10
EWA SOD Purchase	79	123	79	0	123	0	79	0	123	0	79	0	123	0
San Joaquin Supply	6	121	6	0	121	1	6	0	121	0	6	0	121	0
Kern River Intertie	0	27	0	0	27	0	0	0	27	0	0	0	27	0
Net Storage Release	223	8	228	5	7	0	221	-2	8	0	223	0	8	0
EWA NOD Purchase	115	54	115	0	51	-4	115	0	50	-4	115	0	54	-1
Delta Outflow to Bay:														
Total Outflow	5,390	14,318	5,364	-26	14,135	-183	5,410	21	14,305	-13	5,387	-3	14,214	-104

Table 5.1-13. CALSIM–Simulated Summary, for 2020 Baseline Conditions

	2020 Base Study		2020 Scenario A				2020 Scenario B				2020 Scenario C			
	Dry Period Average (May '28–Oct '34)	73-Year Average (1922–1994)	Dry Period Average (May '28–Oct '34)	Dry Period Difference	73-Year Average (1922–1994)	73-Year Difference	Dry Period Average (May '28–Oct '34)	Dry Period Difference	73-Year Average (1922–1994)	73-Year Difference	Dry Period Average (May '28–Oct '34)	Dry Period Difference	73-Year Average (1922–1994)	73-Year Difference
South of Delta Delivery														
SWP Firm	1,876	3,180	1,886	9	3,219	39	1,883	6	3,183	3	1,893	16	3,220	40
SWP Article 21	135	92	145	9	142	50	130	-6	103	11	144	8	133	41
CVP Including CVC	1,733	2,588	1,707	-26	2,689	101	1,736	3	2,603	15	1,718	-15	2,611	23
Total Delivery	3,745	5,860	3,738	-7	6,051	191	3,748	4	5,889	29	3,754	9	5,963	104
Other Outflow/Adjustment:														
EWA San Luis Spill	5	9	5	0	20	11	5	0	9	0	13	7	26	17
SOD Reservoir Evaporation	123	113	123	0	113	0	124	0	114	1	124	1	115	2
DMC VAMP Release	4	4	4	0	4	0	4	0	4	0	4	0	4	0
SWP Channel Loss	66	65	66	0	65	0	66	0	65	0	66	0	65	0
North Bay Adjustment	-31	-53	-31	0	-54	-1	-31	0	-53	0	-31	0	-54	-1
Total Other Outflow/Adjust.	168	137	168	-1	148	11	168	0	138	1	176	8	155	18
South of Delta Exports														
Banks SWP	1,778	3,132	1,843	65	3,228	97	1,777	-2	3,145	13	1,816	37	3,224	92
Banks CVP	57	126	62	5	230	104	58	1	156	29	62	5	167	40
Tracy	1,599	2,302	1,567	-32	2,283	-19	1,596	-3	2,284	-19	1,581	-17	2,274	-29
Banks EWA	157	95	139	-18	97	3	156	-1	89	-6	155	-2	103	9
Total Exports	3,591	5,655	3,611	20	5,839	184	3,587	-4	5,673	17	3,615	24	5,767	112
Other Inflow:														
EWA Unpaid Debt	31	67	9	-22	84	17	31	0	80	13	17	-14	76	9
EWA SOD Purchase	79	123	79	0	123	0	79	0	123	0	79	0	123	0
San Joaquin Supply	6	118	6	0	119	1	6	0	118	0	6	0	118	0
Kern River Intertie	0	27	0	0	27	0	0	0	27	0	0	0	27	0
Net Storage Release	205	7	200	-6	7	0	213	8	7	0	213	7	7	0
EWA NOD Purchase	115	58	115	0	53	-5	115	0	53	-5	115	0	55	-3
Delta Outflow to Bay:														
Total Outflow	5,411	14,165	5,384	-27	13,988	-177	5,417	5	14,147	-18	5,390	-22	14,060	-106

E/I ratio is 65%, there are high water demands for beneficial uses of additional water transfers, there are relatively few fish-related impacts along the river corridors and within the Delta channels, and there are fewer entrainment losses of fish at the export pumps during these summer months. The 2001 and 2020 CALSIM baseline results indicate an average of 300 taf of unused SWP Banks pumping capacity in the July–September period, with a maximum of 1 maf (in 1933). About 15% of the driest years have more than 750 taf of unused capacity that could be used for potential water transfers. However, it may not be likely that all of this pumping capacity would be used for water transfers.

The EWA draft EIS/EIR document (California Department of Water Resources et al. 2003) provides an evaluation of the combined water transfers that might be exported for EWA or other beneficial uses with the existing CVP and SWP facilities and Banks pumping limits under the D-1641 Delta objectives. A maximum water transfer of 600 taf was assumed, but the transfers are limited by the available Banks pumping capacity of 7,180 cfs for July–September and would average about 300 taf/yr. In a few dry years the unused pumping capacity was about 1,000 taf. These results, based on the unused Banks pumping capacity for potential water transfers are similar to the SDIP 2001 and 2020 baselines.

The OCAP Biological Opinion (U.S. Fish and Wildlife Service 2004) also includes a discussion of potential water transfers that are assumed to occur predominantly in the July–September period. The potential water transfers are assumed to range between 200 and 600 taf/yr, based on unused SWP Banks pumping capacity.

The SDIP CALSIM modeling assumes a consistent pattern of upstream EWA water purchases that range from 35 taf in wet years to 135 taf in dry years, with an average upstream EWA water purchase of 54 taf. These simulated EWA purchases are assumed to come from reductions in existing upstream agricultural diversions, and this water is added into the CALSIM model at Freeport. The CALSIM model simulates the transfer of these EWA upstream purchases through the Delta. Upstream effects on reservoir storage and river flows during months when this purchased EWA water might be stored prior to transfer into the Delta in July–September have not been simulated. The Delta impacts of these simulated EWA transfers and exports are already incorporated in the impact assessment methods for the SDIP baseline and alternatives.

Change WS-3: Change in Water Supply from the Use of 8,500 cfs SWP Banks Pumping Capacity for Water Transfers. Table 5.1-14 shows the monthly evaluation of water transfers under existing conditions, based on the CALSIM 2001 baseline simulation. The water transfer capacity for the 2001 CALSIM baseline simulation was estimated by assuming that a maximum of 3,300 cfs would be added to each monthly pumping flow unless the existing pumping limit of 7,180 cfs was reached. The assumed maximum transfer flow of 3,300 cfs is consistent with the maximum transfer of 600 taf/yr used in the EWA and OCAP evaluations.

The average water transfer capacity based on the 2001 CALSIM baseline was 250 taf/yr. Figure 5.1-37 shows the annual sequence of potential water transfers. This graph indicates that there is a considerable water transfer capacity under the 2001 CALSIM baseline conditions. The water transfer capacity will be greatest in dry years with reduced SWP deliveries. However, substantial water transfers of more than 200 taf/yr are possible in a range of delivery years, not just in dry years. Water transfers may be limited by available water supplies and demands, and may also be limited by water quality and fish protection requirements.

Table 5.1-14 indicates that an average of 200 taf/yr out of the total of 250 taf/yr of water transfer (about 80%) might be allowed within the E/I ratio, without any relaxation of the E/I ratio or additional inflow. This water transfer analysis considers only the available unused SWP pumping capacity in the months of July–September. These water transfers may change the E/I ratio above the 0.65 allowed under D-1641. In this case, the water transfers would be subject to a “carriage water” cost. More inflow would be required to allow the water transfer at the pumps within the allowable E/I ratio. Some carriage water may be required to maintain water quality in the Delta with the increased Banks pumping during the transfers.

The SDIP would increase the pumping capacity and might allow increased water transfers during the July–September period. All of the SDIP operational scenarios assume an 8,500 cfs SWP Banks pumping capacity throughout the summer months of July–September, so the potential water transfer and the associated impacts would be the same for each operational scenario. The increased pumping capacity from 7,180 cfs to 8,500 cfs for July–September is 240 taf. However, this capacity would most likely not be used in dry years when the majority of the assumed 3,300 cfs of water transfers would not require an increased pumping limit.

Figure 5.1-38 shows the annual water transfers for Alternative 2A (under 2001 conditions) compared with the water transfers that would be possible without the SDIP increased pumping limits. Alternative 2A would allow an increase in water transfers from 250 taf/yr associated with current pumping limits to 343 taf/yr (Table 5.1-14). The potential water transfer change attributable to SDIP is therefore 93 taf/yr. The SDIP increased SWP pumping limits would allow about 25% (i.e., 93 taf/343 taf) of the total increased SWP pumping from potential water transfers. The environmental impacts that might be associated with these additional water transfers of 93 taf/yr would be SDIP indirect project impacts, and must be mitigated to less than significant. Alternative 2B would allow an increase in water transfers from 250 taf/yr to an average of 349 taf/yr (Table 5.1-14), with 99 taf/yr of SDIP indirect project impacts. Alternative 2C would allow an increase in water transfers from 250 taf/yr to an average of 353 taf/yr (Table 5.1-14), with 103 taf/yr of SDIP indirect project impacts.

Table 5.1-15 shows the annual water transfers for the SDIP 2020 alternatives compared with the water transfers that would be possible without the SDIP increased pumping limits. The baseline water transfers for the 2020 baseline averaged 247 taf/yr. Alternative 2A would allow an increase to 352 taf/yr. The

Table 5.1-14. Calculations of Unused SWP Banks Pumping Capacity and Potential Water Transfers for 2001 Baseline and SDIP Operational Scenarios

				Unused Pumping Assume July–Sep Window				2001 Baseline Transfer Analysis Assume July–Sep Window					2001 Scenario 2A		2001 Scen 2B	2001 Scen 2C
	2001 Baseline CALSIM SWP Banks Exports (cfs)			7,180 cfs Maximum Pumping				7,180 cfs Maximum Pumping 3,300 cfs Maximum Transfer per Month			Water Transfer Total (taf)	Within E/I Total (taf)	Water Transfer Total (taf)	Within E/I Total (taf)	Water Transfer Total (taf)	Water Transfer Total (taf)
Year	Jul	Aug	Sep	Jul	Aug	Sep	Total (taf)	Jul	Aug	Sep						
22	3,678	6,680	6,680	3,502	500	500	275	3,300	500	500	263	233	408	247	337	338
23	5,285	5,480	6,680	1,895	1,700	500	250	1,895	1,700	500	250	221	351	193	416	416
24	3,487	2,428	1,544	3,693	4,752	5,636	853	3,300	3,300	3,300	601	601	601	601	601	601
25	2,579	5,809	3,977	4,601	1,371	3,203	557	3,300	1,371	3,203	477	287	562	366	562	562
26	6,414	5,785	3,387	766	1,395	3,793	358	766	1,395	3,300	329	232	492	396	461	484
27	3,367	7,180	6,678	3,813	0	502	264	3,300	0	502	232	203	383	241	388	376
28	4,209	6,977	4,851	2,971	203	2,329	333	2,971	203	2,329	333	195	478	282	416	466
29	4,099	2,491	1,156	3,081	4,689	6,024	835	3,081	3,300	3,300	588	588	601	601	601	601
30	6,814	5,263	3,844	366	1,917	3,336	338	366	1,917	3,300	336	140	464	268	463	463
31	2,784	4,107	1,658	4,396	3,073	5,522	786	3,300	3,073	3,300	587	587	601	601	601	601
32	6,658	661	3,868	522	6,519	3,312	629	522	3,300	3,300	431	301	497	408	511	515
33	3,002	300	1,237	4,178	6,880	5,943	1,032	3,300	3,300	3,300	601	601	601	601	601	601
34	2,665	2,456	1,838	4,515	4,724	5,342	884	3,300	3,300	3,300	601	601	601	601	601	601
35	7,041	6,280	4,781	139	900	2,399	206	139	900	2,399	206	64	303	136	376	364
36	7,180	5,819	5,799	0	1,361	1,381	166	0	1,361	1,381	166	84	338	146	341	341
37	6,138	6,794	5,269	1,042	386	1,911	201	1,042	386	1,911	201	88	381	190	318	400
38	7,180	6,749	7,180	0	431	0	26	0	431	0	26	26	255	255	214	185
39	7,180	6,923	5,762	0	257	1,418	100	0	257	1,418	100	16	313	116	327	336
40	7,180	5,749	5,153	0	1,431	2,027	208	0	1,431	2,027	208	88	273	109	399	408
41	4,182	6,680	7,180	2,998	500	0	215	2,998	500	0	215	215	226	214	214	214
42	3,589	6,680	7,180	3,591	500	0	251	3,300	500	0	233	233	294	294	214	214
43	3,944	7,180	6,680	3,236	0	500	228	3,236	0	500	228	199	300	231	319	308
44	7,180	6,806	6,017	0	374	1,163	92	0	374	1,163	92	23	196	25	185	174
45	6,491	6,258	6,630	689	922	550	132	689	922	550	132	99	313	168	298	366
46	7,180	6,133	6,117	0	1,047	1,063	127	0	1,047	1,063	127	64	181	76	154	329
47	7,180	6,743	5,027	0	437	2,153	155	0	437	2,153	155	27	261	65	295	258
48	7,180	7,177	6,678	0	3	502	30	0	3	502	30	0	127	37	161	161
49	6,806	2,386	4,098	374	4,794	3,082	500	374	3,300	3,082	409	243	477	300	566	567
50	7,180	7,180	6,680	0	0	500	30	0	0	500	30	0	177	72	178	143
51	6,549	6,749	6,476	631	431	704	107	631	431	704	107	65	247	151	315	308
52	6,083	6,680	7,180	1,097	500	0	98	1,097	500	0	98	98	164	164	188	188
53	3,829	7,180	7,180	3,351	0	0	206	3,300	0	0	203	203	263	252	210	210
54	5,229	5,802	6,630	1,951	1,378	550	237	1,951	1,378	550	237	204	349	248	395	417
55	5,852	2,565	3,090	1,328	4,615	4,090	608	1,328	3,300	3,300	480	368	560	445	573	589
56	4,007	6,680	7,180	3,173	500	0	225	3,173	500	0	225	225	235	235	214	214
57	5,562	5,869	6,680	1,618	1,311	500	209	1,618	1,311	500	209	180	296	197	343	360
58	4,510	6,680	7,180	2,670	500	0	195	2,670	500	0	195	195	182	182	193	206
59	6,680	7,180	6,060	500	0	1,120	97	500	0	1,120	97	31	204	110	301	290
60	7,153	5,480	4,805	27	1,700	2,375	247	27	1,700	2,375	247	106	467	323	443	413

Table 5.1-14. Continued

				Unused Pumping Assume July–Sep Window				2001 Baseline Transfer Analysis Assume July–Sep Window					2001 Scenario 2A		2001 Scen 2B	2001 Scen 2C
	2001 Baseline CALSIM SWP Banks Exports (cfs)			7,180 cfs Maximum Pumping				7,180 cfs Maximum Pumping 3,300 cfs Maximum Transfer per Month			Water Transfer Total (taf)	Within E/I Total (taf)	Water Transfer Total (taf)	Within E/I Total (taf)	Water Transfer Total (taf)	Water Transfer Total (taf)
Year	Jul	Aug	Sep	Jul	Aug	Sep	Total (taf)	Jul	Aug	Sep						
61	6,352	6,524	4,650	828	656	2,530	241	828	656	2,530	241	91	481	303	450	503
62	5,230	6,858	5,782	1,950	322	1,398	222	1,950	322	1,398	222	139	282	140	376	396
63	3,841	7,180	6,209	3,339	0	971	263	3,300	0	971	260	203	331	242	364	353
64	7,180	6,724	5,946	0	456	1,234	101	0	456	1,234	101	28	234	52	284	250
65	4,589	7,180	6,680	2,591	0	500	189	2,591	0	500	189	159	374	190	315	312
66	5,883	6,855	6,680	1,297	325	500	129	1,297	325	500	129	100	273	202	299	298
67	7,180	7,180	7,180	0	0	0	0	0	0	0	0	0	71	71	82	65
68	5,418	7,180	6,466	1,762	0	714	151	1,762	0	714	151	108	305	186	301	255
69	4,745	6,680	7,180	2,435	500	0	180	2,435	500	0	180	180	402	402	215	215
70	3,753	7,180	6,680	3,427	0	500	240	3,300	0	500	232	203	303	203	400	397
71	5,273	7,180	7,180	1,907	0	0	117	1,907	0	0	117	117	203	203	185	203
72	5,809	6,286	3,881	1,371	894	3,299	335	1,371	894	3,299	335	139	443	247	413	452
73	5,820	6,680	6,661	1,360	500	519	145	1,360	500	519	145	114	199	141	327	330
74	5,367	7,180	7,180	1,813	0	0	111	1,813	0	0	111	111	153	153	153	153
75	3,601	6,680	7,180	3,579	500	0	250	3,300	500	0	233	233	214	203	154	112
76	6,278	5,512	4,288	902	1,668	2,892	330	902	1,668	2,892	330	238	534	203	534	528
77	4,854	1,639	1,526	2,326	5,541	5,654	819	2,326	3,300	3,300	541	541	601	601	601	601
78	3,083	6,680	7,180	4,097	500	0	282	3,300	500	0	233	233	325	241	277	278
79	5,100	6,680	6,231	2,080	500	949	215	2,080	500	949	215	158	239	157	381	352
80	4,307	6,680	7,180	2,873	500	0	207	2,873	500	0	207	207	362	259	341	344
81	5,901	6,503	6,095	1,279	677	1,085	185	1,279	677	1,085	185	120	402	265	347	361
82	3,874	6,680	7,180	3,306	500	0	234	3,300	500	0	233	233	214	214	214	214
83	7,180	6,926	6,598	0	254	582	50	0	254	582	50	50	0	0	0	0
84	4,390	7,003	6,592	2,790	177	588	217	2,790	177	588	217	182	299	237	376	368
85	7,180	6,700	6,680	0	480	500	59	0	480	500	59	29	97	5	214	267
86	1,445	6,680	7,180	5,735	500	0	383	3,300	500	0	233	233	340	251	142	282
87	7,180	6,590	5,170	0	590	2,010	156	0	590	2,010	156	74	269	122	377	295
88	3,816	1,214	837	3,364	5,966	6,343	949	3,300	3,300	3,300	601	601	601	601	601	601
89	7,180	6,680	5,305	0	500	1,875	142	0	500	1,875	142	31	320	130	332	288
90	3,990	867	1,810	3,190	6,313	5,370	902	3,190	3,300	3,300	594	594	601	601	601	601
91	4,123	946	1,337	3,057	6,234	5,843	917	3,057	3,300	3,300	586	586	601	601	601	601
92	3,461	1,506	2,905	3,719	5,674	4,275	830	3,300	3,300	3,300	601	601	601	601	601	601
93	7,180	6,749	6,680	0	431	500	56	0	431	500	56	26	186	107	111	89
94	6,680	7,180	5,952	500	0	1,228	104	500	0	1,228	104	31	160	31	248	232
Min	1,445	300	837	0	0	0	0	0	0	0	0	0	0	0	0	0
Max	7,180	7,180	7,180	5,735	6,880	6,343	1,032	3,300	3,300	3,300	601	601	601	601	601	601
Avg	5,350	5,767	5,457	1,830	1,413	1,723	301	1,692	1,042	1,390	250	200	343	251	349	353

Table 5.1-15. Calculations of Unused SWP Banks Pumping Capacity and Potential Water Transfers for 2020 Baseline and SDIP Operational Scenarios

				Unused Pumping Assume July–Sep Window				2020 Baseline Transfer Analysis Assume July–Sep Window					2020 Scenario 2A		2020 Scen 2B	2020 Scen 2C
	2020 Baseline CALSIM SWP Banks Exports (cfs)			7,180 cfs Maximum Pumping				7,180 cfs Maximum Pumping 3,300 cfs Maximum Transfer per Month			Water Transfer Total (taf)	Within E/I Total (taf)	Water Transfer Total (taf)	Within E/I Total (taf)	Water Transfer Total (taf)	Water Transfer Total (taf)
Year	Jul	Aug	Sep	Jul	Aug	Sep	Total (taf)	Jul	Aug	Sep						
22	7,180	6,749	5,870	0	431	1,310	104	0	431	1,310	104	27	501	247	237	225
23	6,685	6,889	6,161	495	291	1,019	109	495	291	1,019	109	53	273	151	309	376
24	3,856	2,007	1,325	3,324	5,173	5,855	869	3,300	3,300	3,300	601	601	601	601	601	601
25	2,450	4,842	3,983	4,730	2,338	3,197	624	3,300	2,338	3,197	536	352	601	405	601	481
26	6,424	4,450	2,162	756	2,730	5,018	512	756	2,730	3,300	410	410	546	450	517	521
27	4,400	7,180	5,040	2,780	0	2,140	298	2,780	0	2,140	298	178	461	245	451	439
28	2,613	7,180	4,880	4,567	0	2,300	417	3,300	0	2,300	339	203	489	293	434	484
29	4,123	2,486	1,422	3,057	4,694	5,758	818	3,057	3,300	3,300	586	586	601	601	601	601
30	6,805	5,339	4,482	375	1,841	2,698	296	375	1,841	2,698	296	137	469	273	463	465
31	2,726	4,381	1,522	4,454	2,799	5,658	781	3,300	2,799	3,300	570	570	601	601	601	601
32	2,051	5,539	3,626	5,129	1,641	3,554	627	3,300	1,641	3,300	499	397	586	498	579	582
33	2,496	302	1,475	4,684	6,878	5,705	1,049	3,300	3,300	3,300	601	601	601	601	601	601
34	2,740	1,859	1,579	4,440	5,321	5,601	932	3,300	3,300	3,300	601	601	601	601	601	601
35	7,180	7,058	4,884	0	122	2,296	144	0	122	2,296	144	57	313	146	298	326
36	7,180	6,070	5,380	0	1,110	1,800	175	0	1,110	1,800	175	68	349	161	312	342
37	5,808	6,594	5,380	1,372	586	1,800	227	1,372	586	1,800	227	121	358	162	393	361
38	7,180	6,749	7,180	0	431	0	26	0	431	0	26	26	45	33	12	15
39	7,180	6,487	5,468	0	693	1,712	144	0	693	1,712	144	43	313	137	313	301
40	7,180	6,543	5,946	0	637	1,234	112	0	637	1,234	112	39	194	120	276	366
41	7,180	6,749	7,180	0	431	0	26	0	431	0	26	26	8	8	7	0
42	5,768	7,180	7,180	1,412	0	0	87	1,412	0	0	87	87	279	279	294	196
43	3,561	7,180	6,678	3,619	0	502	252	3,300	0	502	232	222	369	233	360	354
44	7,180	7,180	5,602	0	0	1,578	94	0	0	1,578	94	15	208	20	207	209
45	6,811	6,099	5,339	369	1,081	1,841	198	369	1,081	1,841	198	101	319	133	404	372
46	7,180	7,026	6,510	0	154	670	49	0	154	670	49	16	84	0	154	133
47	7,180	7,180	5,140	0	0	2,040	121	0	0	2,040	121	32	352	165	343	340
48	7,180	7,180	6,678	0	0	502	30	0	0	502	30	0	136	48	175	154
49	6,391	3,928	4,083	789	3,252	3,097	432	789	3,252	3,097	432	277	521	344	561	558
50	7,180	7,180	6,462	0	0	718	43	0	0	718	43	0	194	63	191	164
51	5,740	6,749	6,200	1,440	431	980	173	1,440	431	980	173	115	342	156	290	301
52	4,398	5,899	7,180	2,782	1,281	0	249	2,782	1,281	0	249	249	294	294	321	321
53	3,964	7,180	7,180	3,216	0	0	197	3,216	0	0	197	197	268	252	233	221
54	5,910	6,190	6,380	1,270	990	800	186	1,270	990	800	186	142	348	243	377	371
55	5,237	1,161	3,361	1,943	6,019	3,819	716	1,943	3,300	3,300	518	426	565	449	598	580
56	7,180	6,749	7,180	0	431	0	26	0	431	0	26	26	407	308	295	48
57	4,342	7,033	6,153	2,838	147	1,027	244	2,838	147	1,027	244	183	395	266	399	366
58	3,583	6,680	7,180	3,597	500	0	251	3,300	500	0	233	233	214	214	214	214
59	6,680	7,180	6,052	500	0	1,128	98	500	0	1,128	98	31	274	111	326	312
60	6,197	3,866	2,576	983	3,314	4,604	537	983	3,300	3,300	459	459	557	412	537	547

				Unused Pumping Assume July–Sep Window				2020 Baseline Transfer Analysis Assume July–Sep Window					2020 Scenario 2A		2020 Scen 2B	2020 Scen 2C
	2020 Baseline CALSIM SWP Banks Exports (cfs)			7,180 cfs Maximum Pumping				7,180 cfs Maximum Pumping 3,300 cfs Maximum Transfer per Month								
Year	Jul	Aug	Sep	Jul	Aug	Sep	Total (taf)	Jul	Aug	Sep	Water Transfer Total (taf)	Within E/I Total (taf)	Water Transfer Total (taf)	Within E/I Total (taf)	Water Transfer Total (taf)	Water Transfer Total (taf)
61	6,935	6,446	4,956	245	734	2,224	192	245	734	2,224	192	60	374	196	348	413
62	5,453	7,158	6,450	1,727	22	730	151	1,727	22	730	151	107	286	164	346	375
63	4,813	7,180	5,857	2,367	0	1,323	224	2,367	0	1,323	224	169	359	203	430	408
64	7,180	6,680	4,773	0	500	2,407	174	0	500	2,407	174	31	314	118	324	317
65	4,622	7,180	6,527	2,558	0	653	196	2,558	0	653	196	162	406	203	337	329
66	5,741	6,453	6,204	1,439	727	976	191	1,439	727	976	191	133	338	224	388	364
67	7,180	7,180	7,180	0	0	0	0	0	0	0	0	0	0	0	0	0
68	5,570	7,157	6,465	1,610	23	715	143	1,610	23	715	143	100	264	119	372	326
69	4,246	6,680	7,170	2,934	500	10	211	2,934	500	10	211	211	349	349	287	323
70	4,111	7,180	6,656	3,069	0	524	220	3,069	0	524	220	188	312	171	386	355
71	6,680	7,180	7,180	500	0	0	31	500	0	0	31	31	153	153	12	124
72	6,547	6,148	4,204	633	1,032	2,976	279	633	1,032	2,976	279	102	475	279	376	451
73	4,102	6,680	6,680	3,078	500	500	249	3,078	500	500	249	220	336	266	386	384
74	3,651	6,680	7,180	3,529	500	0	247	3,300	500	0	233	233	214	214	214	214
75	3,966	6,680	7,180	3,214	500	0	228	3,214	500	0	228	228	224	203	214	214
76	4,052	6,102	4,167	3,128	1,078	3,013	437	3,128	1,078	3,013	437	238	494	124	458	448
77	1,781	3,743	1,532	5,399	3,437	5,648	878	3,300	3,300	3,300	601	601	601	601	601	601
78	2,950	6,680	6,867	4,230	500	313	309	3,300	500	313	252	246	412	263	305	305
79	4,691	6,656	6,499	2,489	524	681	225	2,489	524	681	225	185	455	244	414	418
80	3,761	6,680	6,660	3,419	500	520	271	3,300	500	520	264	264	396	269	317	320
81	7,180	6,738	6,550	0	442	630	65	0	442	630	65	27	238	86	207	249
82	7,180	6,749	7,180	0	431	0	26	0	431	0	26	26	0	0	0	0
83	7,180	7,180	5,537	0	0	1,643	98	0	0	1,643	98	98	4	4	0	0
84	4,816	5,922	6,611	2,364	1,258	569	256	2,364	1,258	569	256	230	292	208	436	435
85	7,180	6,832	6,677	0	348	503	51	0	348	503	51	21	72	0	130	108
86	7,180	6,749	6,686	0	431	494	56	0	431	494	56	34	339	235	138	301
87	7,180	7,063	5,131	0	117	2,049	129	0	117	2,049	129	85	270	123	384	313
88	4,051	369	801	3,129	6,811	6,379	989	3,129	3,300	3,300	591	591	601	601	601	601
89	7,180	6,680	5,028	0	500	2,152	159	0	500	2,152	159	31	224	45	288	237
90	3,990	894	1,801	3,190	6,286	5,379	901	3,190	3,300	3,300	594	594	601	601	601	601
91	2,776	463	1,070	4,404	6,717	6,110	1,046	3,300	3,300	3,300	601	601	601	601	601	601
92	3,580	1,528	2,943	3,600	5,652	4,237	820	3,300	3,300	3,300	601	601	601	601	601	601
93	7,180	6,749	5,652	0	431	1,528	117	0	431	1,528	117	47	234	64	232	221
94	6,853	7,107	6,056	327	73	1,124	91	327	73	1,124	91	33	222	14	286	257
Min	1,781	302	801	0	0	0	0	0	0	0	0	0	0	0	0	0
Max	7,180	7,180	7,180	5,399	6,878	6,379	1,049	3,300	3,300	3,300	601	601	601	601	601	601
Avg	5,433	5,861	5,290	1,747	1,319	1,890	300	1,560	991	1,518	247	198	352	245	349	346

SDIP potential water transfer change for Alternative 2A (under 2020 conditions) is therefore 105 taf/yr. Alternative 2B would allow a similar increase in water transfers, to an average of 349 taf/yr, a difference of 102 taf/yr under 2020 conditions. Alternative 2C would allow an increase in water transfers of 99 taf/yr, to an average of 346 taf/yr under 2020 conditions.

The environmental impacts associated with the 250 taf/yr of water transfers that could occur in the near future without the SDIP are considered cumulative impacts (See Chapter 10). The SDIP is not responsible for mitigation of these cumulative water transfer impacts. Potential indirect effects of transfers on delivery areas are generally discussed in the Growth Inducement Chapter (Chapter 9). Additional environmental documentation for the potential impacts (i.e., groundwater pumping, crop fallowing, or reservoir drawdown) and approval of water transfer source actions caused by the transfers that could occur with the increased diversion limit would likely be needed.

The indirect project impacts and applicable mitigation necessary for additional water transfers that could occur with the increased SWP Banks pumping limits are described in the water quality, vegetations and wetlands, and fish sections.

5.2 Delta Tidal Hydraulics

Introduction

Delta tidal hydraulic conditions are the influences on the movement of water in Delta channels (e.g., tidal forces and river inflows) and the effects of the movement of water in Delta channels (e.g., changes in channel flows and water levels, export flows, and outflow). This section describes Delta tidal hydraulic conditions; discusses the Delta tidal hydraulic model developed by DWR and used to simulate the effects of the SDIP alternatives on the Delta tidal hydraulics; identifies Delta tidal hydraulic variables that could be affected by the SDIP; and presents results of simulations using the DSM2 Delta tidal hydraulic model to determine SDIP effects on those variables. This section discusses potential effects of SDIP facilities and operations on south Delta tidal water level, tidal and net channel flows, and tidal velocities.

Effects assessed in the impact discussion of this section are possible changes in net Delta channel flows and local channel flows, velocities, and water levels resulting from implementation of the SDIP facilities and operations. Other effects related to tidal hydraulics are discussed in this section but are analyzed more fully in other sections, such as Delta water quality and Delta fisheries. The discussion of tidal hydraulics in this section includes several terms that may not be familiar to all readers. The following are definitions of key terms as they are used in this document:

- **Hydraulics.** Study of the practical effects and control of moving water; used to refer to the relationship among channel geometry and flow, velocity, and depth of water.
- **Tidal level.** Water surface elevation; the elevation of the water above mean sea level datum. Sometimes referred to as tidal stage.
- **Tidal hydraulics.** Water movements caused by tidal forces (i.e., gravitational); used to describe the movement of water in Delta channels caused by tidal level variations in San Francisco Bay.
- **Tidal prism.** The volume of water that moves past a location as the result of a change in tidal level; used in this document to refer to the change in volume between low tide and high tide, estimated as the upstream water surface area times the change in tidal level.
- **Hydraulic gradient.** Difference in water surface elevation between two points; describes the water surface slope that controls the movement of water along a channel (i.e., feet per mile).
- **Hydraulic radius.** Channel cross-section area divided by the perimeter of the channel; used in this document as the effective depth of water in a channel.
- **Conveyance.** The flow capacity of a channel related to the hydraulic radius, used to describe the flow in channels.

- **Tidal flow.** Flow caused by tidal changes in level and hydraulic gradient; describes the fluctuating flows in a channel caused by the tide. Tidal flow is equal to the tidal velocity times the channel cross-sectional area.
- **Net flow.** Long-term average of flows in a channel; used to describe the magnitude and direction of flow in a channel after flows during a tidal cycle are averaged.
- **Transport.** Movement of mass from one location to another; used in this document to refer to the movement of salt or fish from one location to another caused by net flows.
- **Mixing.** Exchange of mass between two volumes; used in this document to refer to the movement of salt or fish from one location to another caused by the tidal movement of water within the Delta channels.
- **Tidal excursion.** The distance between the most upstream position and most downstream position of a floating object that is released from a location at mean tide and tracked over a complete tidal cycle.
- **Model calibration.** Adjustments made to a model (i.e., equations or coefficient values) to provide results that more closely follow observed data; used especially during initial model development and testing.
- **Model validation.** Comparative testing of model results with measured data to determine the adequacy of model simulations for describing the observed behavior of the modeled variables; used especially during model application to conditions different from those used to calibrate the model.

Summary of Significant Impacts

There are no significant delta tidal hydraulics impacts as a result of implementation of any of the alternatives.

Affected Environment

Sources of Information

Ongoing studies and analyses of the Delta served as important sources of information on tidal hydraulics for this analysis. The major source of information for this section was simulation results from the “hydrodynamic” module of the DSM2 Delta tidal hydraulic and water quality model developed by DWR. This model was used to simulate the effects of the SDIP facilities and operations on Delta channel flows and salt transport. Appendix D, “DSM2 Tidal Hydraulic and Water Quality Modeling Methods and Results,” describes the DWR DSM2 model of Delta tidal hydraulics and summarizes the model results that were used for the tidal hydraulics impact assessment of the SDIP alternatives. Technical references for many of the Delta tidal hydraulic and water quality reports and modeling studies are given in Appendix D.

DSM2 Simulations

DWR performed modeling of Delta tidal hydraulic conditions for this analysis of SDIP alternatives based on CALSIM monthly average inflows and exports for the 16-year period of water years 1976–1991. This period was selected because it contains a wide range of hydrologic conditions (i.e., droughts and floods) and almost all major CVP and SWP facilities were operational during this historical period. Although CVP and SWP reservoir and Delta operational rules may have changed, this historical sequence of hydrology provides a representative period for detailed evaluation of Delta conditions.

Each of the SDIP operational scenarios was simulated for the same 16-year period. The 2001 baseline and the 2020 baseline conditions (see Section 5.1) were both used for identifying project impacts. A comparison of the 2020 and 2001 baseline Delta flow conditions can be found in Section 5.1. Because the Delta inflows are similar, the Delta tidal hydraulic effects represented by the 2001 baseline and alternative simulations are similar to the 2020 simulated conditions. Graphic results for the simulated SDIP alternatives for 2001 conditions will be shown. The 2020 conditions have also been simulated with DSM2 and will be briefly described. A full set of DSM2 results is available from the SDIP website.

DSM2 calculates tidal hydraulic conditions with a 15-minute time step. This results in 96 values for each variable at each location for each day. A total of more than 560,000 values are calculated for each 16-year simulation for each variable at each Delta location. To report the results, each month of calculations is summarized with the average, and the “sorted” or cumulative percentile values (0% [minimum], 10%, 20%, 30%, 40%, 50% [median], 60%, 70%, 80%, 90%, and 100% [maximum]). These 11 values summarize the full range of values calculated during each month of simulation (i.e., about 3,000 values for each month). Graphics in this section generally show the monthly minimum, average (or median), and maximum values for water level, and the 10%, average and 90% values for monthly tidal flows.

A series of special DSM2 Delta tidal hydraulic simulations was made to help identify the specific effects from CVP and SWP export pumping in south Delta channels. These pumping effects were identified from simulations without any south Delta channel tidal gates. The effects of the VAMP period flows, head of Old River fish control gate, and reduced export pumping also were simulated in a series of special DSM2 runs. Results from these special tidal hydraulic simulations were used to perform particle-tracking evaluations using the Particle Tracking Module (PTM) of DSM2 (see Appendix D). The results of the PTM evaluations are described and used predominantly in the fish impact assessment (Section 6.1 and Appendix J, “Methods for Assessment of Fish Entrainment in SWP and CVP Exports”).

Special DSM2 simulations to illustrate the range of possible operations of the south Delta tidal gates were performed and are described in this section. These results illustrate the effects of the tidal gates on level and tidal flows. These results provide the tidal hydraulic framework for an adaptive management strategy for operation of the tidal gates that balances tidal level, tidal flow, water quality, and fisheries objectives. The simulations for Stage 1 and Stage 2 SDIP alternatives use the enhanced circulation gate operations, which protect the minimum stage and increase circulation in south Delta channels to improve water quality conditions.

Regional Delta Tidal Hydraulics

Delta tidal hydraulics depends primarily on the physical arrangement of Delta channels, inflows, diversions, and exports from the Delta, and the strength of the ocean tides. Delta tidal hydraulics govern channel flows and Delta outflow dynamics that have important effects on salinity intrusion and estuarine habitat conditions. This section summarizes the tidal hydraulics at several important Delta locations and describes the response of these channel flows and water level variations to the range of Delta inflows as simulated by DSM2 for the 2001 baseline existing conditions. Figure 5.2-1 shows a map of the Delta, with many of the major channels and some of the locations with stage (water level), tidal flow, and EC measurement stations. Table 5.2-1 gives a summary of the Delta channel geometry for several important sections of the Delta.

Table 5.2-1. Summary of Delta Channel Geometry

	Length (Miles)	Total Surface Area (acres) at Elevation (feet msl)				Total Volume (acre-feet) at Elevation (feet msl)			
		-2	0	2	4	-2	0	2	4
Vernalis to Head of Old River	19.8	275	342	475	592	952	1,573	2,372	3,447
HOR to Stockton DWSC	14.5	326	346	365	384	2,097	2,769	3,480	4,229
DWSC to Turner Cut	13.5	743	757	770	783	12,276	13,776	15,303	16,855
SJR Turner to Old River Mouth	17.8	1,644	1,684	1,720	1,753	30,788	34,117	37,521	40,995
Mouth of Old River to Jersey Point	21.5	4,644	4,754	4,834	4,884	98,870	108,272	117,865	127,587
Jersey Point to Confluence	33.3	8,542	8,680	8,771	8,839	156,280	173,166	190,276	207,543
HOR to Grant Line Canal	8.2	173	187	199	212	935	1,296	1,683	2,094
Old River at Grant Line to DMC	16.2	313	359	393	419	1,569	2,242	2,995	3,808
OR from DMC to Vict & West Canal	3.1	192	202	211	222	1,676	2,069	2,482	2,914
Old River Victoria to Rock Slough	25.9	1,539	1,578	1,614	1,645	17,688	20,805	23,997	27,257
Old River Rock Slough to Mouth	17.2	1,228	1,280	1,312	1,340	16,941	19,449	22,043	24,696
Middle River Head to Victoria	12.3	126	167	204	230	363	656	1,028	1,462
Middle River Victoria to Mouth	46.0	3,575	3,697	3,801	3,892	46,929	54,201	61,701	69,395
Sugar Cut and Tom Paine	4.6	111	115	119	122	312	538	772	1,013
Paradise Cut and Drainage Canal	6.2	148	165	171	177	522	840	1,177	1,525
Grant Line Canal	8.9	335	366	388	412	2,131	2,835	3,588	4,388
Victoria Canal (North Canal)	4.8	229	246	261	276	1,863	2,340	2,847	3,384
Franks Tract and Big Break	35.7	6,275	6,385	6,437	6,483	46,742	59,407	72,230	85,150
Mokelumne River Channels	461.0	4,398	4,639	4,868	5,075	46,615	55,656	65,165	75,109
Sutter and Steamboat Sloughs	36.2	951	1,023	1,070	1,111	7,477	9,452	11,547	13,728
Sacramento Ship Channel	29.7	1,900	1,960	2,016	2,074	34,901	38,761	42,738	46,828
Cache Slough	21.7	1,235	1,273	1,309	1,339	14,547	17,056	19,639	22,288
Sacramento River to Emmaton	56.5	5,423	5,562	5,682	5,783	82,952	93,938	105,187	116,653
Suisun Bay	48.3	22,282	22,958	23,357	23,603	320,309	365,577	411,919	458,891
Suisun Marsh	110.7	12,390	12,624	12,775	12,881	42,281	66,932	91,976	117,264
Total Delta	1073.6	78,996	81,349	83,123	84,530	988,018	1,147,722	1,311,528	1,478,503
Upstream of Chipps Island	914.7	44,324	45,766	46,991	48,046	625,428	715,213	807,634	902,348
South Delta Channels	178.4	16,124	16,616	16,980	17,301	150,743	183,499	217,108	251,397
Upstream of South Delta Gates	45.7	947	1,078	1,184	1,273	4,999	7,029	9,293	11,751
Clifton Court Forebay	2.0	2,140	2,150	2,160	2,170	13,905	18,200	22,515	26,850

Tide Level Variations at Martinez—The Delta Model Boundary

The tidal water level fluctuations in the Pacific Ocean at the Golden Gate Bridge propagate upstream to the boundary for DSM2 at Martinez, located at the downstream end of Suisun Bay. Photograph 5.2-1 shows the I-680 Martinez Bridge looking west toward Carquinez Strait. Several oil refineries and tanker facilities are located along the downstream end of Suisun Bay. Photograph 5.2-2 shows the I-680 Martinez Bridge looking east toward Suisun Bay. The “mothball fleet” can be seen in the distance. The channel is about a mile wide at this downstream model boundary location.

Figure 5.2-2 shows the measured tidal level fluctuations at Martinez for the month of August 1997, which is considered to be representative of the normal range of monthly tidal variations at Martinez. The minimum water level for August of 1997 was about –2.0 feet msl. The minimum monthly Martinez water level generally varied from –2.0 feet to –3.0 feet, but was –3.5 feet msl for a few months of the 1976–1991 simulation period. These measured tidal levels are used as the tidal boundary for DSM2. The tidal pattern at the Golden Gate Bridge is called a mixed diurnal tide with two high tides of unequal magnitude each lunar day (24.8 hours). There is a higher-high and a lower-high tide each day. The lowest low tides and the highest high tides occur during the lunar-spring tide periods (e.g., corresponds with new moon and full moon each month). The tides during the lunar-neap tide period are smaller and nearly equal in magnitude.

Figure 5.2-3 shows the corresponding (simulated) tidal flows at Martinez for August 1997 because there are no direct tidal flow measurements at Martinez. As the tidal level rises at Martinez, the small water surface slope produces a large tidal flow into the Delta. This flood-tide flow begins to move upstream into all of the Delta channels. The rise in the water surface at Martinez slowly increases and then slowly decreases (i.e., sinusoidal shape) during the flood-tide period, producing an increasing tidal flow that reaches a maximum velocity about halfway during the flood-tide period. The tidal flow (and velocity) then slowly decreases until the high slack tide, when the tidal velocity (and flow) is zero for a short period of time. A positive value refers to flow or velocity in the downstream (i.e., ebb-tide) direction. A negative value refers to flow or velocity moving in the upstream (i.e., flood-tide) direction.

The tidal level then slowly drops and the water surface slope develops in the downstream direction, so that the ebb tide begins to flow toward the model boundary at Martinez into San Francisco Bay and the ocean. The ebb-tide flow (downstream) increases during the first portion of the ebb tide because the higher-high tide is followed by the lower-low tide in the Delta. This is the period with the largest water level drop and the highest tidal flows. The ebb-tide flow then slowly declines as the Martinez water level changes more slowly during the second half of the ebb-tide period. The Delta traditionally has been evaluated as the part of the San Francisco estuary that is upstream of Chipps Island. Photograph 5.2-3 shows an aerial view of Chipps Island, which is directly across the main channel from Pittsburg (and the Pittsburg power plant complex). Chipps Island is the net Delta outflow objective location and one of the D-1641 compliance locations for the February–June salinity objectives (i.e., X2). Photograph 5.2-4 shows the Antioch Bridge, which crosses the San Joaquin River channel upstream of the confluence with the Sacramento River, looking west toward Chipps Island.

Tide Level and Flows at Martinez

The tidal flows at Martinez that are calculated in DSM2 are relatively large. Figures in this section show the monthly range of tidal level, tidal flow, and tidal velocity for the 16-year period that is used to represent the full range of expected hydrologic conditions in the Delta. The 16-year period simulated with DSM2 is water year 1976 (October 1975) through water year 1991 (September 1991).

Figure 5.2-4 shows the minimum, 10%, average, 90%, and maximum water level values at Martinez. Only in a few months is the minimum and maximum water level influenced by high flows through the Delta. The highest tidal level is generally between 4 and 5 feet msl. The 90% tidal level values are about 3 feet, suggesting that the Martinez level is at or above 3 feet msl for about 2–3 hours each day (during the higher-high tide). The average tidal level is about 1 foot msl. The 10% level is usually between –2 feet msl and –1 foot msl. This represents the normal low tides that occur once each day (for about 2–3 hours). The minimum tides each month are generally between –3.5 feet msl and –2 feet msl. The lowest tides simulated during this 16-year period were in December and January of water year 1988.

Figure 5.2-5 shows the tidal flows at Martinez, as simulated by DSM2 for this representative 16-year period. The average tidal flow (net Delta outflow) is close to 0 cfs on this tidal flow graph, except during exceptionally high outflow months in a few years. The 90% downstream (ebb tide) flows are generally about 500,000 cfs, and the maximum downstream tidal flows in almost all months are between 600,000 cfs and 750,000 cfs. The 10% upstream (flood-tide) flows are generally about –500,000 cfs and the minimum (highest upstream) tidal flows at Martinez are between -600,000 cfs and –700,000 cfs. These are very high tidal flows moving into and out of the Delta channels twice each day.

Figure 5.2-6 shows the simulated tidal velocities for the 16-year simulation period. The tidal velocities range from a maximum of about 4 feet per second (feet/sec) during outgoing (ebb) tide, and a maximum of about –3 feet/sec during incoming flood tide. Because the tidal velocities are the direct result of the tidal level differences within the Delta channels, the tidal velocities are not directly affected by the net channel flow that is caused by the river inflows and the export pumping. Therefore, tidal velocities are nearly independent of the slight changes in net flows caused by increased CCF daily diversion (and SWP Banks pumping). Tidal velocities will remain nearly identical under the full range of Delta export conditions in most Delta channels. Changes in tidal flows are evaluated as the primary tidal hydraulic impact variable. Change in tidal velocities will be directly proportional to changes in the tidal flows.

Tide Level and Flows at Freeport

A tidal influence in the Sacramento River occurs upstream to approximately Sacramento. The tidal variation at Freeport, located 62 miles upstream of Martinez, and almost 100 miles upstream from the Golden Gate Bridge, is still about 3 feet. The tidal flows are only about 1,000 cfs and are relatively small compared to the net river flow that is generally more than 10,000 cfs (and often more than 25,000 cfs). Photograph 5.2-5 shows an aerial view of the Sacramento River downstream of the City of Sacramento and near Freeport. Interstate 5 and the Sacramento Regional Wastewater Treatment Plant are shown to the east.

Figure 5.2-7 shows the monthly range of tidal water level at Freeport for the 16-year period. The tidal level during months with low net river flow ranges from about 1 foot msl to 4 feet msl during most months. The Freeport water level increases to almost 18 feet as the river flow increases to 80,000 cfs. The tidal level variation is greatly reduced during these months with higher river inflow. The high tides are about 1 foot higher than at Rio Vista during low river flow months. The 90% monthly tide elevations are usually between 3 feet msl and 4 feet msl at Freeport. The maximum monthly tide is about 1 foot higher than the 90% monthly tide. The low tide values are between 0 feet msl and 2 feet msl, which is 3–4 feet higher than at Rio Vista. The 10% monthly tides are about 0.5 feet higher than the minimum tide in most months.

Figure 5.2-8 shows that the tidal flows at Freeport are only about 5,000 cfs less than the river flow during the flood-tide period and only about 5,000 cfs more than the net river flow during the ebb-tide periods. These tidal flows in the Sacramento River at Freeport are even less when the net river flow increases to more than 10,000 cfs. A U.S. Geological Survey (USGS) tidal flow station was installed at Freeport in 1980 and has been used to calibrate DSM2 in this portion of the Sacramento River.

Figure 5.2-9 shows the stage-discharge “rating” curve for the Sacramento River at Freeport. Photograph 5.2-6 shows the Sacramento River channel and the Freeport Bridge looking upstream. As the Sacramento River flow increases to the flood channel capacity of 80,000 cfs (the remainder of the Sacramento River flow is diverted into the Yolo Bypass), the water level increases steadily to about 18 feet msl. This is an unusual rating curve for a river station and indicates the trapezoidal shape of the Sacramento River levees downstream of Sacramento. Most river stations have a decreasing slope in the stage-discharge curve as the river width increases more rapidly at higher water levels. Figure 5.2-9 also shows the water level at Walnut Grove, located between the DCC and the head (beginning) of Georgiana Slough and indicates that the river level has decreased to about half of the level at Freeport during higher flow periods. This reduced level is caused in part by the diversions of some of the flow into Sutter and Steamboat Sloughs, and because Walnut Grove is 20 miles downstream. The corresponding water level at Rio Vista is almost always controlled by tidal level except for the highest flows, when the average level is 2 or 3 feet msl instead of the 1 foot msl average tidal level during low flow periods. Appendix D shows the DSM2-simulated tidal flows in Sutter and Steamboat Sloughs.

Figure 5.2-10 shows the range of simulated tidal velocities at Freeport. The river velocities are generally less than 2 feet/sec when the flow is less than 20,000 cfs. Average velocity increases to 3 feet/sec when the flow reaches 50,000 cfs and is a maximum of 4 feet/sec when the Sacramento River flow is greater than about

75,000 cfs. These velocities are generally lower than the range that would require riprap protection of the levees. However, many of the state and federal project levees have been strengthened with riprap for added protection during high flood events.

Sacramento River Diversions into Georgiana Slough and Delta Cross Channel

Photograph 5.2-7 shows an aerial view of the Sacramento River near Walnut Grove. The DCC gate and channel are visible flowing from the Sacramento River to the east, as well as Georgiana Slough, which flows to the southwest from Walnut Grove. Georgiana Slough is located just downstream of the DCC and is a natural channel that connects the Sacramento River channel to the Mokelumne River channel near its mouth at the San Joaquin River.

The DCC was constructed by Reclamation in 1951 as part of the CVP to allow more Sacramento River flow to move across the Delta toward the CVP Tracy facility for the DMC. The DCC was designed to increase the net flow in the San Joaquin River channel at Antioch, so that less salinity intrusion of Suisun Bay water would move upstream toward the CCWD Rock Slough intake and the CVP Tracy facility. The DCC was assumed to thereby reduce salinity intrusion during periods of low Delta outflow.

Photograph 5.2-8 shows the DCC and intake gates looking from the Sacramento River. The DCC design capacity (at low Sacramento River flows) was 3,500 cfs. The DCC is a 1.25-mile-long channel that connects the Sacramento River to the Mokelumne River channels through Snodgrass Slough. The DCC has a bottom width of 210 feet, a top width of 366 feet, and a water depth of 26 feet, so that the cross-sectional area is about 7,500 square feet. There are two manually operated radial gates near the opening to the Sacramento River, just upstream of Walnut Grove. The two DCC gates are each 60 feet wide and 30 feet tall. The conveyance area is therefore about 3,000 square feet (assuming a water depth of 25 feet). The DCC gates are normally closed to prevent scouring around the gates when the Sacramento River flow is above 25,000 cfs, indicating a maximum DCC diversion of about 6,000 cfs with a velocity of about 2 feet/sec.

Figure 5.2-11 shows the diversion of flow into Georgiana Slough and the DCC. The top figure shows the diversion flows as a function of the Freeport flow. The bottom figure shows the diversions as a fraction of the Freeport flow. As the Freeport flow increases, the diversion flows entering Georgiana Slough and the DCC increase, but the fraction of the flow diverted decreases as the Freeport flow increases to about 25,000 cfs. When Freeport flows are above 25,000 cfs, the DCC is assumed to be closed to prevent localized scour at the gate structure, which was designed to operate safely only at lower Sacramento River flows. The Georgiana Slough flow increases when the DCC is closed at a given Freeport flow.

Georgiana Slough diverts about 15% of the Freeport flow and the DCC diverts about 25% of the Freeport flow at a Sacramento River flow of 20,000 cfs (with DCC open). The diversion fractions increase at lower flows. At a Freeport flow of 7,500 cfs when the DCC gates are open, Georgiana Slough diverts about 22% and the DCC diverts about 33% of the Freeport flow. A total of more than 50% of the Freeport flow is diverted into the Mokelumne River and central Delta channels at Sacramento River flows of less than 10,000 cfs with the DCC gates open. Appendix D shows the DSM2-simulated tidal flows in Threemile Slough, Montezuma Slough, and the San Joaquin River at Antioch.

The DCC gates are closed during some months (February–May) for fish protection to reduce the fraction of migrating fish that enter the Mokelumne River and central Delta channels where survival is assumed to be less. When the DCC gates are closed, the Georgiana Slough diversions increase by about 5% of the Sacramento flow, but the net Sacramento River diversions are reduced by about 25%. This is considered to result in substantial fish survival benefits for striped bass larvae and migrating juvenile fish (i.e., Chinook salmon).

Tidal and Net Flow in Dutch Slough

Dutch Slough connects the San Joaquin River channel upstream of Antioch through Big Break to Franks Tract and Old River. Dutch Slough is on the south side of Jersey Island and Bethel Island. Dutch Slough is the most downstream channel connecting the San Joaquin River channel with the south Delta channels (channels located south of the San Joaquin River). Photograph 5.2-9 shows an aerial view of the western end of Dutch Slough as it enters Big Break, north of Oakley. The CCC is located south of Dutch Slough and connects to Rock Slough to the east of the photograph. The CCC Pumping Plant #1 is located at the western end of this section of the canal in Oakley. Photograph 5.2-10 shows Dutch Slough looking east from Big Break toward Franks Tract.

Sand Mound Slough connects Dutch Slough with Rock Slough on the west side of Holland Tract. Sand Mound Slough has flap gates to prevent upstream movement of water from Dutch Slough to Rock Slough. These gates were installed to reduce Rock Slough salinity when the CCC and pumping plants (diversion capacity of 350 cfs) were constructed by the CVP in 1948.

Simulated tidal flows in Dutch Slough are about 8,000 cfs during the flood- and ebb-tide periods. These tidal flows in Dutch Slough correspond to channel velocities of about 2 feet/sec. The net flows in Dutch Slough are usually slightly negative, indicating that some (generally less than 200 cfs) of the San Joaquin River water from upstream of Antioch moves upstream toward Franks Tract and Old River. Appendix D shows the DSM2-simulated tidal flows in Dutch Slough.

Tidal and Net Flows in False River and Fisherman's Cut

False River and Fisherman's Cut connect the San Joaquin River with Franks Tract. False River is a wide channel between Jersey Island and Bradford Island. Fisherman's Cut is a narrow channel between Bradford Island and Webb Tract. Photograph 5.2-11 shows an aerial view of False River to the west and Fisherman's Cut to the north as they connect with the western end of Franks Tract. Remnant and partially submerged levees are visible surrounding Franks Tract and the flooded island north of Bethel Island. Photograph 5.2-12 shows False River looking west from Franks Tract toward the San Joaquin River channel. Jersey Island is on the left (south), and Jersey Point is just downstream from the mouth of False River.

The simulated tidal flows in False River (see Appendix D) are about 45,000 cfs during ebb tide and about –45,000 cfs during flood tide. The maximum simulated tidal velocities are about 2 feet/sec in False River. The net flows are generally less than 1,000 cfs and are usually positive, indicating a net flow from Franks Tract (and False River) to the San Joaquin River. Even during periods of high pumping at SWP Banks and CVP Tracy, False River net flows do not reverse direction, but continue to be positive (i.e., downstream) from Franks Tract to the San Joaquin River.

Fisherman's Cut is a relatively small channel with simulated tidal flows of about 4,000 cfs (10% cumulative flow of –4,000 and 90%-cumulative flow of 4,000 cfs). The net flow of less than 500 cfs is positive, indicating a net flow from the San Joaquin River to False River (i.e., around Bradford Island). Fisherman's Cut net flow returns to the San Joaquin River through the False River channel. Therefore, a net flow of about 500 cfs from Franks Tract flows to the San Joaquin River through False River, in addition to the 500 cfs from Fisherman's Cut. DSM2-simulated tidal flows in the San Joaquin River at San Andreas Landing (downstream of the Mokelumne River) and in the mouth of the Mokelumne River are shown in Appendix D.

Tidal and Net Flows at the Mouth of Old River

The mouth of Old River is one of the major connections into the south Delta channels. Photograph 5.2-13 shows an aerial view of the Old River mouth at the northwest corner of Franks Tract connecting to the San Joaquin River just south (upstream) of the Mokelumne River mouth. Diversions from the Sacramento River that flow through the DCC and Georgiana Slough exit the Mokelumne River and flow across the San Joaquin River into the mouth of Old River. Photograph 5.2-14 shows the sea-wall that was constructed along the southwest Franks Tract levee to protect the docks and marinas located along the shore of Bethel Island from the relatively large waves that are common in Franks Tract.

The simulated tidal flows range from approximately –20,000 cfs (10% flows) during flood tide to about 10,000 cfs (90% flows) during ebb tide with a net flow of between –3,000 cfs and –5,000 cfs (i.e., upstream toward CVP and SWP pumps). Some of this negative net flow is caused by the tidal circulation pattern that apparently moves into Franks Tract from the Old River mouth and exists from Franks Tract through False River. Net flows at the mouth of Old River never become positive, even during high San Joaquin River flows. The simulated tidal velocities are less than 1 foot/sec at the mouth of Old River, even at the maximum tidal flows of 20,000 cfs during flood tide.

The net flow at the mouth of Old River is dependent on the total exports and the net agricultural diversions in the south Delta (assumed in DSM2 to be about 40% of total net Delta depletions). If the head of Old River flow from the San Joaquin River is less than the combined pumping and south Delta agricultural diversions (usually), the net flow into the south Delta channels through Old and Middle River must be negative to make up the difference. The south Delta exports and diversions not supplied from the head of Old River must move through the mouth of Old River or Dutch Slough and up the Old River channel, or through the mouth of Middle River (including Columbia Cut) or Turner Cut and up the Middle River and Victoria Canal to the CVP and SWP pumping plants.

DSM2-simulated Dutch Slough net flows supply only about 5% of the net south Delta exports and diversions. Analysis of the DSM2 results indicates that about 45% of the net south Delta exports and diversions enter through the Old River mouth. About 40% of the net south Delta exports and diversions enter through the Middle River mouth or Columbia Cut, and the about 10% of the net flows enter through Turner Cut. These fractions remain about the same for the full range of net exports and diversions, which can be more than 10,000 cfs during periods of high pumping (see Appendix D).

Tidal and Net Flows in Middle River

The simulated tidal flows at the mouth of Middle River (including flows in Columbia Cut) range from –20,000 cfs (10% flow) during flood tide to about 15,000 cfs (90% flow) during ebb tide with a net flow that varies from 0 cfs to about –5,000 cfs (see Appendix D). About 40% of the net south Delta exports and diversions move through the mouth of Middle River or Columbia Cut. The net flow at the Middle River mouth can become slightly positive during high San Joaquin River flows. The maximum tidal velocities in Middle River are about 1 foot/sec.

Turner Cut joins Empire Cut that connects with the Middle River channel just south of flooded Mildred Island. The mouth of Turner Cut is located at San Joaquin River mile 32.5, about 10 miles upstream of the Mokelumne River mouth and about 7 miles downstream of the upstream end of the Stockton DWSC. The simulated tidal flows in Turner Cut range from about –4,500 cfs (10% flow) during flood tide to about 2,500 cfs (90% flow) during ebb tide (see Appendix D). The net flow is usually negative but can be positive during high San Joaquin River flows (i.e., 1983 only). About 10% of the net south Delta exports and diversions move through Turner Cut. The net tidal flows into Turner

Cut range from –200 cfs to about –1,000 cfs. These net flows in Turner Cut join with Middle River net flows to supply the net south Delta exports and diversions.

Tidal and Net Flows in the Stockton Deep Water Ship Channel

The DWSC extends upstream from the San Joaquin River mouth near Antioch to the Port of Stockton. DWR operates a tidal stage recorder and water quality monitor at the downstream end of Rough and Ready Island. Photograph 5.2-15 shows the Port of Stockton, with Rough and Ready Island located to the west. The San Joaquin River flows north into the DWSC at the Port. The Stockton Regional Wastewater Control Facility (RWWCF) (oxidation ponds) is located south of the DWSC. Photograph 5.2-16 shows the DWSC and the east complex of the Port of Stockton on Rough and Ready Island, looking west from Stockton.

The San Joaquin River flow that is not diverted at the head of Old River flows past the RWWCF discharge and into the DWSC. The 10% tidal level values are generally between –1 feet msl and –0.5 foot msl. The average tidal level is about 1 foot msl, and the 90% tidal level values are generally between 2.5 feet msl and 3.0 feet msl. The maximum tidal level is usually between 3.5 feet msl and 4.5 feet msl (see Appendix D). This range of tidal fluctuation at Rough and Ready Island is similar to the tidal fluctuation at Antioch, although Rough and Ready Island is about 40 miles upstream of the San Joaquin River confluence near Antioch.

The range of tidal flow in the San Joaquin River at Rough and Ready Island is between about –5,000 cfs during flood tide (10% tidal flow) and about 5,000 cfs during ebb tide (90% tidal flow). The net flow is often less than 500 cfs when San Joaquin River at Vernalis flow is less than 2,000 cfs but increases to about 50% of the Vernalis flow during periods of higher San Joaquin River flow.

Tidal and Net Flows in the Head of Old River

Photograph 5.2-17 shows an aerial view of the San Joaquin River downstream of Mossdale (southeast corner of photograph) and the head of Old River channel flowing to the west. The San Joaquin River continues to the north. The San Joaquin River makes a “T” at the head of Old River; the two channels are similar in size, and generally the Vernalis flow is split equally at the head of Old River diversion. Photograph 5.2-18 shows the Mossdale Bridges looking north (downstream) toward the head of Old River.

Figure 5.2-12 shows the range of tidal levels in the San Joaquin River at Mossdale, just upstream of the head of Old River. The tidal level range is higher at the head of Old River than at other Delta locations because the San Joaquin River hydraulic conditions influence the level. The minimum tidal level is about 0 feet msl, and the 10% cumulative tidal level is about 0.5 foot. The median tidal level is between about 1 foot msl and 2 feet msl, and the 90% cumulative tidal level is about 2.5 feet msl. The maximum tidal level is about 4 feet msl. The simulated mean tidal flow is always positive and is about 50% of the Vernalis flow when the Vernalis flow is more than 2,000 cfs. At lower river flow, the head of Old River flow is influenced by the south Delta exports and diversions. The tidal flows are about 500 cfs to 1,000 cfs more than the net flow during ebb tide (90% tidal flow) and about 500 cfs to 1,000 cfs less than the net flow during flood tide (10% tidal flow). The minimum tidal flow is negative only if the net head of Old River flow is less than 1,000 cfs.

The head of Old River diversion from the San Joaquin River is similar to the DCC diversion from the Sacramento River. The head of Old River diversion is about 50% of the San Joaquin River flow at higher flows and is increased by about 5% of the combined south Delta exports and diversions. The effects of temporary agricultural barriers (No Action conditions) or the proposed permanent fish control tidal gate on the head of Old River flows will be further described in the environmental consequences section.

Water Level and Velocity in the San Joaquin River at Vernalis

Vernalis is located at San Joaquin River mile 72 and is just upstream of the tidal influence from the Delta. Vernalis is the upstream boundary for DSM2. Photograph 5.2-19 shows an aerial view of the San Joaquin River just downstream of the Vernalis Bridge (just off the bottom of the photograph). The Banta-Carbona diversion canal is visible near the top of the photograph. The tidal range is less than a foot at the diversion canal. Photograph 5.2-20 shows the Vernalis Bridge and the San Joaquin River looking north (downstream).

Figure 5.2-13 shows the monthly flows at Vernalis and Mossdale for the 16-year period simulated with DSM2. Simulated monthly average flows at Vernalis are almost always between 1,000 cfs and 2,500 cfs. Only a few high flows are simulated in the winter months of wet years. During high flow periods, Mossdale flow is less than Vernalis because some of the San Joaquin River flow is diverted into Paradise Cut. The highest monthly average flow during the 16-year period was just above 35,000 cfs in March and June of 1983.

Figure 5.2-14 shows the water level and velocity at Vernalis as a function of flow (i.e., stage-discharge curve). The river level and velocity increase with flow in a manner typical of river cross sections with levees. The water level and velocity continue to increase even at higher flows because the river width is confined by levees. The flood-warning level at Vernalis is about 29 feet, corresponding to a flow of about 32,500 cfs. DSM2 level is slightly lower than the actual rating curve for Vernalis, but there is not any large effect from this difference. The top of levee is about 37 feet msl, and the peak level was recorded on January 5, 1997, at 35 feet msl. The simulated average velocity was about 1 foot/sec at flows of less than 1,000 cfs, about 2 feet/sec at a flow of 5,000 cfs and increased to about 3 feet/sec at a San Joaquin River flow of about 25,000 cfs.

Photograph 5.2-21 shows the flood control diversion weir downstream of Vernalis at Paradise Cut, looking west across the San Joaquin River. The weir notch in the left-hand levee is at elevation 12.5 feet and is 237 feet long. DSM2-simulated flood diversions begin at a Vernalis flow of about 15,000 cfs (Vernalis water level of 20 feet). DSM2 indicates that the Paradise Cut flow will be half of the Vernalis flow in excess of 15,000 cfs. Paradise Cut therefore diverts 5,000 cfs when the Vernalis flow is 25,000 cfs and diverts 10,000 cfs when Vernalis flow is 35,000 cfs.

The CALSIM simulations of the SDIP alternatives show that there will be no direct effects on the San Joaquin River flows at Vernalis. Because flows at Vernalis will not change, the river water level downstream of Vernalis will not be changed with the SDIP alternatives, and the river stage (i.e., depth) will fluctuate with existing condition flows. Figure 5.2-14 indicates that the San Joaquin River flows have a substantial influence on river stage (i.e., depth) at relatively low flows. The river stage at a flow of 500 cfs will be about 6 feet msl, will be about 8 feet msl at a flow of 1,000 cfs, and will be about 10 feet msl at a flow of 2,000 cfs. Downstream near Mossdale, the river stage is influenced by the tides and by the head of Old River fish control gate. Without the gate, the DSM2 minimum stage at Mossdale is about 0 feet msl at river flows of less than 1,000 cfs, about1 foot msl at a flow of 2,000 cfs. However, with the gate in place (or closed), the minimum stage is raised by 1 foot at low flows of less than 2,000 cfs. Therefore, because the flows at Vernalis and Mossdale will not be changed by SDIP alternatives, the only change in river level near Mossdale will be an increase of about 1 foot when the head of Old River gate is closed.

South Delta Tidal Hydraulics

The proposed SDIP facilities would be located in the south Delta channels of Old River, Middle River, and Grant Line Canal. The tidal hydraulics in these channels must be accurately described and understood to allow the proper evaluation of the existing conditions (i.e., agricultural water supply and water quality), and the assessment of the expected improvements and potential impacts from the SDIP alternatives.

Figure 2-1 shows a map of the San Joaquin River and south Delta channels, the existing Tracy fish facility and CVP Tracy, and the SWP CCF, Skinner Fish Facility, and SWP Banks. The south Delta channel geometry is introduced below and simulations of south Delta tidal hydraulics are illustrated and described.

South Delta Channel Geometry

There are three main pathways for water to enter the south Delta channels as it moves toward the CVP Tracy and SWP Banks facilities:

- from the San Joaquin River through the upstream end of Old River, called the head of Old River, west along Old River and Grant Line Canal toward Tracy;
- from the central Delta through Middle River along the eastern edge of Bacon Island and Woodward Tract, and then southwest in Victoria Canal along the southeast edge of Victoria Island; and
- from the central Delta through Old River along the western edge of Bacon Island, Woodward Tract, and Victoria Island and south in West Canal between Coney Island and CCF.

San Joaquin River flow (measured at the Vernalis Bridge at San Joaquin River mile 72) enters the upstream end of the Old River channel at the head of Old River, located downstream of Mossdale at San Joaquin River Mile 53.5. Photograph 5.2-17 shows that the San Joaquin River channel makes a sharp turn at the head of Old River. In the absence of any CVP or SWP pumping, about 50% of the San Joaquin River flow splits into the Old River channel, and the other 50% continues down the San Joaquin River channel toward Stockton. During storm flows of greater than about 15,000 cfs at Vernalis, the Paradise Cut weir (elevation 12.5 feet) will divert some of the flow at San Joaquin River mile 60 into Paradise Cut toward Grant Line Canal, reducing the San Joaquin River flow at Mossdale and the head of Old River.

The proposed San Joaquin River fish control gate would be located at the head of Old River and can be used to control the flow split from the San Joaquin River. Photograph 5.2-22 shows the head of Old River channel with a temporary barrier installed.

South Delta Channels Upstream of the Proposed Tidal Gates

The Old River channel flows west about 4 miles to the upstream end of Middle River and continues past Doughty Cut (which connects with the upstream end of Grant Line Canal) toward Tracy. Photograph 5.2-23 shows an aerial view of Grant Line Canal and Old River channel with Doughty Cut. The Old River channel in the vicinity of Tracy is the southernmost Delta channel.

The Old River channel length between the head of Old River and Grant Line Canal is about 8 miles with a surface area of about 187 acres and a volume of 1,296 acre-feet at an elevation of 0 feet msl. Old River channel between Grant Line Canal and the CVP Tracy facility (DMC) is about 16 miles long, with a surface area of 359 acres and a volume of 2,242 acre-feet. One of the proposed tidal gates would be constructed on Old River just upstream of the DMC CVP Tracy facility, about where the temporary barrier is installed each year. Most of the flow in Old River flows through Doughty Cut to Grant Line Canal. These south Delta channel geometry values are given in Table 5.2-1.

Middle River is a relatively narrow and shallow channel that extends 12 miles from the head to Victoria Canal. Photograph 5.2-24 shows the Middle River channel at its head at Old River. The channel has been dredged wider and deeper in the lower 4 miles from Victoria Canal to between the Tracy Boulevard Bridge and the Howard Road Bridge. Photograph 5.2-25 shows an aerial view of the Middle River channel at the confluence with Victoria Canal (and North Canal). The temporary barrier and the proposed tidal gate location are just west of the confluence with Victoria Canal. Photograph 5.2-26 shows the Middle River channel looking south from above Jones Tract across the SR 4 Bridge, with Victoria Canal to the southwest. The surface area of Middle River is about 167 acres, with a volume of 656 acre-feet at an elevation of 0 feet msl.

The Grant Line Canal is the common name for what are actually two parallel canals. The Grant Line Canal is about 9 miles long, and the Fabian and Bell Canal begins near the Tracy Boulevard Bridge and continues to the downstream end of Grant Line Canal where it rejoins the Old River channel just north of the Tracy fish facility. Photograph 5.2-27 shows an aerial view of the western end of Grant Line Canal where it intersects with Old River just north of the DMC intake channel and the Tracy fish facility, and south of the CCF intake channel. The southeast corner of CCF is shown. Photograph 5.2-28 shows the mouth of Grant Line Canal, looking to the west toward Old River. The CCF intake is located to the north, and the CVP DMC intake is located to the south. The proposed Grant Line tidal gate would be here. The surface area of Grant Line Canal is about 366 acres, with a volume of about 2,835 acre-feet at an elevation of 0 feet msl. One of the proposed tidal gates would be constructed at the downstream end of Grant Line Canal near the confluence with Old River near the DMC and the CCF gates.

Paradise Cut is a dead-end tidal slough connected to Old River by Sugar Cut (north of Tracy) that is about 6 miles long with a surface area of 165 acres and a volume of 840 acre-feet at an elevation of 0 feet msl. Tom Paine Slough is about 5 miles long and has been isolated from tidal influence with siphons; it is operated as a long lake to supply approximately 10 major irrigation diversions. DWR and SDWA dredged portions of the channel in 1986 and installed new siphons in 1989. Photograph 5.2-29 shows the siphons for Tom Paine Slough, which are located on Sugar Cut, just south of Old River. DWR installed temporary pumps in 2003 to increase the diversion flow into Tom Paine Slough. The CCF gate operations (i.e., schedule) were modified to reduce SWP diversions during the flood-tide period of the higher-high tide (referred to as Priority 3 operations) to increase the water level maintained in Tom Paine Slough. Photograph 5.2-30 shows the Old River channel looking west from Sugar Cut across the Tracy Boulevard Bridge. The riparian vegetation along this meandering channel is relatively thick.

The total surface area encompassed by the four proposed south Delta gates (three tidal gates and one fish control gate) is about 1,100 acres with a volume of 7,300 acre-feet at a water surface elevation of 0 feet msl. As the tidal elevation fluctuates, the surface area and volume will change, as indicated in Table 5.2-1. For the average tidal fluctuation of 3 feet (i.e., from –1.0 foot to 2 feet) the surface area will increase from 1,000 acres to 1,200 acres, and the volume will increase from about 6,000 acre-feet to about 9,500 acre-feet, a change of about 3,500 acre-feet. This tidal prism, meaning the volume change between the low tide and the high tide, will move into and out of the south Delta channels twice each day. This represents an average tidal flow of about 3,500 cfs flowing into these channels during the flood tides (for about 12 hours each day) and about 3,500 cfs flowing out of these channels during the ebb tides. The next section describes the channels that convey these tidal flows into and out of the south Delta.

South Delta Channels Downstream of the Proposed Tidal Gates

The CCF was completed in 1969 to provide a short-term storage forebay to reduce the tidal fluctuations at the SWP Banks facility and allow off-peak power (i.e., nighttime) to be used to pump water into the California Aqueduct. Photograph 5.2-31 shows an aerial view of the western end of the CCF with the John E. Skinner Fish Salvage Facility located at the southwest corner of CCF. The SWP Banks facility is located just off the southwest corner of the picture. The CCF surface area is 2,180 acres with a volume of 31,260 acre-feet at a maximum elevation of 6 feet msl, so the average depth is about 15 feet. However, the CCF operates at an average elevation of only about 0 feet msl. Table 5.2-1 indicates that the surface are at 0 feet msl is about 2,150 acres and the volume is about 18,200 acre-feet.

Photograph 5.2-32 shows an aerial view of the eastern side of CCF with the intake gates on the southeast corner of CCF and Coney Island, which is located just east of the CCF. West Canal forms the eastern boundary of CCF along the western edge of Coney Island. Victoria Canal (and North Canal) connects with Old River at the north end of Coney Island. The Old River channel flows around the eastern edge of Coney Island. The Old River channel and West Canal between the DMC Tracy facility and Victoria Canal have a surface area of 202 acres and a volume of 2,069 acre-feet at an elevation of 0 feet msl. Victoria Canal connects the Middle River to the Old River Channel just north of Coney Island. Victoria Canal is the common name for the Victoria Canal along the southeastern edge of Victoria Island and the parallel North Canal along the northwestern edge of Union Island. Victoria Canal is about 5 miles long and has a surface area of 246 acres and a volume of 2,340 acre-feet at a water elevation of 0 feet msl.

Old River channel continues north past the western edge of Victoria Island, Woodward Island, and Bacon Island and along the eastern edge of Holland Tract and the eastern edge of Franks Tract, which is a flooded island, to the Old River mouth (i.e., downstream end) at the San Joaquin River. About half of the water entering the south Delta on its way to the CVP and SWP pumping plants flows in this portion of the Old River channel. The tidal flows and net flows are described in a subsequent section. The Old River channel from Victoria Canal to the mouth at the San Joaquin River is about 40 miles long. The surface area is about 1,578 acres from Victoria Canal to Rock Slough and 1,280 acres from Rock Slough to the mouth. The Old River volume is about 20,000 acre-feet from Victoria Canal to Rock Slough (including Rock, Indian, and Italian Sloughs and Discovery Bay) and another 20,000 acre-feet from Rock Slough to the mouth (not including Franks Tract).

Franks Tract connects with the San Joaquin River through False River, Fisherman's Cut, and Dutch Slough to Big Break. The surface area of these channels and flooded islands is about 6,400 acres with a volume of about 60,000 acre-feet at a water surface elevation of 0 feet msl.

Middle River channel extends north from Victoria Canal along the eastern edge of Victoria Island, Woodward Island, and Bacon Island. Jones Tract is located to the east. Turner Cut and Empire Cut connect the San Joaquin River to Middle River near the middle of Bacon Island, along the north edge of Jones Tract. Mildred Island, which flooded in 1983 is located just downstream (north) of Empire Cut. Middle River continues north along the eastern edge of Mandeville Island and splits around both the eastern side of Medford Island in Columbia Cut and around the western side of Medford Island to the mouth at the San Joaquin River, located only about 3 miles upstream of the mouth of Old River. The Middle River channels north of Victoria Canal have a surface area of 3,700 acres with a volume of 54,200 acre-feet, including the Turner and Columbia Cuts that connect with the San Joaquin River, three channels that connect Old River, and flooded Mildred Island. About half of the water moving across the Delta from the Sacramento River through the Mokelumne River channels flows down Middle River to Victoria Canal toward the SWP and CVP pumping plants.

The south Delta can be generally defined as all Delta channels and flooded islands located south and west of the San Joaquin River. The total south Delta surface area is therefore about 16,600 acres with a volume of 183,500 acres at an elevation of 0 feet msl (including CCF). The tidal level changes and the corresponding tidal flows that occur within these south Delta channels are described in the next section. Table 5.2-1 summarizes these south Delta channel geometry data (obtained from DSM2 model geometry files) as well as the geometry for the remainder of the Delta.

Simulated Effects of Central Valley Project and State Water Project Pumping on Tidal Hydraulics in the South Delta without Barriers or Gates

DSM2 was used to simulate typical summer tidal level and flow variations with a relatively low San Joaquin River inflow of 1,500 cfs and several different constant pumping cases for August 1997 measured Martinez tides and measured Sacramento River daily inflows. Results for no CVP or SWP pumping are compared to results with 4,600 cfs CVP Tracy pumping and to results with 6,680 cfs and 8,500 cfs of SWP Banks pumping to identify the maximum tidal effects of the CVP and SWP pumping simulated with no temporary barriers. These model results are considered typical of the maximum potential effects of the CVP Tracy facility and the maximum allowed SWP Banks pumping with associated CCF gate operations. Results for SWP pumping of 6,680 cfs and 8,500 cfs in addition to CVP pumping of 4,600 cfs are used to demonstrate the maximum likely effects of increased SWP Banks pumping without temporary barriers. Table 5.2-2 shows simulated August 1997 flow in the south Delta Channels for a range of CVP and SWP exports. These changes in hydraulic conditions are not simulated impacts from the SDIP alternatives, but represent the general tidal hydraulic differences caused by increasing CVP and SWP pumping, with no temporary barriers or tidal gates.

Table 5.2-2. Simulated August 1997 Net Channel Flow (cubic feet per second) in South Delta Channels for a Range of CVP and SWP Exports

A. Net Channel Flows

State Water Project Exports	**0**	**0**	**6,680**	**8,500**	**10,300** [1]
Central Valley Project Exports	**0**	**4,600**	**4,600**	**4,600**	**4,600**
Delta Outflow	5,000	5,000	5,000	5,000	5,000
Sacramento River at Freeport	5,864	10,464	17,144	18,964	20,764
San Joaquin River	1,500	1,500	1,500	1,500	1,500
Old River at Head	895	1,078	1,342	1,393	1,452
San Joaquin River at Stockton	605	422	158	107	48
Turner Cut	-130	-473	-957	-1,098	-1,236
Middle River at Mouth	-94	-1,918	-4,524	-5,241	-5,944
Old River at Mouth	-2,260	-3,632	-5,518	-6,024	-6,514
False River at Franks Tract	1,770	1,239	353	103	-148
Dutch Slough	0	-250	-550	-650	-750
Old River at Bacon Island	382	-1,510	-4,355	-5,142	-5,901
Middle River at Bacon	-177	-2,428	-5,626	-6,518	-7,406
Grant Line Canal at Tracy Blvd Bridge	552	692	980	1,042	1,118
Old River at Tracy Blvd Bridge	102	164	176	173	168
Middle River at Tracy Blvd Bridge	-17	-36	-72	-79	-87
Total Inflow to South Delta	**1,607**	**6,111**	**12,538**	**14,304**	**16,044**
Total Exports (CVP and SWP)	**0**	**4,600**	**11,280**	**13,100**	**14,900**

B. Percent of Flow Entering South Delta that does not come from Head of Old River

Total Flow Not from Head of Old River	**713**	**5,034**	**11,196**	**12,910**	**14,592**
Percent from Turner Cut	18%	9%	9%	9%	8%
Percent from Middle River	13%	38%	40%	41%	41%
Percent from Old/False River	69%	48%	46%	46%	46%
Percent from Dutch Slough	0%	5%	5%	5%	5%

[1] Shown for comparison purposes only.

Review of DSM2 results indicates that the effects of constant CVP Tracy pumping of 4,600 cfs and the tidal diversion of water into CCF for SWP Banks pumping would both cause an increase in the flows moving from the San Joaquin River toward the pumping plants. The increased flow would move along all three pathways from the San Joaquin River—from the head of Old River and Grant Line Canal to the DMC, from the mouth of Middle River and Columbia Cut and Turner Cut to Victoria Canal and the Old River channel, and from the mouth of Old River through Franks Tract and down the Old River channel to the CCF gates and the DMC. The effects of the CVP and SWP pumping on tidal level in the south Delta can be detected at the head of Old River but cannot be detected at the mouth of Middle River or the mouth of Old River. Details of how CVP and SWP pumping changes tidal level and flows in the south Delta channels are described in Appendix D and summarized here.

Figure 5.2-15 provides a summary of the tidal level variations for Old River at Tracy Boulevard and Grant Line Canal at Tracy Boulevard. The 0% (minimum), 10%, 20%, 30%, 40%, 50% (median), 60%, 70%, 80%, 90%, and 100% (maximum) tidal level values have been graphed. These cumulative percentile values have then been plotted as a function of the export pumping to indicate the shift in the tidal level range that was caused by the different assumed pumping flows. CVP maximum pumping of 4,600 cfs caused a slight reduction in the tidal level at these selected Old River and Grant Line Canal locations. SWP pumping of 6,680 cfs and 8,500 cfs (total pumping of 11,280 cfs and 13,100 cfs) caused an additional reduction in the tidal level. Maximum SWP pumping of 10,300 cfs (total pumping of 14,900 cfs) was included in these figures for comparison and to indicate the potential for this next increment of SWP export pumping to influence the range of tidal level in south Delta channels. The SDIP alternatives would include SWP pumping of 8,500 cfs but not SWP pumping at full capacity of 10,300 cfs.

The minimum tidal level was reduced from about 0.0 foot msl with no pumping to –1.0 foot msl with 14,900 cfs total pumping (i.e., 4,600 cfs CVP and 10,300 cfs SWP pumping) at the Grant Line Canal station. The maximum tidal level was reduced from about 4.0 feet msl to 2.25 feet msl at Grant Line Canal, with maximum export pumping of 14,900 cfs with no temporary barriers or tidal gates. These appear to be relatively small changes in the tidal level in Grant Line canal for the full change in pumping from 0 cfs to about 15,000 cfs. The bottom of Figure 5.2-15 indicates a similar relatively small effect of export pumping on tidal level in Old River at Tracy Boulevard Bridge. The minimum tidal level shifted from about –0.25 foot msl with no pumping to –1.25 feet msl with full export pumping of about 15,000 cfs. The maximum tidal level shifted down from about 4.0 feet to 2.25 feet with full pumping.

Figure 5.2-16 shows the simulated effects of the export pumping on Middle River level at Mowry Bridge and at Tracy Boulevard Bridge. The minimum tide in Middle River at Tracy Boulevard Bridge shifted from about –0.5 foot msl to -1.0 foot msl. This is a decline of only 6 inches in the low tidal level resulting from an increase in the export pumping from 0 cfs to about 15,000 cfs with no temporary barriers or tidal gates. Tides at this end of the Middle River channel are farther from the export pumping plants and are therefore less affected than other south Delta locations.

Figure 5.2-17 shows the effects of pumping on tides simulated at Clifton Court Ferry station and the head of Old River. Clifton Court Ferry is located just upstream of the CCF gates and experiences the maximum effects from increased CVP and SWP pumping. The minimum tide at Clifton Court Ferry declined from –0.5 foot msl to about –1.5 feet msl for the full range of export pumping change from 0 cfs to about 15,000 cfs. The simulated change in the minimum tides at the head of Old River is very small, because the tidal level is strongly influenced by the San Joaquin River level near Mossdale. The simulated minimum tidal level declined from about 1.0 foot msl to about 0.25 foot msl for the full change in pumping from 0 cfs to about 15,000 cfs.

These simulated changes in the minimum tidal level suggest that the effects of CVP and SWP pumping on tidal level in the south Delta channels are moderate. The effects of full pumping capacity of about 15,000 cfs on minimum tidal levels are less than a 1-foot decline at most south Delta channel locations.

These simulation results indicate that the maximum effect of increasing SWP pumping from 6,680 cfs to 8,500 cfs would be very small, even without tidal gates to maintain a target minimum tidal level of 0 feet msl. The maximum decrease in the minimum tidal level caused by increased SWP pumping from 6,680 cfs to 8,500 cfs is less than 3 inches (0.25 feet) at Clifton Court Ferry and less than 2 inches (0.15 feet) at other south Delta locations.

Simulated South Delta Hydraulic Effects of the Vernalis Adaptive Management Plan

The tidal hydraulic conditions caused by the head of Old River fish control gate, increased San Joaquin River flows, and reduced CVP and SWP export pumping that are specified during the VAMP period in April and May of each year are described in Appendix D and summarized below.

VAMP involves three management actions that are used in combination to improve Chinook salmon survival from the San Joaquin River tributaries:

1. An increase of the natural San Joaquin River flow during the April 15–May 15 period to one of five target flows: 2,000 cfs, 3,200 cfs, 4,450 cfs, 5,700 cfs, or 7,000 cfs.
2. The installation of a temporary rock barrier with culverts at the head of Old River to reduce the diversion of San Joaquin River water into Old River during the peak migration of Chinook smolts (April 15–May 15).
3. The reduction of CVP Tracy and SWP Banks pumping to less than the 1995 WQCP–mandated level (D-1641) that allows combined CVP and SWP pumping to be equal to the San Joaquin River flow. The combined pumping targets are 1,500 cfs, 2,250 cfs, or 3,000 cfs.

The temporary rock barrier placed across the Old River channel at the head reduces the diversion of flow into the Old River channel and thereby reduces the loss of Chinook smolts at CVP Tracy and SWP Banks. Photograph 5.2-22 shows the head of Old River fish control barrier being installed during the VAMP period in April 2002. The elevation of the rock weir has varied slightly during the period of spring placement. The 2003 barrier had a top elevation of 1 foot msl. The weir prevents the majority of the San Joaquin River flow from entering Old River. Culverts have been included to allow a controlled portion of the San Joaquin River flow to enter Old River to provide a water supply to the south Delta channels. The six culverts are 48-inch-diameter pipes with a combined capacity of about 150 cfs averaged over the daily tidal level variation. There is also some seepage of water through the rock weir structure. Photograph 5.2-23 shows the Old River channel downstream of the head barrier. This section of Old River has federal project levees with very little riparian vegetation.

A series of DSM2 simulations was made to evaluate the effects on south Delta tidal hydraulic conditions. The San Joaquin River flow was assumed to be at one of the VAMP target flows of 2,000 cfs, 3,200 cfs, 4,450 cfs, 5,700 cfs, or 7,000 cfs, and the head of Old River temporary fish control barrier (2002 design) was assumed to be either open or installed without culverts to show the maximum tidal hydraulic effects from the temporary barrier. Exports were assumed to be equal to the San Joaquin River flow with export pumping split between CVP and SWP, or equal to the VAMP export target (i.e., 1,500 cfs export when the San Joaquin River flow is 2,000 cfs, 3,200 cfs or 4,450 cfs; 2,250 cfs export when the San Joaquin River flow is 5,700 cfs; and 3,000 cfs exports when the river flow is 7,000 cfs). This resulted in a total of 20 modeled combinations to evaluate the five VAMP target conditions. These results are fully described in Appendix D.

Figure 5.2-18 shows the effects of the San Joaquin River flow and export pumping on tidal level variations at the head of Old River (downstream of gate location) for San Joaquin River flows of 2,000 cfs to 7,000 cfs. The VAMP cases shown are with export pumping equal to the San Joaquin River flow, which is the highest export pumping allowed under D-1641. The actual VAMP export pumping targets are less (see Appendix D). The tidal level increases with San Joaquin River flow if the gate remains open (top graph). The tidal flows and level variations are reduced as the tidal level increases with higher San Joaquin River flows and corresponding head of Old River diversions.

The bottom graph shows that when the head of Old River fish control gate is completely closed, the tidal level ranges are similar to the other south Delta channel tidal ranges, and the tidal levels are only slightly reduced as export pumping increases. The minimum tidal level remains at between –0.5 foot and -1.0 foot msl.

Figure 5.2-19 shows the effects of the San Joaquin River flow and export pumping on tidal level variations in Old River at Tracy Boulevard Bridge for San Joaquin River flows of 2,000 cfs to 7,000 cfs. The minimum tidal level increases slightly with San Joaquin River flow if the gate remains open (top graph). The bottom graph shows that when the head of Old River fish control gate is closed, the tidal level ranges are similar to the other south Delta channel tidal ranges and are only slightly reduced as pumping increases. The minimum tide remains at between –0.5 foot and –1.0 foot msl.

Figure 5.2-20 shows the effects of the San Joaquin River flow and export pumping on tidal level variations in Middle River at the upstream end near Old River for San Joaquin River flows of 2,000 cfs to 7,000 cfs. The minimum tidal level increased slightly with San Joaquin River flow if the gate remains open (top graph). The bottom graph shows that when the head of Old River fish control gate is completely closed, the tidal level ranges are similar to the other south Delta channel tidal ranges and are only slightly reduced as pumping increases. The minimum tide remains at between –0.5 foot and –1.0 foot msl.

Figure 5.2-21 shows the effects of the San Joaquin River flow and export pumping on tidal level variations in Grant Line Canal at Tracy Boulevard Bridge for San Joaquin River flows of 2,000 cfs to 7,000 cfs. The minimum tidal level remained between –0.5 feet and 0.0 feet msl for the entire range of San Joaquin River flow if the gate remains open (top graph). The bottom graph shows that when the head of Old River fish control gate is closed, the tidal level ranges are similar to the other south Delta channel tidal ranges, and are only slightly reduced as pumping increases. The minimum tide remains at between –0.5 foot and –1.0 foot msl.

Closing the head of Old River fish control gate reduced the level in the south Delta channels to the normal tidal variations, with low tides of about –0.5 to -1.0 feet. With the head of Old River fish control gate closed, the effects of additional pumping (2,000 cfs to 7,000 cfs) during the VAMP period does not have a substantial effect on reducing the minimum tidal level at the Old River, Grant Line Canal, and Middle River stations.

Table 5.2-3 shows how the net flows change in south Delta channels as the San Joaquin River flow increases and as the head of Old River fish control gate is closed. The head of Old River diversions from the San Joaquin River move directly to the CVP and SWP export pumps. When the head of Old River gate is closed, additional water moves upstream into Turner Cut, the mouth of Middle River, and the mouth of Old River near Franks Tract to supply the export pumping flow that is no longer diverted at the head of Old River. The consequences of these changes in net flow patterns on the fate of fish that may be migrating in the San Joaquin River during the VAMP period is evaluated in Section 6.1, Fish, and in Appendix J.

Clifton Court Forebay Operations

This section describes the hydraulic operations of the CCF. The CCF is a large (2,100 acres) tidal impoundment that was designed to reduce the tidal fluctuations of the water surface level to allow a more uniform water depth for the SWP Banks units and to provide a forebay reservoir for off-peak pumping.

Table 5.2-3. Simulated Net Channel Flow in Delta Channels for the Range of San Joaquin River Flows and Exports during Vernalis Adaptive Management Plan Period

Sacramento River at Freeport	15,000 cfs				15,000 cfs				15,000 cfs				15,000 cfs				15,000 cfs			
San Joaquin River	2,000 cfs				3,200 cfs				4,450 cfs				5,700 cfs				7,000 cfs			
Head of Old River Barrier	Open	Open	Closed	Closed	Open	Open	Closed	Closed	Open	Open	Closed	Closed	Open	Open	Closed	Closed	Open	Open	Closed	Closed
Total Exports	2,000	1,500	2,000	1,500	3,200	1,500	3,200	1,500	4,450	1,500	4,450	1,500	5,700	2,250	5,700	2,250	7,000	3,000	7,000	3,000
San Joaquin River at Mossdale	1914	1914	1914	1914	3115	3115	3115	3115	4365	4365	4365	4365	5615	5615	5615	5615	6915	6915	6915	6915
Old River at Head	1225	1207	0	0	1780	1727	0	0	2358	2287	0	0	2996	2931	0	0	3679	3620	0	0
Old River at Tracy Blvd Bridge	134	133	-14	-16	200	200	-8	-16	262	272	-1	-15	325	345	6	-12	407	420	16	-9
Old River at Clifton Court Ferry	-140	89	-1311	-1063	-206	583	-1906	-1063	-277	1111	-2524	-1063	-298	1341	-3141	-1435	-311	1607	-3784	-1807
Old River near Byron	-733	-419	-1523	-1195	-1157	-84	-2308	-1194	-1603	275	-3129	-1192	-2015	198	-3951	-1681	-2436	149	-4806	-2169
Old River at Bacon Island	-350	-139	-877	-657	-627	92	-1401	-649	-919	340	-1951	-640	-1191	296	-2506	-961	-1467	272	-3082	-1282
Old River at Mouth	-2787	-2674	-3207	-3087	-3005	-2613	-3620	-3207	-3240	-2549	-4049	-3330	-3455	-2635	-4478	-3631	-3670	-2709	-4921	-3937
Grant Line Canal at Tracy Blvd*	862	843	-161	-161	1330	1269	-161	-161	1822	1726	-161	-161	2363	2258	-162	-161	2917	2824	-165	-161
Middle River at Mowry Bridge	77	80	24	26	98	107	18	26	124	139	12	26	159	177	6	23	206	226	-1	19
Middle River at Tracy Blvd Bridge	-7	-4	-60	-58	14	23	-66	-58	40	55	-72	-58	75	93	-78	-61	123	142	-84	-65
Middle River at Bacon Island	-1003	-760	-1629	-1378	-1331	-503	-2234	-1387	-1668	-225	-2860	-1397	-1970	-282	-3485	-1783	-2273	-314	-4138	-2168
Turner Cut	-271	-234	-420	-381	-354	-229	-562	-432	-433	-218	-714	-489	-502	-253	-872	-609	-573	-286	-1046	-735
Middle River at Mouth	-817	-625	-1379	-1179	-1116	-462	-1932	-1256	-1424	-282	-2503	-1334	-1705	-366	-3068	-1709	-1985	-431	-3650	-2082
False River	1550	1638	1499	1588	1526	1825	1449	1751	1500	2020	1395	1921	1474	2086	1342	1957	1447	2159	1288	2001
San Joaquin River at Antioch	4170	4536	4157	4524	4160	5401	4145	5386	4151	6301	4135	6286	4146	6655	4127	6637	4142	7047	4120	7026

Notes:

cfs = cubic feet per second.

* Grant Line Canal at Tracy Boulevard Bridge is Grant Line Canal East.

The CCF intake gate is located on Old River just north of the mouth of Grant Line Canal. The intake channel is about 300 feet wide, there are five radial gates with widths of 20 feet, and the water depth is about 15 feet at 0 feet msl. Photograph 5.2-33 shows the CCF intake looking east from over the CCF. Photograph 5.2-34 shows a close-up view of the CCF intake gates. The five radial gates are generally opened when the tidal level in Old River is higher than the water surface elevation in CCF. The gates are closed as the outside tidal level declines to below the CCF water surface elevation. The CCF was designed to reduce the tidal fluctuations that the SWP Banks units facility experiences, and to maintain the CCF surface elevation somewhat above the lowest tide elevations. The CCF radial gates are referred to as tidal gates because they open and close in response to the tidal level and the inside water surface elevation.

CCF was also designed as a forebay reservoir to provide a volume of water that could be pumped by the SWP Banks pumping units during the nighttime off-peak power period. This off-peak power regulation of the CCF has been used more extensively since the last four pumping units were installed in 1991, which increased the pumping capacity of the SWP Banks facility to 10,668 cfs. The large CCF surface area provides a reservoir of water for the off-peak pumping that is normally used to minimize the power expense for this large pumping plant (310 megawatts at full pumping capacity).

Figure 5.2-22a shows the daily minimum, average and maximum daily SWP Banks pumping flows for water year 2002. Off-peak pumping appears to be used every day of the year, with maximum pumping of more than 9,000 cfs occurring on many days when the average pumping approaches 6,000 cfs. This indicates that full SWP Banks pumping capacity of about 9,000 cfs (with one unit held in reserve) is used regularly with the current daily average diversion limit of 6,680 cfs. Figure 5.2-22b indicates that the use of off-peak pumping will decline as the average daily pumping increases and approaches the installed physical capacity. Some off-peak pumping would still be possible with an 8,500 cfs daily diversion and pumping limit if all of the SWP Banks pumping units (i.e., 10,668 cfs) were used.

Pumping at full capacity (21,000 af/day) would cause a drawdown in CCF of about 1 foot in just 2.5 hours if there were no inflow through the CCF radial gates. The SWP Banks pumping units experience some operational problems from cavitation (i.e., air entrainment that may damage the pumping blades) when the CCF water elevation drops below –2.0 feet msl. Therefore off-peak pumping is sometimes limited by CCF elevations during days with lower tidal elevations (neap tide periods).

The CCF gates have been used for several years to maintain the higher-high-tide level in the south Delta channels by closing during the rising tide (i.e., flood tide) until about an hour after higher-high tide each day. This has been referred to by SWP as priority 3 CCF gate operations and has been effective in maintaining the relatively high tide elevations that are necessary to supply water to the Tom Paine Slough siphons (see Photograph 5.2-29). The priority 3 CCF gate operations have also been used to ensure that the high tides overtop the temporary barriers and provide tidal flushing flows for the channels upstream of the temporary agricultural barriers. Priority 3 CCF gate operations reduce the periods when CCF gates can be opened to allow refilling of CCF and supply the SWP Banks facility. The net result of priority 3 operations is to reduce the average CCF surface water elevations. At times, the CCF water level has approached the –2-foot-msl limit for SWP Banks pumping.

The 2001 and 2020 baseline simulations of the temporary barriers include this priority 3 operation of the CCF gates. The SDIP alternatives use priority 4 operations of CCF gates, which allow the gates to be opened when the outside tidal level is above the inside water surface elevation. This causes a difference between the simulated baseline tidal level variations and the SDIP alternative tidal level variations that is not a necessary condition for the SDIP alternatives. However, this assumed shift from priority 3 to priority 4 CCF operations was evaluated as part of the environmental impacts of the SDIP alternatives.

Figure 5.2-23a shows an example period (July 2002) of recent historical CCF operations. The hourly tidal level at Clifton Court Ferry is measured just outside the CCF gates. The CCF water level fluctuates as SWP Banks pumping increases during the night for off-peak pumping and as the CCF gate closes (solid symbols) and opens (open symbols) according to the outside tidal level. For the example period, the CCF level remains above –2.0 feet msl. Figure 5.2-23b shows that SWP Banks pumping ranged from about 2,000 cfs to 8,000 cfs in an off-peak pumping pattern. The average pumping rate increased during the month. Operating CCF to maintain the minimum elevation needed to protect against cavitation damage will be more difficult as the SWP Banks pumping increases and may require that the CCF gates be opened for a greater fraction of each day, reducing or eliminating the use of priority 3 CCF gate operations.

Capacity of the Clifton Court Forebay Tidal Gates

Understanding CCF operations depends on an accurate description of the CCF tidal gates. Physically, there are five 20-foot-wide radial gates with a bottom sill at elevation –15 feet msl. If the gates are fully open, there is a conveyance area of about 1,500 square feet. At a velocity of 10 feet/sec, the inflow rate would be about 15,000 cfs. Flows above 15,000 cfs are limited by closing the radial gates to restrict the flow under the radial gates and through the intake structure. The flow through the gated intake structure can be generally described with a weir or orifice equation, where the velocity will depend on the square root of the water surface (i.e., head) difference. For the gate section of 1,500 square feet at a velocity of 10 feet/sec, the maximum (i.e., design) CCF gate flow is about 15,000 cfs at a head difference of about 1 foot.

Direct measurements of velocity in the CCF intake structure are not available to confirm this relationship. Therefore, hourly records of the CCF level and the outside level along with hourly pumping records for the SWP Banks facility have been used to confirm that the CCF intake gate capacity is about 15,000 cfs at a head difference of about 1 foot. Figure 5.2-23b shows the results of these calculations for CCF gate flows. The normal range of head differences when the gates are open is about 0.1 foot to about 2.0 feet. Higher level differences require the CCF gates to be closed to limit the flow to the 15,000 maximum.

Figure 5.2-24 indicates that the upper end of the back-calculated hourly average flows can be approximated by the simple equation:

$$\text{CCF Intake Gate Flow (cfs)} = 15{,}000 \times \text{Head}^{0.5}$$

The hourly calculated flow may not reach the maximum possible value because the head difference changes within the hour and may have been less than the end-of-hour values that are used in these calculations. The gates may also have been closed for part of the hour and this may not be reflected in these end-of-hour gate positions.

This assumed relationship is incorporated into DSM2 simulations of the CCF gate flows. The maximum design flow of 15,000 cfs into CCF will be achieved when the head difference between the Old River tidal level and the CCF water surface level is greater than 1.0 foot. Flows that could be higher than the 15,000 cfs design flow are assumed to be limited by partial closure of the CCF radial gates.

Simulated Clifton Court Forebay Operations

The flow into CCF will influence the tidal level in Old River because the opening of CCF gates will reduce the level until the channel slope is sufficient to supply the additional flow down Old River and Victoria Canal. DSM2 was used to illustrate the basic effects of the CCF gate operations on south Delta tidal level and flow.

The CCF gates as originally constructed in 1969 provide sufficient inflow to sustain the proposed 8,500 cfs SWP Banks pumping under typical August 1997 tidal conditions. This is demonstrated with several DSM2 simulations of August 1997 tidal conditions. All of the simulations assume the CCF gates would be open all the time unless the Old River level dropped below the CCF surface elevation (priority 4 operations).

Figure 5.2-25a shows the effects on the CCF level for both a constant (even) SWP Banks pumping rate of 6,680 cfs and an off-peak pumping rate that averages 6,680 cfs but is at a maximum at night. The peak pumping rate ranges from 2,500 to 10,200 cfs, and the CCF level ranges from –1.1 to 1.8 feet msl. Off-peak pumping generally causes the CCF level to decline more than the even pumping. Simulated level for both even and off-peak pumping at the currently permitted pumping rate of 6,680 cfs caused the CCF level to remain above -2 feet without requiring any reduction in pumping for the typical August 1997 tidal conditions.

The effects of the proposed 8,500 cfs SWP Banks pumping on the CCF level would not differ substantially from the effects observed at the 6,680 cfs pumping rate. The simulated CCF level with 8,500 cfs pumping is generally lower than for 6,680 cfs and ranges from approximately –1.1 to 1.3 feet msl. The off-peak pumping in this simulation ranges from 6,500 to 10,200 cfs. The difference between the 8,500 cfs even and off-peak pumping CCF levels is minimal. The maximum difference between the off-peak and constant pumping level is less than 0.5 foot. Simulated CCF level for both the even and off-peak pumping of 8,500 cfs did not result in a CCF level decline to below the –2-foot cavitation limit for the typical August 1997 tidal conditions.

Figure 5.2-25b indicates that the effects of even or off-peak pumping on the Old River tidal level at Clifton Court Ferry are relatively small. The effects of off-peak pumping can both raise and lower the level in Old River, depending on the timing of the tidal level and off-peak pumping. The simulated level in Old River at Clifton Court Ferry ranges from about –1.0 foot msl to about 2.5 feet msl on some days in the middle of the month. The maximum tidal level difference between the 6,680 cfs pumping and the 8,500 cfs pumping is approximately 0.3 foot. For all pumping regimes the minimum tidal level remains above -1.0 foot msl. The CCF gates as originally constructed in 1969 provide sufficient inflow to sustain the proposed 8,500 cfs SWP Banks pumping without causing a significant drawdown of the south Delta channel tidal level for the typical August 1997 tidal conditions.

Figure 5.2-26 summarizes these CCF level variations as percentiles of the monthly 15-minute simulated water levels in CCF and outside tidal level in Old River at Clifton Court Ferry. The largest differences in CCF level were generally less than 0.5 foot between the 8,500 and 6,680 cfs pumping conditions, indicating the effect of increasing the pumping from 6,680 cfs to 8,500 cfs would have a minimal effect on the CCF water level, for either even pumping or off-peak pumping. These simulations used priority 4 CCF gate operations that allow the gates to be open when the outside tidal level is higher than the CCF level; priority 4 operations are assumed in the SDIP simulations with the permanent tidal gates.

Adaptive Management of South Delta Tidal Gate Operations

The permanent operable tidal gates that will be constructed in the south Delta will be operated within an adaptive management framework so that the various benefits from these tidal gate operations can be maximized. Tidal gates can be opened or closed at any time in response to the local tidal level and tidal flow conditions within the south Delta. In this regard they are very different from the temporary barriers that have been installed for the past several years.

Because these tidal gates are designed as “lift gates” that are hinged at the bottom of the channel, “closure” of the gates can be specified at any tidal level, leaving a weir opening for some tidal flow over the gate. The ability to operate the tidal gates with any specified weir crest elevation (i.e., top of the gates) provides a great deal of flexibility. The top elevation of each individual gate can be slightly different (i.e., steps) to provide less weir flow as the tidal level declines. The top elevation of the gates can also be slowly raised or lowered to adjust the tidal level and/or tidal flow in response to local south Delta conditions.

An example of the tidal gate concept proposed for the SDIP is the tidal gates at the Montezuma Slough entrance to the Suisun Marsh channels near Collinsville. These tidal gates are called the Montezuma Slough salinity control gates (MSSCG). The purpose of the MSSCG operation is to reduce salinity in the Suisun Marsh channels by creating a large net flow from the Sacramento River into the Suisun Marsh channels. The general MSSCG operations are to close the gates during the flood-tide flow (i.e., upstream flow) from the Suisun Marsh channels to the Sacramento River. During ebb tide periods, the gates are opened and the full tidal flow of about 2,000 cfs enters the Suisun Marsh channels from the Sacramento River. Photograph 5.2-35 shows the MSSCG in the open (raised) position. Photograph 5.2-36 shows the flashboard portion of the MSSCG being removed to allow open channel flow during periods when the gates are not operated.

The MSSCG facility is operated during the fall of most years when salinity (i.e., EC values) in Suisun Bay is relatively high because of low Delta outflow. The gates are operated in response to local tidal level and flow conditions. As the level downstream of the tidal gate begins to rise during flood tide, the gates are closed to prevent any flood-tide flow. The gates are open during ebb tide to allow low salinity Sacramento River water into the marsh channels. The south Delta tidal gates can be operated in a similar manner to control tidal flows. The SDIP gates will use a bottom “lift gate” design and will not have the large radial gates shown in these photographs. The south Delta gates will be visible only when they are in the raised position, when they will appear as small dams or drop structures.

South Delta Tidal Gates

The proposed management of south Delta tidal level and tidal flow conditions will use five tidal gates:

- CCF intake tidal gate (existing),
- Grant Line Canal (at western end) tidal gate,
- Old River at DMC tidal gate,
- Middle River tidal gate, and
- head of Old River fish control gate.

The CCF intake tidal gate already exists and has been used since SWP Banks began operations in 1972 to control flows from Old River and maintain the water level inside of CCF.

The south Delta tidal gates would be operated to accomplish the following purposes:

1. Maintain a relatively high water level within the CCF to allow SWP Banks to maximize pumping during the off-peak (nighttime) hours. The CCF level cannot be allowed to fall below –2 feet msl because of cavitation concerns at the SWP Banks pumps. The CCF gates are closed when the outside tidal level in Old River drops below the CCF level (to avoid outflow from CCF).
2. Control the inflow to CCF to remain less than the design flow of about 15,000 cfs to prevent excessive erosion of the entrance channel. The CCF gates are partially closed when the difference between the CCF level and Old River tidal level is more than 1.0 foot to avoid inflow velocities of greater than 10 feet/sec.
3. Maintain the high-tide conditions in the south Delta by not diverting into CCF during the flood-tide period that precedes the higher-high tide each day. The CCF intake gates are closed for about 6 hours each day to preserve the high-tide level in Old River to supply sufficient water for Tom Paine Slough siphons. This CCF tidal gate operation is referred to as priority 3 by DWR.
4. Control the minimum tidal level elevation upstream of the tidal gates to be greater than a selected target elevation (i.e., 0.0 feet msl). The tidal gates can be closed (raised) to a specified top elevation (e.g., 0.0 feet msl) as the upstream tidal level declines during ebb tide.
5. Control the tidal flushing upstream of the tidal gates with relatively low-salinity water from Old River and Middle River downstream of the tidal gates (i.e., high fraction of Sacramento River water). The tidal gates would remain fully open during periods of flood tide (i.e., upstream flow) and then be fully closed (i.e., top elevation of gates above upstream water surface) during periods of ebb tide (i.e., downstream flow). One of the gates (i.e., Grant Line) must be maintained at a lower elevation (i.e., 0.0 feet msl) to allow the ebb tide flow to exit from the south Delta channels so that the flood-tide flow over the tidal gates can be maximized during each tidal cycle. A water surface elevation upstream of the tidal gates that is higher than 0.0 feet msl will reduce the cumulative flood-tide flows and reduce tidal flushing upstream of the gates.
6. Control the San Joaquin River flow diversion into Old River. This could increase the flow past Stockton and raise the low DO concentrations in the DWSC. Reduced flow to Old River might also reduce salinity in the south Delta channels by limiting the volume of relatively high-salinity water from the San Joaquin River that enters the south Delta channels. The head of Old River fish control barrier has been installed in October and November of many years to improve flow and DO conditions in the DWSC for up-migrating Chinook salmon. In recent years the barrier has also been installed during the outmigration period of April and May to reduce the percentage of Chinook salmon smolts that are diverted into Old River and toward the CVP and SWP pumping plants.

Operation of the tidal gates to accomplish the SDIP purposes without significant environmental impacts to water quality or fish habitat conditions will require an accurate understanding of the effects of these tidal gates.

Comparison of South Delta Tidal Gate Operations

A series of one-month DSM2 simulations for representative historical tidal variations of July 1985 have been used to compare the general effects of tidal gate operations. The natural tidal level and flow variations in the south Delta channels without any CVP or SWP pumping or tidal gates will be shown as a reference for the comparison of alternative tidal gate operations. Tide level and flow variations with full pumping (i.e., CVP at 4,600 cfs and SWP at 8,500 cfs) will then be presented and compared with the tidal level and flow variations when the temporary barriers are installed. Finally, the tidal level and flow variations that could be achieved with two possible south Delta tidal gate operations will be contrasted. The head of Old River fish control gate was assumed to be open during the entire study month. The full range of potential tidal gate operations can then be described and understood in reference to these example conditions.

Table 5.2-4. Summary of Simulated Downstream and Upstream Tidal Flows at South Delta Tidal Gate Locations with Range of CVP and SWP Pumping and Gate Operations

Tidal Flow Direction	No Pumping and No Gates		Full Pumping and No Gates		Full Pumping and Temporary Barriers		Full Pumping and Tidal Gates Plan A		Full Pumping and Tidal Gates Plan C	
	cfs	af/day	cfs	af/day	cfs	af/day	cfs	af/day	cfs	af/day
Head of Old River										
Downstream	990	1,964	1,470	2,916	929	1,843	1,308	2,594	1,276	2,531
Upstream	-14	-28	0	0	0	0	0	0	0	0
Net	976	1,936	1,470	2,916	929	1,843	1,308	2,594	1,276	2,531
Grant Line Canal										
Downstream	1,981	3,929	1,361	2,700	997	1,978	909	1,803	1,164	2,309
Upstream	-1,586	-3,146	-344	-682	-539	-1,069	-163	-323	-142	-282
Net	395	783	1,017	2,017	458	908	747	1,482	1,022	2,027
Old River at DMC										
Downstream	675	1,339	343	680	12	24	312	619	0	0
Upstream	-746	-1,480	-359	-712	-86	-171	-155	-307	-139	-276
Net	-71	-141	-17	-34	-73	-145	157	311	-139	-276
Middle River										
Downstream	405	803	201	399	100	198	158	313	11	22
Upstream	-385	-764	-348	-690	-179	-355	-268	-532	-235	-466
Net	20	40	-147	-292	-78	-155	-110	-218	-224	-444
CCF Intake	0	0	8,500	16,860	7,180	14,242	8,500	16,860	8,500	16,860
CVP Tracy	0	0	4,600	9,124	4,533	8,991	4,600	9,124	4,600	9,124

af/day = acre-feet per day.
CCF = Clifton Court Forebay.
cfs = cubic feet per second.

South Delta Tide Level and Flow with No Pumping and No Gates

The tidal level variations and corresponding tidal flows in the south Delta channels will be described for a selected study month (July 1985) with no tidal gate operations and no CVP or SWP pumping. The tidal level and flow will be shown as monthly graphs for each proposed tidal gate location. The upstream and downstream tidal flow volumes and net daily flow volumes will be used to describe the strength of the tidal movement at each location. Table 5.2-4 gives a summary of the simulated range of tidal level at each tidal gate location for each of the simulated conditions. Table 5.2-5 gives a summary of the simulated upstream (i.e., flood-tide) and downstream (i.e., ebb-tide) tidal flows at each location for each simulated tidal gate operation. The upstream and downstream tidal flows (cfs) are converted to tidal flow volumes (af/day) and used to describe tidal movement in south Delta channels. The daily tidal flow volume has a monthly variation corresponding to the lunar tidal cycle and is greatest during spring tides.

Table 5.2-5. Simulated Tidal Level Range for South Delta Channels with No Pumping and Maximum Pumping with Temporary Barriers and Tidal Gate Operations (feet msl)

	No Pumping and No Gates		Full Pumping and No Gates		Full Pumping and Temporary Barriers		Full Pumping and Tidal Gates Plan A		Full Pumping and Tidal Gates Plan C	
	Down-stream	Up-stream	Down-stream	Up-stream	Down-stream	Up-stream	Down-stream	Up-stream	Down-stream	Up-stream
Head of Old River										
Minimum	0.4	0.4	0.0	0.0	0.9	0.9	0.4	0.4	0.3	0.4
Median	2.0	2.0	1.3	1.3	1.8	1.8	1.5	1.5	1.5	1.5
Maximum	4.1	4.1	3.1	3.1	3.5	3.5	3.1	3.2	3.1	3.2
Grant Line Canal										
Minimum	-0.8	-0.8	-1.4	-1.4	-1.7		-1.7	-0.2	-1.6	0.0
Median	1.4	1.4	0.0	0.0	0.1		0.1	0.5	0.1	0.6
Maximum	4.1	4.1	2.1	2.1	3.7		2.1	2.1	2.2	2.2
Old River at DMC										
Minimum	-0.8	-0.8	-1.5	-1.5	-1.8	0.8	-1.9	0.1	-1.8	-0.1
Median	1.4	1.4	-0.1	-0.1	0.0	1.3	0.0	0.4	0.0	0.6
Maximum	4.0	4.0	2.0	2.0	3.6	2.7	2.0	2.0	2.1	2.2
Middle River										
Minimum	-0.9	-0.9	-1.3	-1.3	-1.5	0.1	-1.5	0.1	-1.5	0.0
Median	1.4	1.4	0.6	0.6	0.6	1.1	0.6	0.8	0.6	1.1
Maximum	4.1	4.1	3.0	3.0	3.9	3.7	3.0	3.0	3.1	3.0
CCF Intake (cfs)	0		8,500		7,180		8,500		8,500	
CVP Tracy (cfs)	0		4,600		4,533		4,600		4,600	

Figure 5.2-27 shows the tidal level and flow at the head of Old River. The tidal level at the head of Old River fluctuates from 0.4 foot msl to about 4.1 feet msl, with a median level of 2.0 feet msl. The tidal range (i.e., difference between the higher-high tide and lower-low tide) is about 3 feet each day, although the tidal range during the neap tide periods is only about 2 feet. The tidal flow at the head of Old River fluctuates from about –500 cfs (i.e., upstream flow) for short periods prior to high tide to about 1,700 cfs during flood tides. The tidal flow averages about 1,000 cfs (about 60% of the simulated San Joaquin River flow at Vernalis of 1,640 cfs). The head of Old River tidal flow is actually highest during rising tide as upstream flood-tide flow on the San Joaquin River combines with the downstream river flow. The resulting head of Old River flow can be greater than the San Joaquin River flow at Vernalis. This head of Old River flow to the south Delta channels will produce a net downstream flow across the tidal gates at Old River, Grant Line Canal and Middle River.

Figure 5.2-28 shows that the simulated tidal level variations near the mouth of Grant Line Canal (i.e., western end) ranged from about –0.8 feet to about 4.1 feet msl, with a median of 1.4 feet msl. The corresponding cumulative tidal flow volumes are shown in acre-feet. During flood-tide periods (rising tidal level) there was an upstream tidal volume that ranged from 1,000 acre-feet to about 2,000 acre-feet during each flood tide. During ebb tide periods (falling tidal level) there was a downstream tidal volume that ranged from 1,000 acre-feet to about 3,000 acre-feet. There was a wider range of tidal volumes during ebb tide because in the Delta, the higher-high tide is usually followed by the lower-low tide (large ebb flow), but the lower-high tide is followed by the higher-low tide (small ebb flow). The average daily ebb tidal volume was about 3,929 af/day and the average daily flood tidal volume was about 3,146 af/day, with a net ebb (downstream) volume of about 783 af/day.

Figure 5.2-29 shows the simulated tidal level and tidal flow volumes at the Old River tidal gates near the DMC entrance. The water level ranged from about –0.8 feet to about 4.0 feet msl, with a median of 1.4 feet msl. The corresponding average downstream tidal flow volume was 1,339 af/day, the average upstream tidal flow volume was –1,480 af/day, and the net upstream tidal flow volume was –141 af/day.

Figure 5.2-30 shows the simulated tidal level and tidal flow volumes at the Middle River tidal gate near Victoria Canal. The water level ranged from –0.9 feet to 4.1 feet msl, with a median of 1.4 feet msl. The tidal level variations are greatest at the Middle River gates because this location is closest to the tidal influences from Suisun Bay. The average downstream tidal flow volume was 803 af/day, the average upstream tidal flow volume was –764 af/day, and the net downstream tidal flow was 40 af/day. The tidal flow volumes at the Old River tidal gate location were about 50% greater than the tidal flow volumes at the Middle River tidal gate location, because the Middle River channel is smaller than the Old River channel.

The average flow at head of Old River compared with the average downstream flows at the three gate locations suggests that the DSM2-simulated net daily consumptive use (i.e., diversions) within these channels was about 632 cfs (1,250 af/day) for July of 1985.

Effects of Maximum Central Valley Project and State Water Project Pumping with No Gates

Figure 5.2-31 shows the simulated tidal level and tidal flow at the head of Old River with full CVP pumping of 4,600 cfs and full SWP pumping of 8,500 cfs. The median level and level variation were somewhat less than with no pumping. The water level ranged from 0.0 feet msl to about 3.1 feet msl, with a median of 1.3 feet msl. The high tide was reduced by about 1.0 foot, and the low tide was reduced by about 0.5 foot compared to the previous no pumping and no gates scenario. The average diversion flow into Old River was higher, at about 1,500 cfs, but the flow variation was less, ranging from about 1,000 cfs to 2,250 cfs. The fraction of the San Joaquin River flow at Vernalis of 1,640 cfs that was diverted into Old River increased to about 90%.

Figure 5.2-32 shows the simulated tidal level and tidal flow volumes at the Grant Line Canal tidal gate location under this scenario. The tidal level ranged from –1.4 feet msl to about 2.1 feet msl, with a median of 0.0 feet msl. The low tide was reduced by about 0.5 feet, and the high tide was reduced by about 2.0 feet compared with the tides without any CVP or SWP pumping. The low tide was more affected by the CVP pumping because the CCF gates are not usually opened at low tide (unless the CCF water surface is also very low). The high tides were affected by both the CVP pumping and the SWP pumping (diversions into CCF). The CCF gates were opened whenever the outside water level was greater than the inside water level. The simulated tidal flow volumes into the south Delta channels were considerably reduced compared with the tidal flow volumes without any CVP or SWP pumping. The average downstream tidal flow volume was 2,705 af/day, and the average upstream tidal flow volume was 682 af/day. The net flow was increased to 2,017 af/day at the Grant Line Canal tidal gate location.

Figure 5.2-33 shows the simulated tidal level and tidal flow volumes at the Old River tidal gate location. The average downstream tidal flow volume was 680 af/day and the average upstream tidal flow volume is –712 af/day, with a net upstream flow volume of –34 af/day. The tidal flows at the Old River gate location were about half of the tidal flows without any CVP or SWP pumping. The net flow volume was almost zero.

Figure 5.2-34 shows the simulated tidal levels and tidal flow volumes at the Middle River tidal gate location. The average downstream tidal flow volume was 400 af/day and the average upstream tidal flow volume was –690 af/day, with a net flow volume of -290 af/day, moving upstream. The downstream tidal flow volume at the Middle River tidal gate location was about half of the downstream tidal flow without any CVP or SWP pumping, but the upstream tidal flow volume was about the same.

These simulated tidal level fluctuations and tidal flow volumes are the expected south Delta conditions with maximum CVP and SWP pumping but without any tidal gates or barriers. The next section will describe the tidal level and flow volumes with the temporary barriers. The potential effects of the tidal gates will then be described for two slightly different operational strategies.

Effects of Maximum Central Valley Project and State Water Project Pumping with Temporary Barriers

The temporary barriers (i.e., weirs) block the tidal flows if the level is lower than the barrier crest elevation. The weirs may also restrict the tidal flow when the level is slightly higher than the weir crest because the weir reduces the channel cross section that was available with no barriers in place. Weirs tend to restrict the tidal flows, but they maintain the water level during low-tide periods.

Figure 5.2-35 shows the DSM2-simulated tidal level and tidal flow at the head of Old River. There is no temporary head of Old River fish control barrier during July. The tidal level ranged from about 0.9 foot msl to about 3.5 feet msl with a median of 1.8 feet msl. The high-tide level was only about 0.6 foot below the maximum tidal level without any pumping. The effects of the temporary barriers, which maintain the upstream level during low tide periods, and the priority 3 CCF gate operations, which preserves the high-tide level, caused the diversion of San Joaquin River flow at the head of Old River to be reduced. The average simulated San Joaquin River diversion is 930 cfs (57% of the Vernalis flow of 1,640 cfs).

Figure 5.2-36 shows the DSM2-simulated tidal level and tidal flow volumes at the Grant Line Canal tidal gate location (the temporary barrier is actually located upstream near the Tracy Boulevard Bridge). The downstream tidal level ranged from about –1.7 feet msl to about 3.7 feet msl (the upstream level is not shown). The high-tide level was only about 0.4 foot below the maximum tidal level without any pumping. The high-tide level was preserved because the CCF tidal gates were closed during the flood tide prior to the higher-high tide each day. The average downstream tidal flow volume was 1,978 af/day, the upstream tidal flow volume was –1,069 af/day, and the net downstream flow volume was 906 af/day at the Grant Line Canal tidal gate location. The upstream tidal flows with the temporary barriers were greater than without the barriers, and the downstream tidal flows were less than without any barriers. The barriers protect the low-tide level (maintained above 1.0 foot msl by the temporary barrier weir) but reduce the diversion of San Joaquin River water into the south Delta channels. The barriers allow similar tidal flows to provide flushing upstream of the Grant Line Canal barrier for water quality improvement.

Figure 5.2-37 shows the simulated tidal level and tidal flow volumes at the Old River temporary barrier location near the DMC. The downstream tidal level ranged from -1.8 feet msl to about 3.6 feet msl, with a median of 0.0 feet msl. The upstream level during low tide was maintained by the temporary barrier weir, which had a simulated crest elevation of about 2.0 feet. The upstream tidal level varied from about 0.8 feet to about 2.7 feet, with a median of 1.3 feet msl. The downstream tide reached a maximum of 3.5 feet msl on many days but the flow over the weir (of about 1,000 cfs) was not sustained for long and was not sufficient to raise the upstream level to more than 2.5 feet msl. Upstream flow over the barrier did not begin until the downstream level reached the 2.0-foot weir crest. This did not occur during the neap-tide periods from July 7 to July 11 and again from July 23 to July 25. Downstream flow was blocked once the upstream level dropped to 2.0 feet msl. The tidal flow volume at the Old River barrier was very restricted compared to conditions without the temporary barrier.

Figure 5.2-38 shows the simulated tidal level and tidal flow volumes at the Middle River temporary barrier location. The downstream tidal level ranged from –1.5 feet msl to about 3.9 feet msl, with a median of 0.6 feet msl. The upstream level during low tides was maintained by the temporary barrier weir, which had a simulated crest elevation of about 1.0 foot. The upstream level ranged from about 0.1 foot msl to 3.7 feet msl, with a median of 1.1 feet msl. The upstream water level dropped below the 1.0-foot crest elevation because of consumptive uses (i.e., agricultural diversions) within the south Delta channels. Upstream flow over the gate did not begin until the downstream level reached 1.0 foot. This occurred for only a few hours each day during the neap-tide periods from July 7 to July 11 and again from July 23 to July 25. Downstream flow was blocked once the upstream level dropped to 1.0 foot msl. The average downstream tidal flow volume was 198 af/day and the average upstream tidal flow volume was –354 af/day, with a net upstream flow volume of –154 af/day. The tidal flow volume at the Middle River barrier was very restricted compared to conditions without the temporary barrier.

Tide Level and Flow Controls with Tidal Gate Operations

Two potential gate operations are described and compared. Basic gate operations represent the minimal tidal gate operations necessary to protect the minimum level at 0.0 feet msl. Circulation gate operations will produce the maximum circulation of water within the south Delta channels and requires the operation of the gates during most ebb-tide (i.e., falling level) periods.

Basic gate operations would raise (i.e., close) the gates at Old River at Tracy, Middle River, and Grant Line West only during periods of low tide to maintain a minimum tidal level target of 0.0 feet msl. Circulation gate operations would raise the Old River at Tracy and Middle River gates at each high tide to produce a circulation of water in the south Delta channels down Grant Line Canal. The Old River at Tracy and Middle River gates remain closed until the next flood-tide period when the downstream level is above the upstream water level. These gates are then opened to allow flood-tide (upstream) flows across the gates. Circulation gate operations uses a Grant Line gate weir crest at 0.0 feet msl during most periods of ebb tide (downstream flow) to protect the minimum level elevation of 0.0 feet msl. All tidal gates are lowered (i.e., opened) during flood-tide periods as soon as the downstream tidal level is above the upstream water level.

The simulated San Joaquin River diversion flow into Old River is about 1,300 cfs for both tidal gate operations, representing about 80% of the San Joaquin River flow at Vernalis. This is higher than the diversion with the temporary barriers because the average tidal level in the south Delta channels is slightly lower with the tidal gate operations.

Tidal Flows with Basic Gate Operations

Figure 5.2-39 shows the DSM2-simulated tidal level and flow at the head of Old River for July 1985 with the basic gate operations. The head of Old River level is generally maintained between 0.4 foot msl and 3.1 feet msl, with a median of 1.5 feet msl. The reduced tidal fluctuation in the neap-tide period of July 8–11 and July 23–24 produces a lower net daily flow into Old River. The monthly average flow diversion into Old River was 1,308 cfs, representing 80% of the Vernalis flow of 1,640 cfs.

Figure 5.2-40 shows the DSM2-simulated tidal level and tidal flow volumes at Grant Line Canal gates for July 1985 with the basic gate operations. The downstream level varies from about –1.7 feet msl to about 2.1 feet msl, with a median of 0.1 feet msl. The tidal gates are raised to an elevation of 0.0 feet msl during most ebb-tide (falling- level) periods, but the reduction in downstream (positive) tidal flow is noticeable only as the upstream water level declines to about 1.0 foot msl, when the gate opening (weir crest of 0.0 feet msl) begins to reduce the normal tidal flow. The upstream level ranges from –0.2 foot msl to 2.1 feet msl, with a median of 0.5 feet msl. The gates are opened (lowered) during flood-tide as soon as the downstream level reaches the upstream level, but the upstream tidal flows are reduced to just a few hours each day because the level is kept relatively high compared to the no-gate scenario. The monthly average downstream tidal volume was 1,800 af/day, the monthly average upstream tidal volume was –320 af/day, and the net downstream flow over the Grant Line gates was 1,480 af/day.

Figure 5.2-41 shows the DSM2-simulated tidal level and tidal volume at the Old River at Tracy tidal gates for July 1985 with the basic gate operations. The downstream level varies from about –1.9 feet msl to about 2.0 feet msl, with a median of 0.0 feet msl. The tidal gates are raised to an elevation of 0.0 feet during all ebb-tide (falling- level) periods when the water level declines to about 0.5 feet, which reduces the positive tidal flow. The upstream level ranges from 0.1 foot msl to 2.0 feet msl, with a median of 0.4 foot msl. The gates are opened (lowered) during flood tide as soon as the downstream level reaches the upstream level, but the upstream tidal flows are reduced to just a few hours each day. The average downstream tidal volume was 618 af/day, the average upstream tidal volume was –307 af/day, and the net downstream flow was 311 af/day.

Figure 5.2-42 shows the DSM2-simulated tidal level and tidal volume at the Middle River tidal gates July 1985 with the basic gate operations. The downstream tidal level ranged from about –1.5 feet msl to about 3.0 feet msl. The upstream level ranged form 0.1 foot msl to 3.0 feet msl, with a median of 0.8 foot msl. The same operations are used for the Middle River gate as the Old River at Tracy gate. The flood-tide (negative, upstream) flow was blocked until the downstream level rose above the upstream level, and the downstream flow was reduced by the tidal gate weir crest when the falling level approached about 0.5 foot msl. The average downstream tidal volume was 313 af/day, the average upstream tidal volume was –531 af/day, and the net upstream flow volume was –218 af/day.

Tidal Flows with Circulation Gate Operations

The DSM2-simulated tidal level and flow at the head of Old River for July 1985 with the circulation gate operations were nearly identical to the simulations for the basic gate operations. The average tidal level at the head of Old River remained nearly the same because the tidal fluctuations in the south Delta channels remained similar, although the operations of the tidal gates were somewhat different. The head of Old River level was between 0.4 foot msl and 3.2 feet msl, with a median of 1.5 feet msl. The monthly average flow diversion into Old River was about 1,275 cfs, representing 78% of the Vernalis flow of 1,640 cfs.

Figure 5.2-43 shows the DSM2-simulated tidal level and tidal flow volumes at Grant Line Canal gates for July 1985 with the circulation gate operations. The Grant Line tidal gates were operated the same as with the basic gate operations, with the gate raised to 0.0 feet msl only during ebb-tide (falling water levels). The upstream level ranged from 0.0 feet msl to 2.2 feet msl, with a median of 0.6 foot msl. The average downstream tidal volume was 2,305 af/day, the average upstream tidal volume was –281 af/day, and the net downstream flow volume at the Grant Line gates was 2,024 af/day. The net downstream flow is 500 af/day more than with the basic gate operations. This increase in downstream flow at Grant Line is caused by the closure of the Old River and Middle River gates during most ebb tide periods. The upstream tidal flow volume at Grant Line Canal is reduced somewhat by this increase in the downstream flow.

Figure 5.2-44 shows the DSM2-simulated tidal level and tidal volume at the Old River at Tracy tidal gates for July 1985 with the circulation gate operations. The tidal gates were closed (raised) at each high tide and remained closed during all ebb-tide periods, so that there was no downstream (positive) tidal flow across the tidal gates. The tidal gates were opened during flood-tide when the downstream level rose above the upstream level. The upstream level ranged from –0.1 foot msl to 2.2 feet msl, with a median of 0.6 foot msl. The water level was maintained somewhat higher than with the basic gate operations. The average downstream tidal volume was 0 af/day, the average upstream tidal volume was -275 af/day, and the net upstream flow was –275 af/day. The circulation gate operations produced a net upstream flow that was slightly smaller than the upstream tidal flow with the basic gate operations, because the upstream elevations with the circulation operations were somewhat higher, blocking the upstream tidal flow for a longer period each day.

Figure 5.2-45 shows the DSM2-simulated tidal level and tidal volume at the Middle River tidal gates July 1985 with the circulation gate operations. The tidal gates were closed at each high tide, and remained closed during all ebb-tide periods, so that there was no downstream tidal flow across the tidal gates. The tidal gates were opened during flood tide when the downstream level rose above the upstream level. The upstream level ranged from 0.0 feet msl to about 3.0 feet msl, with a median of 1.1 feet msl. The water level was maintained somewhat higher than with the basic gate operations. The average downstream tidal volume was 22 af/day (from some simulated flow before the tidal gates were raised), the average upstream tidal volume was –467 af/day, and the net upstream flow was –445 af/day. The circulation gate operations produced a net upstream flow that was slightly smaller than the upstream tidal flow with the basic gate operations, because the upstream elevations with the circulation gate operations were somewhat higher, blocking the upstream tidal flow for a longer period each day.

Although these two simulated gate operations provided similar water level protections for south Delta diversions, the circulation gate operations provided improved water quality in the south Delta channels and was used for the 16-year DSM2 simulations of SDIP alternatives.

Daily Operations of the South Delta Tidal Gates

The simulated effects of the south Delta tidal gate operations on tidal levels and tidal and net flows have been accurately described. The daily operations for each of the south Delta tidal gates will be considered within an adaptive management framework to satisfy the several interrelated purposes for these gates. Adaptive management procedures for the south Delta tidal gates can be developed from three major gate operation choices to provide maximum benefits from the tidal gate operations:

1. The CCF intake gates have two somewhat contradictory effects that must be balanced: If the gates are closed during higher tides (CCF priority 3 schedule), the effects of CCF diversions in the south Delta channels are minimized and levels at high tide throughout the south Delta channels are preserved. This will allow Tom Paine Slough siphons to operate and provide the maximum tidal flushing upstream of the tidal gates. The CCF intake gates, however, must be opened for a sufficient period each day to maintain the CCF elevations above -2.0 feet msl to prevent cavitation problems at SWP Banks Pumping Plant, which is often used for maximum off-peak (nighttime) pumping.
2. The head of Old River fish control gate can be operated to reduce the San Joaquin River diversions into Old River. This will increase the San Joaquin

River flow past Stockton and improve DO conditions in the DWSC. This may be beneficial for adult up-migrating Chinook salmon during the months of late September through November. This might also benefit outmigrating Chinook salmon juveniles and smolts during the March–May period. Reduction of the head of Old River diversions will also reduce the inflow of higher-salinity San Joaquin River water into the south Delta channels. However, reduced diversions will cause more water to be drawn from the central Delta to supply the CVP and SWP pumping, which may cause entrainment of some larval or juvenile fish (i.e., delta smelt) to be increased. Partial closure of the head of Old River gate will also shift the distribution of San Joaquin River salinity away from the CVP Tracy facility toward the CCWD intakes and the SWP Banks facility. The water quality effects of these potential tidal gate operations are more fully described in Section 5.3, Delta Water Quality.

3. The tidal gates at Grant Line Canal, Old River at Tracy, and Middle River can be used to control the water levels in the south Delta channels. In addition, ebb-tide closure of the Old River and Middle River tidal gates can produce a net circulation upstream on Old River and Middle River and downstream in Grant Line Canal. This may have a beneficial effect on salinity in these south Delta channels (see Section 5.3, Delta Water Quality). The operation of the tidal gates is not anticipated to substantially change the fish movement patterns that may be triggered by or associated with tidal flows.

The tidal gate operations will vary on a day-by-day basis depending on the inflows, export pumping, and water quality conditions within the south Delta. The tidal gate operations will follow these adaptive management procedures and will be periodically evaluated by the Gate Operation Review Team (GORT), as described in Chapter 2.

Environmental Consequences

Assessment Methods

Assessment of the Delta hydrodynamic impacts of SDIP facilities and operations was accomplished by considering tidal hydraulic variables in the Delta and selecting those that would likely be changed or influenced by SDIP facilities and operations. The selected impact variables were then analyzed with DSM2 model to determine whether significant changes from the simulated existing conditions/No Action Alternative conditions would likely occur with any proposed SDIP alternative facilities and operations.

Channel tidal flows and tidal level variations at several south Delta locations have been selected to describe possible effects of SDIP facilities and operations on south Delta tidal hydraulics. These following locations include south Delta channels upstream and downstream of the temporary barriers as well as the proposed tidal gates:

- Old River at SR 4 Bridge. This is slightly downstream of the CCWD Los Vaqueros Pumping Plant intake and fish screen facility. This is about 4 miles downstream (north) of the CCF entrance.
- Old River at Clifton Court Ferry. This station is between Grant Line Canal and the CCF intake gates. It is just downstream of the CVP Tracy intake canal. The CVP and SWP pumping have the greatest combined effect on tidal level and flow at this station.
- Old River at Tracy Boulevard Bridge. This station is a traditional tidal level and EC monitoring location and is upstream of the Old River at DMC temporary barrier and proposed permanent tidal gate structure.
- Old River downstream of the head of Old River. This station is located just downstream of the temporary fish control barrier and proposed fish control gate at the head of Old River and is influenced by the San Joaquin River flow and tidal level.
- Grant Line Canal at Tracy Boulevard Bridge. This station is just upstream of the temporary barrier on Grant Line Canal and will be about 4 miles upstream of the permanent tidal gate on Grant Line Canal.
- Middle River at Mowry Bridge. This station is about 1.5 miles downstream of the upstream end (head) of Middle River at Old River. This station is a monitoring location for tidal level effects of the temporary barriers.
- Middle River at Tracy Boulevard Bridge. This station is located just upstream of the temporary barrier near Victoria Canal and the proposed permanent tidal gate.

These seven south Delta locations will be used to characterize the effects of the SDIP alternative facilities and operations compared with the 2001 baseline (existing conditions) and 2020 baseline (future no-action conditions). The baseline conditions include temporary barriers operated during the irrigation season of May through October. The SDIP alternatives include permanent tidal gates that would be operated year-round to maintain minimum tidal level above 0.0 feet msl. Because the DSM2 tidal flow and stage results for the 2001 and 2020 conditions are similar, only the 2001 results will be described and shown on graphs in this chapter. The 2020 results are compared in the tables, and the graphs of the DSM2 results for 2020 conditions are available from the SDIP website.

Figure 5.2-46 shows the daily minimum and maximum tidal level in Old River near the DMC for calendar year 2003. This is the location of the Old River temporary barrier just east (upstream) of the DMC intake and fish facility. Tidal level records above and below the temporary barrier are shown to illustrate the effects of the temporary barriers during 2003. The tidal level variations downstream of the barrier (thick solid lines) reflect the full influence of the CVP and SWP pumping. The daily minimum tidal level is generally between 0.0 feet msl and –1.0 foot msl. The period of lowest low tide was in late March with a minimum tidal level of –1.5 feet msl. The daily maximum tidal level is much more variable than the low tide, with maximum tidal level fluctuating between 1.0 foot msl and almost 4.0 feet msl.

The thin lines at the bottom and top of the graph show the daily minimum and maximum tide elevations at Martinez for 2003. The tidal variation at Martinez is greater than the tidal variation in the south Delta. The variation in the daily minimum tidal level at Martinez has a stronger spring-neap variation than the minimum tidal level in the south Delta near the DMC intake. The minimum south Delta tidal level cannot be lower than the minimum tidal level at Martinez, nor can the maximum tidal level in the south Delta be greater than the maximum tidal level at Martinez. The 28-day period of the spring-neap lunar cycle is strongly evident throughout the year.

The minimum and maximum tidal level upstream of the temporary barrier location was the same as the level downstream when the temporary barriers were not installed from January through March. The temporary barriers (including the head of Old River fish control barrier and Middle River barrier) were installed by April 15. The upstream minimum tidal level increased to between 0.0 feet msl and 1.0 foot msl from April 15 until June 10. The Grant Line temporary barrier was installed on June 10. This raised the minimum tidal level at the Old River near DMC barrier to between 1.0 foot and 2.0 feet msl from June 10 until November 10, when the Old River barrier was removed. The temporary barriers were effective in raising the minimum tidal level in the south Delta channels located upstream of the temporary barriers. Old and Middle River barriers raised the minimum tide elevation to about 0.0 feet msl. Installation of the Grant Line temporary barrier raised the minimum tidal level to about 1.0 foot.

During the period when all three temporary agricultural barriers were installed (June 10 to November 10) the daily maximum tidal level was slightly reduced upstream of the temporary barriers compared with the downstream maximum tidal level. The resulting tidal variation upstream of the temporary barriers was greatly reduced to a variation of less than 1.5 feet. The tidal level variations at the other agricultural barrier locations are similar. The temporary barriers act as small dams that effectively maintain a higher minimum level but also reduce the tidal flows over the barriers, so that the maximum tide level is reduced slightly.

The operation of these temporary barriers as illustrated for 2003 is considered to be representative of the existing tidal hydraulic conditions for the south Delta channels. The tidal hydraulic conditions resulting from the proposed tidal gate operations will be somewhat different from the tidal hydraulics conditions resulting from these temporary barriers. (See Chapter 10 for an evaluation of the potential cumulative effects.)

Significance Criteria

The tidal hydraulic effects of the proposed SDIP project alternatives were assessed based on the following criteria:

- **Tidal gate and export pumping effects on tidal flows, velocities, and levels.** A project alternative is considered to have a significant impact on local channel hydraulics if it would cause local tidal flows to substantially exceed the historical range of tidal flows, or cause the local range of tidal levels to be substantially reduced below historical tidal levels. Significant effects on water level during the irrigation season of April to October are defined to be any reductions below the assumed minimum operating level for agricultural water supply pumps and siphons, of 0.0 feet msl. Because tidal flows are the tidal velocities times the channel cross-sectional area, substantial changes in tidal flows would correspond to substantial changes in the tidal velocities.
- **Tidal gate effects on tidal (circulation) flows.** A project alternative is considered to have a significant impact on tidal circulation flows if it would cause monthly average tidal flows to be reduced substantially below historical tidal flows. A substantial reduction in tidal flows will likely cause higher salinity from agricultural drainage in the south Delta channels. There is considerable natural variability in tidal conditions. A 10% threshold is selected to distinguish an impact from this natural variability. A reduction in simulated average tidal flows of more than 10% was assumed to be substantial.

CALFED Programmatic Mitigation Measures

The August 2000 CALFED Programmatic ROD includes mitigation measures for agencies to consider and use where appropriate in the development and implementation of project-specific actions. The mitigation measures address the short-term, long-term, and cumulative effects of the CALFED Program.

The CALFED Programmatic EIS/EIR does not specifically address Delta tidal hydraulic conditions and, therefore, does not provide recommended mitigation for potential tidal hydraulic impacts.

Alternative 1 (No Action)

DSM2-simulated tidal hydraulic effects from the SDIP alternatives are described below for the 1976–1991 simulation period. The existing tidal hydraulic conditions for either the 2001 baseline or the 2020 baseline are assumed to be the same as the No Action Alternative. Table 5.2-6A gives an overall summary of the simulated 2001 no action minimum tidal level and average (net) flow for the impact assessment locations. The major assumptions for the 2001 baseline conditions that correspond to the No Action Alternative simulation are listed below:

- Maximum SWP Pumping of 6,680 cfs, except for December 15–March 15 when the maximum SWP pumping can be 8,500 cfs (modeled monthly maximum in January and February) if the San Joaquin River flow is high (greater than 5,460 cfs). Therefore, the baseline existing conditions already have some months with SWP Banks pumping of 8,500 cfs. During the 16-year DSM2 simulation period, the baseline has four months with 8,500 cfs pumping. For the entire 73-year CALSIM sequence, SWP pumping is already 8,500 cfs in 19 months.

- The simulated operations of the temporary barriers are complicated. In some months (June–August) all three agricultural barriers are in place so that the minimum tidal level is about 1 foot msl. In other months (September–November) the barriers have weirs set at 0 feet msl. In other months (December–March) there are no barriers in place. April and May have split month operations for VAMP, so the first half of April has no barriers to protect minimum tidal level. The first half of May has no Grant Line barrier, so minimum tidal level is not protected as much as from June to August. These simulated conditions are similar to the actual temporary barrier operations that were shown for 2003 (see Figure 5.2-46). Appendix D provides more details about the simulation of the temporary barriers.
- The head of Old River fish control gate is assumed to be closed from April 15 to May 15, and installed with a 0.0-foot-msl weir from September 15 through November in the 2001 and 2020 baseline conditions (some water is diverted during the fall closure).
- CCF gates were operated with priority 3, which means that the CCF gates are closed during the flood-tide period prior to the higher-high tide, to allow the high tide to overflow the temporary barriers and fill the south Delta channels to the maximum extent possible, without any diversions into CCF.

The simulated 2001 baseline tidal level and flow for the 16-year DSM2 simulation period are shown in each of the SDIP Alternative graphs for the seven selected locations with the lines; the alternative simulation results are shown in the graphs with the box symbols.

Table 5.2-6. Summary of DSM2-Simulated Tidal Level and Flows for SDIP Alternatives for 1976–1991 Period

		Alternative					
	Baseline	2A Stage 1	2A	2B	2C	3B	4B
A. 2001 Conditions							
16-Year Average for Monthly Minimum Tidal Stage (feet above mean sea level)							
Old River at State Route 4	-1.08	-1.13	-1.13	-1.12	-1.13	-1.05	-1.01
Old River at Clifton Court Ferry	-1.16	-1.21	-1.21	-1.20	-1.21	-1.11	-1.06
Old River at Tracy Blvd Bridge	0.56	0.61	0.58	0.59	0.58	0.14	-0.60
Old River at Head	2.31	1.96	1.94	1.94	1.94	1.38	1.15
Middle River at Mowry Bridge	1.32	1.29	1.21	1.21	1.21	0.57	0.22
Middle River at Tracy Blvd Bridge	0.03	0.44	0.31	0.32	0.31	0.06	-0.92
Grant Line Canal at Tracy Blvd Bridge	0.63	0.68	0.65	0.66	0.66	-0.34	-0.52
16-Year Average Tidal Flow (cubic feet per second)							
Old River at State Route 4	-3,198	-3,377	-3,531	-3,401	-3,467	-3,354	-3,381
Old River at Clifton Court Ferry	-929	-1,144	-1,173	-1,167	-1,173	-1,079	-1,214
Old River at Tracy Blvd Bridge	417	122	105	105	105	25	325
Old River at Head	2,214	1,735	1,757	1,754	1,755	1,802	1,830
Middle River at Mowry Bridge	221	89	150	150	150	110	273
Middle River at Tracy Blvd Bridge	147	15	76	76	76	36	198
Grant Line Canal at Tracy Blvd Bridge	1,734	1,814	1,788	1,785	1,787	1,953	1,518
B. 2020 Conditions							
16-Year Average for Monthly Minimum Tidal Stage (feet above mean sea level)							
Old River at State Route 4	-1.07	-1.13	-1.13	-1.12	-1.13	-1.05	-1.01
Old River at Clifton Court Ferry	-1.15	-1.21	-1.21	-1.20	-1.20	-1.11	-1.06
Old River at Tracy Blvd Bridge	0.46	0.61	0.58	0.59	0.58	0.14	-0.61
Old River at Head	2.21	1.92	1.90	1.90	1.90	1.33	1.10
Middle River at Mowry Bridge	1.23	1.27	1.19	1.20	1.19	0.55	0.20
Middle River at Tracy Blvd Bridge	0.00	0.46	0.32	0.33	0.33	0.06	-0.92
Grant Line Canal at Tracy Blvd Bridge	0.53	0.68	0.65	0.65	0.65	-0.35	-0.53
16-Year Average Tidal Flow (cubic feet per second)							
Old River at State Route 4	-3,208	-3,424	-3,556	-3,451	-3,504	-3,404	-3432
Old River at Clifton Court Ferry	-864	-1,138	-1,140	-1,142	-1,130	-1,055	-1,191
Old River at Tracy Blvd Bridge	390	108	91	92	92	15	320
Old River at Head	2,227	1,692	1,711	1,709	1711	1,757	1,785
Middle River at Mowry Bridge	208	84	141	141	141	101	265
Middle River at Tracy Blvd Bridge	136	11	68	68	68	28	192
Grant Line Canal at Tracy Blvd Bridge	1,787	1,795	1,771	1,769	1,771	1,933	1,492

2020 Conditions

There are no assumed changes in temporary barrier operations between the 2001 baseline and the 2020 baseline conditions. Although the CALSIM results for monthly inflows and pumping may be slightly different (Table 5.2-6B), the effects of these simulated 2020 CVP and SWP pumping levels on south Delta tidal hydraulics are similar to the simulated tidal hydraulic conditions for the 2001 baseline with temporary barriers.

Alternative 2A

Stage 1 (Physical/Structural Components)

Construction of the tidal gates will not substantially change or influence the fluctuations in tidal level, flows, or velocities within the south Delta channels. Localized effects of cofferdams or temporary structures in the channels during construction of the tidal gates will not have any significant effects on tidal hydraulics. Operation of the tidal gates during Stage 1 of the SDIP will change the tidal hydraulic conditions in the south Delta channels to be somewhat different from the tidal hydraulics conditions resulting from the temporary barriers. These differences during Stage 1 of the SDIP will be the same for Alternatives 2A–2C, because each of these alternatives would include all four tidal gates. The changes in the simulated tidal conditions with tidal gates during Stage 1 of the SDIP are compared to the simulated tidal conditions with temporary barriers (existing conditions) at the seven tidal hydraulic impact assessment locations.

Impact HY-1: Effects on Tide Level and Flow in Old River at State Route 4 Bridge. Photograph 5.2-37 shows an aerial view of Old River at the SR 4 Bridge (middle-right of photograph). Indian Slough, which connects with Discovery Bay (upper left of photograph), is located just north of the photograph area. Photograph 5.2-38 shows the SR 4 Bridge over Old River just north of the Los Vaqueros Pumping Plant (building along the west levee). The Byron Tract drainage canal is visible in the upper-left portion of the photograph.

Figure 5.2-47 shows the 16-year period of monthly minimum, median, and maximum tidal level and monthly tidal flows in Old River at the SR 4 Bridge (near the Los Vaqueros intake) for the baseline and Alternative 2A Stage 1 conditions. The changes in monthly tidal level (minimum, median, and maximum) are just slightly detectable on the graph for some months. The simulated changes in tidal flow (minimum, average, and maximum) can be identified in many months, with both the downstream and the upstream flows slightly reduced under Alternative 2A Stage 1 conditions with tidal gates operating. The average tidal flows did not change because the export pumping at the CVP Tracy and the SWP Banks did not change. There are no significant tidal level or tidal flow effects in Old River at the SR 4 Bridge. No mitigation is required.

Impact HY-2: Effects on Tide Level and Flow in Old River at Clifton Court Ferry. This station is between Grant Line Canal and the CCF intake (see Photographs 5.2-27 and 5.2-28).

Figure 5.2-48 shows the 16-year period of monthly minimum, median, and maximum levels and monthly minimum, average, and maximum tidal flows in Old River at Clifton Court Ferry for the baseline and Alternative 2A Stage 1 conditions. The changes in minimum and median tidal level are hardly detectable on the graph. The changes in the maximum tidal level were greatest in the summer months, but were less than 0.1 foot. Tidal flows in Old River at Clifton Court Ferry range between about 5,000 cfs downstream and –10,000 cfs upstream toward the DMC. The average tidal flow ranges from 0 cfs to –5,000 cfs, depending on the CVP pumping flows.

Upstream tidal flows under Alternative 2A Stage 1 with tidal gates generally increase by about 2,000 cfs during the summer months, when the temporary barriers restrict this upstream tidal flow under existing conditions. The operation of the Old River tidal gate at DMC, located just upstream of this station, allows stronger flood-tide flows upstream in Old River. This is considered to be a benefit of tidal gate operations that is expected to improve water quality conditions. There are no significant tidal level or tidal flow effects in Old River at Clifton Court Ferry. No mitigation is required.

Impact HY-3: Effects on Tide Level and Flow in Old River at Tracy Boulevard Bridge. Photograph 5.2-39 shows the Tracy Boulevard Bridge crossing the Old River channel, looking toward the east, with the Tracy Wildlife Club Island in the foreground. Photograph 5.2-40 shows the Old River at DMC temporary barrier. The temporary barrier or tidal gates will control the tidal level and tidal flow at Tracy Boulevard Bridge, located about 12 miles upstream.

Figure 5.2-49 shows the 16-year period of monthly minimum, median, and maximum levels and monthly minimum, average, and maximum tidal flows in Old River at Tracy Boulevard Bridge for the baseline and Alternative 2A Stage 1 conditions. The changes in the monthly maximum tidal level are relatively small, because the CCF gates are operated on a priority 3 schedule that preserves the high-tide elevations each day. The minimum tidal level for Alternative 2A Stage 1 is held above 0 feet msl in all months. The temporary barriers that were simulated for existing conditions (2001 baseline) held the minimum tidal level at about 1.0 foot msl during the summer irrigation months. Because the minimum level is maintained above 0.0 feet msl in all months under Alternative 2A Stage 1, there are no significant tidal level effects in Old River at the Tracy Boulevard Bridge.

The simulated tidal flows are relatively small under the existing conditions, with a typical range of –600 cfs to 600 cfs during the winter months and only –250 cfs to 250 cfs during the summer months with the temporary barrier. Under Alternative 2A Stage 1, the Old River at DMC tidal gate will be operated to allow mostly flood-tide flows upstream, and the simulations show a net upstream flow of about 250 cfs, with a maximum downstream tidal flow of 250 cfs and maximum upstream tidal flow of about 750 cfs. This is considered to be a benefit of tidal gate operations that is expected to improve water quality conditions. There are no significant tidal level or tidal flow effects in Old River at Tracy Boulevard Bridge. No mitigation is required.

Impact HY-4: Effects on Tide Level and Flow in Old River at the Head of Old River. Figure 5.2-50 shows the 16-year period of minimum, median, and maximum levels and monthly minimum, average, and maximum tidal flows in Old River at the head of Old River, just downstream of the temporary barrier and proposed tidal gate for the baseline and Alternative 2A Stage 1 conditions. The changes in the maximum tidal level are relatively small, even though the fish control gate was simulated to be completely closed in April and May, with a constant flow of 500 cfs from the San Joaquin River in June–November under Alternative 2A Stage 1. This suggests that the high tide is controlled by tidal flows and not strongly affected by the San Joaquin River diversions into Old River, except during high flows. The temporary barriers held the minimum level at about 1.0 foot msl during the summer irrigation months. Because the minimum level is maintained above 0.0 feet msl in all months under Alternative 2A Stage 1, there are no significant tidal level effects at the head of Old River.

Tidal flows are 0 cfs during April and May, when the head of Old River gates are simulated to be closed under Alternative 2A Stage 1. A constant flow of about 500 cfs was simulated in the summer and fall months of June–November. The head of Old River gate was simulated to be open only in the months of December–March under Alternative 2A Stage 1. The reductions in tidal flows at the head of Old River are greater than 10% of the existing conditions. However, the increased flow in the San Joaquin River past Stockton is expected to reduce the number of steelhead and Chinook salmon diverted into Old River, and is expected to improve water quality (i.e., DO) conditions in the DWSC. The reduced diversions of the San Joaquin River water are also expected to provide a water quality (i.e., salinity) benefit in the south Delta channels. These changes in tidal flow at the head of Old River are considered to be beneficial. No mitigation is required.

Impact HY-5: Effects on Tide Level and Flow in Middle River at Mowry Bridge. Photograph 5.2-41 shows the Middle River channel at Mowry Bridge (looking north), which is located about 1.5 miles north of the head of Middle River at Old River. Figure 5.2-51 shows the 16-year period of monthly minimum, median, and maximum levels and monthly minimum, average, and maximum tidal flows in Middle River at Mowry Bridge. The changes in the maximum tidal level are relatively small (less than 0.5-foot reduction in the summer months). The temporary barriers held the minimum level at 1.0 foot msl during the summer irrigation months. Because the minimum level is maintained above 0.0 feet msl in all months under Alternative 2A Stage 1 with tidal gates operating, there are no significant tidal level effects in Middle River at Mowry Bridge.

Tidal flows in Middle River at Mowry Bridge are very small (less than 200 cfs upstream or downstream). The upstream tidal flushing flows would be substantially increased under Alternative 2A Stage 1, with the Middle River tidal gate operated to provide a net flood-tide upstream flow. These increased upstream tidal flows are considered a benefit, and there are no significant tidal impacts in Middle River at Mowry Bridge. No mitigation is required.

Impact HY-6: Effects on Tide Level and Flow in Middle River at Tracy Boulevard Bridge. Photograph 5.2-42 shows the Tracy Boulevard Bridge over Middle River, looking north toward Victoria Canal. Photograph 5.2-43 shows the Middle River temporary barrier that is located between the Tracy Boulevard Bridge and Victoria Canal. Photograph 5.2-44 shows the Middle River channel upstream of the temporary barrier (looking east). This section of the Middle River channel has been dredged and widened substantially compared with the upstream portion of Middle River.

Figure 5.2-52 shows the 16-year period of minimum, median, and maximum levels and monthly tidal flows in Middle River at Tracy Boulevard Bridge. The minimum level is held at 0 feet msl in almost all months under Alternative 2A Stage 1 with tidal gates. The infrequent minimum level values of –1.0 foot msl are during months when the Middle River tidal gate was not operated, because the San Joaquin River flows were assumed to be high enough to protect the water level without the tidal gates. The actual tidal gate operations during Stage 1 will maintain the minimum level of 0.0 feet msl at this location.

The maximum tidal flows under existing conditions are about 1,000 cfs upstream and downstream. Maximum upstream (i.e., negative) tidal flows in Middle River at Tracy Boulevard Bridge are the same as under existing conditions, but the downstream tidal flows are eliminated by the gate operations. The average tidal flows will be increased by about 100 cfs with the tidal gates. This net upstream tidal flow is considered a benefit, and there are no significant tidal impacts in Middle River at Tracy Boulevard Bridge. No mitigation is required.

Impact HY-7: Effects on Tide Level and Flow in Grant Line Canal at Tracy Boulevard Bridge. Photograph 5.2-45 shows the Grant Line Canal looking west toward the Tracy Boulevard Bridge (center of photograph) and the proposed tidal gate, about 4 miles west of the Bridge at the confluence with Old River. The tidal gate would be located at the western end of Grant Line Canal to protect the minimum level elevation for agricultural pumps located along Grant Line Canal and Fabian and Bell Canal. The temporary barrier is located just upstream of (east of) the Tracy Boulevard Bridge. Photograph 5.2-46 shows the Grant Line Canal looking east. The Fabian and Bell Canal is on the south (right of photograph) and ends at the Tracy Boulevard Bridge (middle of photograph). Photograph 5.2-47 shows a close-up view of the Tracy Boulevard Bridge from the temporary barrier. Photograph 5.2-48 shows the Grant Line Canal upstream of the temporary barrier. Agricultural diversion pumps can be seen on both banks of Grant Line Canal.

Figure 5.2-53 shows the 16-year period of monthly minimum, median, and maximum levels and monthly tidal flows in Grant Line Canal at Tracy Boulevard Bridge for the existing conditions baseline and Alternative 2A Stage 1. The changes in the maximum tidal level are relatively small. The temporary barriers held the minimum level at above 1.0 foot msl during the summer irrigation months. Because the minimum level is maintained above 0.0 feet msl in all months under Alternative 2A Stage 1 with tidal gates, there are no significant tidal level effects in Grant Line Canal at Tracy Boulevard Bridge.

Maximum tidal flows in Grant Line Canal at Tracy Boulevard Bridge under the baseline were about 3,000 cfs upstream and downstream during the winter months without any temporary barriers. The maximum tidal flows were reduced to about 1,000 cfs in the summer months with the temporary barriers installed. Maximum tidal flows will be about 3,000 cfs to 4,000 cfs under Alternative 2A Stage 1 with tidal gates. The net downstream flow will be increased by about 500 cfs with the tidal gate operations. This represents the net circulation flows from Old River and Middle River that the tidal gates will produce. This is considered a benefit for water quality. There is no significant impact on tidal flows in Grant Line Canal at Tracy Boulevard Bridge. No mitigation is required.

2020 Conditions

The tidal hydraulic effects during construction under 2020 conditions would be the same (no impacts) as those under 2001 conditions. The changes in tidal hydraulic conditions with tidal gate operations under 2020 conditions would be the same as shown for the 2001 existing conditions simulations. The likely benefits for water quality are assumed to be the same as under 2001 Alternative 2A Stage 1 conditions with tidal gate operations. There are no significant tidal hydraulic effects. No mitigation is required.

Stage 2 (Operational Components)

The operations of the tidal gates are the same as described and evaluated for Stage 1 of Alternative 2A. The major operational assumptions for Alternative 2A Stage 2 are described in Chapter 2.

Maximum SWP pumping of 8,500 cfs is simulated by CALSIM in more months than for the No Action Alternative, because the 8,500 cfs limit applies in all months except during VAMP (April 15–May 15). However, other Delta operating criteria may limit the SWP pumping to less than 8,500 cfs in many months. During the 16-year DSM2 simulation period, Alternative 2A had 29 months (15% of the months) with 8,500 cfs pumping. For the entire 73-year CALSIM sequence, SWP pumping under Alternative 2A was 8,500 cfs in 138 months (16% of months simulated). For the 2001 baseline simulation, 8,500 cfs was simulated in some months (i.e., January and February) with 4 months (2%) during the 16-year DSM2 period, and 19 months (2%) during the 73-year simulation. The maximum pumping of 8,500 cfs is therefore simulated in about 13% more of the months.

Figure 5.2-54a shows the CALSIM simulated monthly average CVP and SWP pumping for the 2001 baseline and Alternative 2A during the 16-year DSM2 simulation period. There are very few changes in the CVP Tracy pumping. The simulated SWP pumping is at 8,500 cfs more often, and pumping increases of more than 1,000 cfs were simulated in about 35 of the 192 months. Figure 5.2-54b shows the CALSIM-simulated monthly average CVP and SWP pumping for the 2020 baseline and 2020 Alternative 2A during the 16-year DSM2 simulation period. The changes in CVP and SWP pumping identified in the 2020 simulations are similar to the changes identified in the 2001 simulations. There are very few changes in the 2020 CVP Tracy pumping. The simulated 2020 SWP pumping is at 8,500 cfs more often than the 2020 baseline, and pumping increases of more than 1,000 cfs were simulated in about 35 of the 192 months.

The number of months with a substantial change in CVP or SWP pumping was similar for the 2001 CALSIM results and the 2020 CALSIM results. The impacts for Alternative 2A Stage 2 are therefore considered to be similar for these CALSIM-simulated CVP and SWP operations for either the 2001 LOD or the 2020 LOD.

DSM2-simulated tidal hydraulic effects for the 2001 CALSIM results for Alternative 2A Stage 2 are shown and described in the following section. DSM2-simulated tidal effects for the 2020 CALSIM results for Alternative 2A Stage 2 are not shown but can be reviewed in files that are available on the SDIP Web site.

Impact HY-1: Effects on Tide Level and Flow in Old River at State Route 4 Bridge. Figure 5.2-55 shows the 16-year period of monthly tidal level and monthly tidal flows in Old River at the SR 4 Bridge (near the Los Vaqueros intake) for the baseline and Alternative 2A Stage 2 conditions. The changes in monthly tidal level (minimum, median, and maximum) are slightly detectable on the graph and are similar to the Stage 1 changes. This suggests that the small changes in stage and flow are the result of the tidal gate operations, and not associated with pumping changes. The largest changes in the negative (flood-tide) flows are associated with the increased SWP pumping conditions, which increase the upstream average tidal flow by about half of the export pumping change. There are no significant tidal level or tidal flow effects in Old River at the SR 4 Bridge. No mitigation is required.

Impact HY-2: Effects on Tide Level and Flow in Old River at Clifton Court Ferry. Figure 5.2-56 shows the 16-year period of monthly tidal levels and monthly tidal flows in Old River at Clifton Court Ferry for the baseline and Alternative 2A Stage 2 conditions. The changes in minimum and median tidal level are detectable on the graph for some months. The changes in the maximum tidal level are the greatest, with a reduction of about 0.5 foot in some months.

Figure 5.2-57 shows three possible causes for a change in the minimum water level in Old River at Clifton Court Ferry. The effect on minimum water level from increased SWP Banks pumping is not simulated to be a major factor. The monthly minimum level does not appear to decline with increased pumping. The minimum level in Old River at Clifton Court Ferry is increased with higher San Joaquin River flows, with a flow of 20,000 cfs raising the minimum monthly level to about 0.0 feet msl. The greatest effect on minimum level in Old River at Clifton Court Ferry is the Martinez boundary tide, but this effect is not changed under Alternative 2A compared with the baseline relationship. The changes in the minimum tidal level are less than 0.1 foot, and there are no tidal hydraulic impacts associated with a reduction in the maximum tides. There are no significant tidal level or tidal flow effects in Old River at Clifton Court Ferry. No mitigation is required.

Impact HY-3: Effects on Tide Level and Flow in Old River at Tracy Boulevard Bridge. Figure 5.2-58 shows the 16-year period of monthly tidal levels and monthly tidal flows in Old River at Tracy Boulevard Bridge, located upstream of the temporary barrier and proposed tidal gates for the baseline and Alternative 2A Stage 2 conditions. The minimum tidal level for Alternative 2A Stage 2 is held at 0 feet msl in almost all months. The gate operations were not simulated in months with a Vernalis flow of more than 4,500 cfs. Actual gate operations would be used in these months if necessary to maintain a minimum level of 0.0 feet msl. The temporary barriers that were simulated for Alternative 1 (baseline) held the minimum tidal level at about 1.0 foot msl during the summer irrigation months. Because the minimum level will be maintained above 0.0 feet msl in all months under Alternative 2A, there are no significant tidal level effects in Old River at the Tracy Boulevard Bridge.

The simulated tidal flows in Old River at Tracy Boulevard Bridge are the same as for Alternative 2A Stage 1. The increased upstream tidal flows in the summer and fall months under Alternative 2A Stage 2 are expected to improve water quality conditions. Under Alternative 2A Stage 2, the Old River at DMC tidal gate will be operated to allow mostly flood-tide flows upstream, and the simulations show a net upstream flow of about 250 cfs, with a maximum downstream tidal flow of 250 cfs and maximum upstream tidal flow of about 750 cfs. There are no significant tidal level or tidal flow effects in Old River at Tracy Boulevard Bridge. No mitigation is required.

Impact HY-4: Effects on Tide Level and Flow in Old River at the Head of Old River. Figure 5.2-59 shows the 16-year period of monthly tidal levels and tidal flows in Old River at the head of Old River, just downstream of the temporary barrier and proposed tidal gate for the baseline and Alternative 2A conditions. The changes in the maximum tidal level are relatively small, even though the fish control gate was simulated to be completely closed in April and May, with a constant flow of 500 cfs from the San Joaquin River in June–November under Alternative 2A Stage 2. The temporary barriers held the minimum level at about 1.0 foot msl during the summer irrigation months. Because the minimum level is maintained above 0.0 feet msl in all months under Alternative 2A Stage 2, there are no significant tidal level effects at the head of Old River.

Tidal flows are 0 cfs during April and May, when the head of Old River gates are simulated to be closed under Alternative 2A Stage 1. A constant flow of about

500 cfs was simulated in the summer and fall months of June–November. The head of Old River gate was simulated to be open only in the months of December–March under Alternative 2A Stage 1. The tidal flows are the same as under Stage 1, indicating that the diversions are not strongly dependent on pumping during the months when the gate is open. The reductions in tidal flows at the head of Old River are greater than 10% of the existing conditions. However, the increased flow in the San Joaquin River past Stockton is expected to reduce the number of steelhead and Chinook salmon diverted into Old River and is expected to improve water quality (i.e., DO) conditions in the DWSC. The reduced diversions of the San Joaquin River water are also expected to provide a water quality (i.e., salinity) benefit in the south Delta channels. These changes in tidal flow at the head of Old River are considered beneficial. No mitigation is required.

Impact HY-5: Effects on Tide Level and Flow in Middle River at Mowry Bridge. Figure 5.2-60 shows the 16-year period of monthly tidal levels tidal flows in Middle River at Mowry Bridge, just downstream of the head of Middle River. Because the minimum level is maintained above 0.0 feet msl in all months under Alternative 2A Stage 2, there are no significant tidal level effects in Middle River at Mowry Bridge.

Tidal flows in Middle River at Mowry Bridge are very small (less than 200 cfs upstream or downstream) for baseline conditions. The upstream tidal flushing flows would be substantially increased under Alternative 2A Stage 2, with the Middle River tidal gate operated to provide a net flood-tide upstream flow. The maximum upstream tidal flows are simulated to be greater under Stage 2 than they are under Stage 1, because of dredging changes in the Middle River channel (these would actually occur under Stage 1). These increased upstream tidal flows are considered a benefit, and there are no significant tidal impacts in Middle River at Mowry Bridge. No mitigation is required.

Impact HY-6: Effects on Tide Level and Flow in Middle River at Tracy Boulevard Bridge. Figure 5.2-61 shows the 16-year period of monthly tidal levels and tidal flows in Middle River at Tracy Boulevard Bridge, just upstream of the temporary barriers and the proposed tidal gates. The minimum level is held at 0 feet msl in almost all months under Alternative 2A Stage 2. The infrequent minimum level values of –1.0 foot msl are during months when the Middle River tidal gate was not simulated. The tidal gate operations were assumed to be unnecessary when the San Joaquin River flow at Vernalis was greater than 2,500 cfs. The actual gate operations would maintain the water level above 0.0 feet msl, so that there would be no significant tidal level impact.

The maximum tidal flows under existing conditions are about 1,000 cfs upstream and downstream. Maximum upstream (i.e., negative) tidal flows in Middle River at Tracy Boulevard Bridge under Alternative 2A Stage 2 are the same as under existing conditions, but the downstream tidal flows are eliminated by the gate operations in months when the tidal gates were simulated. The average tidal flows will be increased by about 200 cfs with the tidal gates and dredging of Middle River upstream of the Tracy Boulevard Bridge. This net upstream tidal flow is considered a benefit, and there are no significant tidal impacts in Middle River at Tracy Boulevard Bridge. No mitigation is required.

Impact HY-7: Effects on Tide Level and Flow in Grant Line Canal at Tracy Boulevard Bridge. Figure 5.2-62 shows the 16-year period of monthly tidal levels and tidal flows in Grant Line Canal at Tracy Boulevard Bridge, just downstream of the temporary barriers and 4 miles upstream of the proposed tidal gates. Because the minimum level is maintained above 0.0 feet msl in all months under Alternative 2A Stage 2, there are no significant tidal level effects in Grant Line Canal at Tracy Boulevard Bridge.

Maximum tidal flows in Grant Line Canal at Tracy Boulevard Bridge under the baseline were about 3,000 cfs upstream and downstream during the winter months without any temporary barriers. The maximum tidal flows were reduced to about 1,000 cfs in the summer months with the temporary barriers installed. Maximum tidal flows will be about 3,000 cfs to 4,000 cfs under Alternative 2A Stage 2 with tidal gates. The net downstream flow will be increased by about 500 cfs with the tidal gate operations. This represents the net circulation flows from Old River and Middle River that the tidal gates will produce. This is considered a benefit for water quality. There is no significant impact on tidal flows in Grant Line Canal at Tracy Boulevard Bridge. No mitigation is required.

2020 Conditions

The simulated tidal hydraulic impacts for Alternative 2A Stage 2 under 2020 conditions would be similar to those simulated for Alternative 2A Stage 2under 2001 baseline conditions, because the simulated pumping patterns are similar (see Figure 5.2-54). The 2020 simulated tidal hydraulic results for Alternative 2A are available in an Excel file from the SDIP Web site.

Interim Operations

Interim Operations would be similar to the proposed Alternative 2A operations for December 15 through March 15. Under Interim Operations, the temporary barriers would continue to be installed; however, they are not installed at this time of the year when pumping would be increased to 8,500 cfs. Therefore, it is anticipated that there would be no significant tidal hydraulic effects under interim operations because they would be the same as under Alternative 1 (existing conditions). No mitigation is required.

Alternative 2B

Stage 1 (Physical/Structural Components)

Construction of the tidal gates will not substantially change or influence the tidal fluctuations in levels, flows, or velocities within the south Delta channels. Localized effects of cofferdams or temporary structures within the channels during construction of the tidal gates will not have any significant effects on tidal hydraulics. Operation of the tidal gates during Stage 1 of the SDIP will change the tidal hydraulic conditions in the south Delta channels to be somewhat different from the tidal hydraulics conditions resulting from the temporary barriers. These differences during Stage 1 of the SDIP will be the same for Alternative 2A, 2B, and 2C, because each of these alternatives would include all four tidal gates. The changes have already been shown under Alternative 2A at each of the impact assessment locations. There are no significant changes in tidal level or tidal flows.

2020 Conditions

The tidal hydraulic effects during construction and operation of tidal gates under 2020 conditions would be the same (none) as those under 2001 conditions.

Stage 2 (Operational Components)

Figure 5.2-63a shows the CALSIM-simulated CVP and SWP pumping for the 1976–1991 period used in DSM2 simulations for the 2001 baseline and Alternative 2B. There are very few changes in the CVP Tracy pumping. The simulated SWP pumping is at 8,500 cfs more often than under existing conditions, but SWP pumping increases of more than 1,000 cfs were simulated in about 15 of the 192 months during the 1976–1991 period. The CALSIM-simulated pumping changes for Alternative 2B are similar to the changes in pumping for Alternative 2A, and the effects of these Alternative 2B pumping changes on tidal hydraulics in the south Delta are expected to be similar to those for Alternative 2A.

Figure 5.2-63b shows the CALSIM-simulated monthly average CVP and SWP pumping for the 2020 baseline and 2020 Alternative 2B. The changes in CVP and SWP pumping identified in the 2020 simulations are similar to the changes identified in the 2001 simulations. There are very few changes in the 2020 CVP Tracy pumping. The simulated 2020 SWP pumping is at 8,500 cfs more often than the 2020 baseline, but pumping increases of more than 1,000 cfs were simulated in about 23 of the 192 months. The number of months with a substantial change in CVP or SWP pumping was similar for the 2001 CALSIM results and the 2020 CALSIM results. The impacts for Alternative 2B are therefore considered to be similar for either the 2001 LOD or the 2020 LOD simulations.

DSM2-simulated tidal hydraulic effects for the 2001 CALSIM results for Alternative 2B are shown and described in the following section. Figures of the monthly range of tidal level and tidal flows is shown for four of the selected impact assessment locations. Tidal figures for other locations and for the DSM2 results for the 2020 simulations are available from the SDIP website.

Impact HY-1: Effects on Tide Level and Flow in Old River at State Route 4 Bridge. The simulated changes in the monthly ranges of tidal levels and tidal flows in Old River at the SR 4 Bridge under Alternative 2B Stage 2 are almost identical to the changes simulated for Alternative 2A Stage 2. Alternative 2B Stage 2 allows higher pumping in many months, but the minimum monthly stage in Old River at the SR 4 Bridge during these months is not lower than the baseline range of minimum tidal level of –1 to –2 feet msl. Alternative 2B Stage 2 changes in the minimum and maximum tidal levels are less than 0.15 foot. There are no significant tidal level or flow effects in Old River at the SR 4 Bridge from Alternative 2B. These impacts are less than significant. No mitigation is required.

Impact HY-2: Effects on Tide Level and Flow in Old River at Clifton Court Ferry. Figure 5.2-64 shows the 16-year period of monthly tidal levels and tidal flows in Old River at Clifton Court Ferry (just upstream of the CCF intake) for the 2001 baseline and Alternative 2B Stage 2 conditions. The changes in tidal level are detectable on the graph in some months. The minimum tide level remains at about –2 feet msl. The changes in the maximum level are the greatest, with a reduction of about 0.25 foot, and changes in minimum tide level are less than 0.1 foot.

The changes in tidal flow can be identified in many months, with the downstream flows slightly higher and the upstream flows slightly lower under Alternative 2B Stage 2 compared with the 2001 baseline conditions. This is the result of the flood-tide operation of the Old River at DMC tidal gate. There are very small changes in the average (net) tidal flow in Old River at Clifton Court Ferry. There are no significant tidal level or tidal flow effects in Old River at Clifton Court Ferry. No mitigation is required.

Impact HY-3: Effects on Tide Level and Flow in Old River at Tracy Boulevard Bridge. Figure 5.2-65 shows the 16-year period of monthly tidal levels and tidal flows in Old River at Tracy Boulevard, located upstream of the temporary barrier and proposed tidal gates, for the 2001 baseline and Alternative 2B Stage 2 conditions. The minimum tidal level for Alternative 2B Stage 2 is held at 0 feet msl in almost all months. The gate operations were not simulated in months with a Vernalis flow of more than 4,500 cfs. Actual gate operations would be used in these months if necessary to maintain a minimum level of 0.0 feet msl. Because the minimum level will be maintained above 0.0 feet msl in all months under Alternative 2B, there are no significant tidal level effects in Old River at the Tracy Boulevard Bridge.

The simulated tidal flows in Old River at Tracy Boulevard Bridge are the same as for Alternative 2A. The increased upstream tidal flows in the summer and fall months under Alternative 2B Stage 2 are expected to improve water quality conditions. Under Alternative 2B Stage 2, the Old River at DMC tidal gate will be operated to allow mostly flood-tide flows upstream, and the simulations show a net upstream flow of about 250 cfs, with a maximum downstream tidal flow of 250 cfs and maximum upstream tidal flow of about 750 cfs. There are no significant tidal level or tidal flow effects in Old River at Tracy Boulevard Bridge. No mitigation is required.

Impact HY-4: Effects on Tide Level and Flow in Old River at the Head of Old River. The changes in the simulated tidal levels are relatively small, even though the fish control gate was simulated to be completely closed in April and May, with a constant flow of 500 cfs from the San Joaquin River in June–November under Alternative 2B Stage 2. The temporary barriers held the minimum level at about 1.0 foot msl during the summer irrigation months. Because the minimum level is maintained above 0.0 feet msl in all months under Alternative 2B Stage 2, there are no significant tidal level effects at the head of Old River.

The reductions in tidal flows at the head of Old River for Alternative 2B Stage 2 are greater than 10% of the existing conditions. However, the increased flow in the San Joaquin River past Stockton is expected to reduce the number of steelhead and Chinook salmon diverted into Old River and is expected to improve water quality (i.e., DO) conditions in the DWSC. The reduced diversions of the San Joaquin River water are also expected to provide a water quality (i.e., salinity) benefit in the south Delta channels. These changes in tidal flow at the head of Old River are considered beneficial. No mitigation is required.

Impact HY-5: Effects on Tide Level and Flow in Middle River at Mowry Bridge. Because the minimum level is maintained above 0.0 feet msl in all months under Alternative 2B Stage 2, there are no significant tidal level effects in Middle River at Mowry Bridge.

The upstream tidal flushing flows would be substantially increased under Alternative 2B Stage 2, with the Middle River tidal gate operated to provide a net flood-tide upstream flow. These increased upstream tidal flows are considered a benefit, and there are no significant tidal impacts in Middle River at Mowry Bridge. No mitigation is required.

Impact HY-6: Effects on Tide Level and Flow in Middle River at Tracy Boulevard Bridge. Figure 5.2-66 shows the 16-year period of monthly tidal levels and tidal flows in Middle River at Tracy Boulevard Bridge, just upstream of the temporary barriers and the proposed tidal gates for the 2001 baseline and Alternative 2B Stage 2 conditions. The minimum level under Alternative 2B is held at 0 feet msl in almost all months. The infrequent minimum level values of –1.0 foot msl are during months when the Middle River tidal gate was not simulated. The tidal gate operations were assumed to be unnecessary when the San Joaquin River flow at Vernalis was greater than 2,500 cfs. The actual gate operations would maintain the water level above 0.0 feet msl, so there would be no significant tidal level impact.

The maximum tidal flows under existing conditions are about 1,000 cfs upstream and downstream during the winter without any barriers. Maximum upstream (i.e., negative) tidal flows in Middle River at Tracy Boulevard Bridge under Alternative 2B Stage 2 are the same as under existing conditions, but the downstream tidal flows are eliminated by the gate operations in months when the tidal gates were simulated. The average tidal flows will be increased by about

200 cfs with the tidal gates and dredging of Middle River upstream of the Tracy Boulevard Bridge. This net upstream tidal flow is considered a benefit, and there are no significant tidal impacts in Middle River at Tracy Boulevard Bridge. No mitigation is required.

Impact HY-7: Effects on Tide Level and Flow in Grant Line Canal at Tracy Boulevard Bridge. Figure 5.2-67 shows the 16-year period of monthly tidal levels and tidal flows in Grant Line Canal at Tracy Boulevard Bridge, just upstream of the temporary barriers and 4 miles upstream of the proposed tidal gates, for the 2001 baseline and Alternative 2B conditions. Because the minimum level is maintained above 0.0 feet msl in all months under Alternative 2B, there are no significant tidal level effects in Grant Line Canal at Tracy Boulevard Bridge. No mitigation is required.

Maximum tidal flows both upstream and downstream will be about 3,000 cfs to 4,000 cfs under Alternative 2B Stage 2 with tidal gates. The net downstream flow will be increased by about 500 cfs with the tidal gate operations. This represents the net circulation flows from Old River and Middle River that the tidal gates will produce. This is considered a benefit for water quality. There is no significant impact on tidal flows in Grant Line Canal at Tracy Boulevard Bridge. No mitigation is required.

2020 Conditions

The simulated tidal hydraulic impacts for Alternative 2B under 2020 conditions would be similar to those simulated for Alternative 2B under 2001 baseline conditions, because the simulated pumping patterns are similar (see Figure 5.2-63). The 2020 simulated tidal hydraulic results for Alternative 2B are available in an Excel file from the SDIP Web site.

Alternative 2C

Stage 1 (Physical/Structural Components)

Construction of the tidal gates will not substantially change or influence the fluctuations in tidal level, flow, or velocity within the south Delta channels. Localized effects of cofferdams or temporary structures within the channels during construction of the tidal gates will not have any significant effects on tidal hydraulics. Operation of the tidal gates during Stage 1 of the SDIP will change the tidal hydraulic conditions in the south Delta channels to be somewhat different from the tidal hydraulics conditions resulting from the temporary barriers. These differences during Stage 1 of the SDIP will be the same for Alternatives 2A–2C, because each of these alternatives would include all four tidal gates. The changes have already been shown under Alternative 2A at each of the impact assessment locations. There are no significant changes in tidal level or tidal flows.

2020 Conditions

The tidal hydraulic effects during construction under 2020 conditions would be the same (none) as those under 2001 conditions.

Stage 2(Operational Components)

Figure 5.2-68a shows the CALSIM-simulated CVP and SWP pumping for the 1976–1991 period used in DSM2 simulations for the 2001 baseline and Alternative 2C. There are very few changes in the CVP Tracy pumping. The simulated SWP pumping is at 8,500 cfs more often than in the baseline, but SWP pumping increases of greater than 1,000 cfs were simulated in about 23 of the 192 months during the 1976–1991 period for Alternative 2C. Figure 5.2-68b shows the CALSIM-simulated monthly average CVP and SWP pumping for the 2020 baseline and 2020 Alternative 2C. The changes in CVP and SWP pumping identified in the 2020 simulations are similar to the changes identified in the 2001 simulations of Alternative 2C. There are very few changes in the 2020 CVP Tracy pumping. The simulated 2020 SWP pumping is at 8,500 cfs more often than the 2020 baseline, but pumping increases of more than 1,000 cfs were simulated in only about 31 of the 192 months. The number of months with a substantial change in CVP or SWP pumping was similar for the 2001 CALSIM results and the 2020 CALSIM results. The impacts and mitigation measures for Alternative 2C are therefore considered to be identical for these CALSIM-simulated CVP and SWP operations for either the 2001 LOD or the 2020 LOD simulations.

DSM2-simulated tidal hydraulic effects for the 2001 CALSIM results for Alternative 2C are shown and described in the following section. Figures of the monthly range of tidal level and tidal flow are shown for four of the selected impact assessment locations. Tidal figures for other locations and for the DSM2 results for the 2020 simulations are available from the SDIP website.

Impact HY-1: Effects on Tide Level and Flow in Old River at State Route 4 Bridge. There are no significant tidal level or flow effects in Old River at the SR 4 Bridge from Alternative 2C Stage 2. These impacts are less than significant. No mitigation is required.

Impact HY-2: Effects on Tide Level and Flow in Old River at Clifton Court Ferry. Figure 5.2-69 shows the 16-year period of monthly tidal levels and tidal flows in Old River at Clifton Court Ferry for the 2001 baseline and Alternative 2C Stage 2 conditions. The changes in maximum tidal level are moderate because CCF gates are operated with a priority 3 schedule. The simulated changes in minimum tidal level for Alternative 2C Stage 2 were very small. No mitigation is required.

Upstream flood-tide flows were increased because of the tidal gate operations. These impacts are less than significant. No mitigation is required.

Impact HY-3: Effects on Tide Level and Flow in Old River at Tracy Boulevard Bridge. Figure 5.2-70 shows the 16-year period of monthly tidal levels and tidal flows in Old River at Tracy Boulevard Bridge for the 2001 baseline and Alternative 2C Stage 2 conditions. Because minimum level is maintained above 0.0 feet msl in almost all months under Alternative 2C Stage 2, there are no significant tidal level effects in Old River at the Tracy Boulevard Bridge. Actual tidal gate operations would maintain the minimum level in all months. No mitigation is necessary.

Tidal flow in Old River at Tracy Boulevard Bridge was generally increased in the upstream direction because of the tidal gate operations under Alternative 2C Stage 2. These tidal circulation flows are considered a benefit for water quality. No mitigation is required.

Impact HY-4: Effects on Tide Level and Flow in Old River at the Head of Old River. The simulated changes in the tidal level at the head of Old River are relatively small. Because the minimum tidal level is maintained above 0.0 feet msl in all months under Alternative 2C Stage 2, there are no significant tidal level effects in Old River at the head of Old River. The reduced diversions from the San Joaquin River are considered to be a benefit for fish protection and water quality. No mitigation is required.

Impact HY-5: Effects on Tide Level and Flow in Middle River at Mowry Bridge. Because the minimum tidal level was maintained above 0.0 feet msl in all months under Alternative 2C Stage 2, there are no significant tidal level effects in Middle River at Mowry Bridge.

The upstream tidal flushing flows in Middle River at Mowry Bridge would be increased under Alternative 2C Stage 2. This is considered to be a water quality benefit. There are no significant tidal impacts in Middle River at Mowry Bridge. No mitigation is required.

Impact HY-6: Effects on Tide Level and Flow in Middle River at Tracy Boulevard Bridge. Figure 5.2-71 shows the 16-year period of monthly tidal levels and tidal flows in Middle River at Tracy Boulevard Bridge for the 2001 baseline and Alternative 2C Stage 2 conditions. The minimum tidal level for Alternative 2C Stage 2 was held at 0.0 feet msl in almost all months. The infrequent minimum level values of –1.0 foot msl are during months when the Middle River tidal gate was not operated. The tidal gate operations were assumed to be unnecessary when the San Joaquin River flow at Vernalis was greater than 2,500 cfs. The actual gate operations would maintain the water level above 0.0 feet msl, so that there would be no significant tidal level impact.

The maximum tidal flows under existing conditions are about 1,000 cfs upstream and downstream during the winter without any barriers. Maximum upstream (i.e., negative) tidal flows in Middle River at Tracy Boulevard Bridge under Alternative 2C Stage 2 are the same as under existing conditions, but the downstream tidal flows are eliminated by the gate operations in months when the tidal gates were simulated. The average tidal flows will be increased by about

200 cfs with the tidal gates and dredging of Middle River upstream of the Tracy Boulevard Bridge. This net upstream tidal flow is considered a benefit, and there are no significant tidal impacts in Middle River at Tracy Boulevard Bridge. No mitigation is required.

Impact HY-7: Effects on Tide Level and Flow in Grant Line Canal at Tracy Boulevard Bridge. Figure 5.2-72 shows the 16-year period of monthly tidal levels and tidal flows in Grant Line Canal at Tracy Boulevard Bridge for the 2001 baseline and Alternative 2C Stage 2 conditions. Because the minimum tidal level is maintained above 0.0 feet msl in all months for Alternative 2C Stage 2, there are no significant tidal level effects in Grant Line Canal at Tracy Boulevard Bridge. No mitigation is necessary.

Maximum tidal flows will be about 3,000 cfs to 4,000 cfs under Alternative 2C Stage 2 with tidal gates. The net downstream flow will be increased by about 500 cfs with the tidal gate operations. This represents the net circulation flows from Old River and Middle River that the tidal gates will produce. This is considered a benefit for water quality. There is no significant impact on tidal flows in Grant Line Canal at Tracy Boulevard Bridge. No mitigation is required.

2020 Conditions

The simulated tidal hydraulic impacts for Alternative 2C Stage 2 under 2020 conditions would be similar to those simulated for Alternative 2C Stage 2 under 2001 baseline conditions, because the simulated pumping patterns are similar (see Figure 5.2-68). The 2020 simulated tidal hydraulic results for Alternative 2C are available in an Excel file from the SDIP Web site.

Alternative 3B

Stage 1 (Physical/Structural Components)

Localized effects of cofferdams or temporary structures within the channels during construction of the tidal gates will not have any significant effects on tidal hydraulics. Alternative 3B does not include the Grant Line tidal gate. Construction and operation of the tidal gates will change the fluctuations in tidal level and flow in the south Delta channels. The Middle River and Old River tidal gates will be operated to close on most high tides and circulate water upstream to Grant Line Canal during ebb-tide periods. Because the Grant Line tidal gate is not being constructed under this alternative, water level will decline more rapidly during ebb-tide periods. The tidal level and tidal flow conditions in the south Delta channels under Stage 1 would be similar to those already shown for Stage 1 of Alternative 2A. Some differences in minimum tidal levels in Grant Line Canal are indicated because the Grant Line Canal tidal gate would not be constructed and operated. Simulated results for Stage 2 of Alternative 3B are shown below.

2020 Conditions

The tidal hydraulic effects during construction and operation of the tidal gates under 2020 conditions would be the same as those under 2001 conditions.

Stage 2(Operational Components)

Figures of the monthly range of tidal level and tidal flow are shown for four of the selected impact assessment locations. Tidal figures for other locations and for the DSM2 results for the 2020 simulations are available from the SDIP website. The simulated changes in south Delta tidal level and tidal flow conditions are primarily the result of constructing and operating the head of Old River fish control gate, and Old River at DMC and Middle River tidal gates. The tidal conditions would be very similar to those already shown for Stage 2 of Alternative 2B. Some differences in minimum tidal levels in Grant Line Canal are indicated because the Grant Line Canal tidal gate would not be constructed and operated.

Impact HY-1: Effects on Tide Level and Flow in Old River at State Route 4 Bridge. The simulated changes in the monthly tidal level in Old River at the SR 4 Bridge under Alternative 3B are small. The simulated changes in both the downstream and the upstream tidal flows are also relatively small under Alternative 3B conditions. The largest changes in the negative (flood-tide) flows are associated with the tidal circulation operation of the Old River at DMC gate and removal of the Grant Line temporary barrier in the summer.

Alternative 3B allows higher pumping in many months, but the minimum monthly stage in Old River at the SR 4 Bridge during these months is not lower than the baseline range of minimum tidal level of –1 to –2 feet msl. There are no significant tidal level or flow effects in Old River at the SR 4 Bridge from Alternative 3B. No mitigation is required.

Impact HY-2: Effects on Tide Level and Flow in Old River at Clifton Court Ferry. Figure 5.2-73 shows the 16-year period of monthly tidal levels and tidal flows in Old River at Clifton Court Ferry for the 2001 baseline and Alternative 3B conditions. The changes in tidal level are barely detectable on the graph. The minimum tide elevations were maintained at about –2 feet msl. The elimination of the Grant Line tidal gate under Alternative 3B cannot be detected in the modeling results in Old River at Clifton Court Ferry (i.e., tidal conditions look the same as for Alternative 2B—see Figure 5.2-64) at this station. There was an increase in the upstream tidal flow associated with the tidal circulation operation of the Old River near DMC tidal gate. There are no significant tidal effects in Old River at Clifton Court Ferry. No mitigation is required.

Impact HY-3: Effects on Tide Level and Flow in Old River at Tracy Boulevard Bridge. Figure 5.2-74 shows the 16-year period of monthly tidal levels and tidal flows in Old River at Tracy Boulevard Bridge for the 2001 baseline and Alternative 3B conditions. Baseline minimum tidal level was generally about 1.0 foot msl in the summer and –1.0 foot msl in the winter.

Alternative 3B would result in minimum tidal level of between 0.0 feet and -1 foot msl in almost all months. It is assumed that actual operation of the Old River gate will maintain the water level above the 0.0 feet msl objective. The tidal flows are shifted to a net upstream flow of about 250 cfs because of the tidal gate operation. This is considered to be a benefit for water quality. No mitigation is required.

Impact HY-4: Effects on Tide Level and Flow in Old River at the Head of Old River. The simulated changes in the tidal level at the head of Old River are relatively small. The reduction in diversions into Old River is considered to be beneficial for both water quality and fish protection. No mitigation is required.

Impact HY-5: Effects on Tide Level and Flow in Middle River at Mowry Bridge. The simulated changes in the maximum tidal level in Middle River at Mowry Bridge are relatively small. Because the minimum tidal level is maintained above 0.0 feet msl in all months under Alternative 3B, there are no significant tidal level effects in Middle River at Mowry Bridge.

The upstream tidal flushing flows in Middle River at Mowry Bridge would be increased under Alternative 3B because of the tidal circulation operation (i.e., closing gate during most ebb-tide periods) of the Middle River tidal gate. This is considered to be a benefit for water quality. No mitigation is required.

Impact HY-6: Effects on Tide Level and Flow in Middle River at Tracy Boulevard Bridge. Figure 5.2-75 shows the 16-year period of monthly tidal levels and tidal flows in Middle River at Tracy Boulevard Bridge for the 2001 baseline and Alternative 3B conditions. Baseline minimum levels were about 1 foot msl in the summer and –1.5 feet msl during the winter. Alternative 3B would result in a minimum tidal level of between 0.0 feet and –0.5 feet msl in most months. It is assumed that actual Middle River gate operations will maintain the water level above 0.0 feet msl. Upstream tidal flows will be increased by the tidal circulation operation of the Middle River tidal gate. This is considered to be a benefit for water quality. No mitigation is required.

Impact HY-7: Effects on Tide Level and Flow in Grant Line Canal at Tracy Boulevard Bridge. Figure 5.2-76 shows the 16-year period of monthly tidal levels and tidal flows in Grant Line Canal at Tracy Boulevard Bridge, for the 2001 baseline and Alternative 3B conditions. Baseline minimum tidal levels were held above 1 foot msl during the summer with the temporary barrier. The simulated minimum tidal levels were between –0.5 feet and –1.25 feet msl throughout the year because there would not be a tidal gate in Grant Line Canal under Alternative 3B.

Although the minimum tide elevations in Grant Line Canal would be below the SDIP objective of 0 feet msl, the actual impacts on local agricultural water supply are not expected to be significant. Because the agricultural diversion pumps in Grant Line Canal are relatively large with well-constructed pump platforms that allow the pump intakes to be located away from the levee banks, a minimum tide elevation of –1 foot msl is not expected to actually limit the continuous pumping from these pumps. Most of these pumps are downstream of the temporary barrier that is located near Tracy Boulevard Bridge, so they already experience these moderately low tidal levels (i.e., –1.0 feet msl) under existing conditions.

Tidal flow changes in Grant Line Canal at Tracy Boulevard Bridge under Alternative 3B were generally increased in the downstream direction because of the tidal circulation operation of the tidal gates in Old River at DMC and Middle River near Victoria Canal. This is considered to be a benefit for water quality (See Section 5.3), and a less than significant impact on tidal levels. No mitigation is required.

2020 Conditions

The simulated tidal hydraulic impacts for Alternative 3B under 2020 conditions would be similar to those simulated for Alternative 3B under 2001 baseline conditions, because the simulated pumping patterns are similar (see Figure 5.2-63). The 2020 simulated tidal hydraulic results for Alternative 3B are available in an Excel file from the SDIP Web site.

Alternative 4B

Stage 1 (Physical/Structural Components)

Localized effects of cofferdams or temporary structures within the channels during construction of the tidal gates will not have any significant effects on tidal hydraulics. Alternative 4B includes only the head of Old River fish control gate. Construction and operation of the head of Old River tidal gate will change the fluctuations in tidal level and flow within the south Delta channels. Because only the head of Old River fish control gate will be constructed, minimum water levels will be reduced in channels that are upstream of the temporary barriers. Simulated results for Stage 2 of Alternative 4B are discussed below.

2020 Conditions

The tidal hydraulic effects during construction and operation of the head of Old River gate under 2020 conditions would be the same as those under 2001 conditions.

Stage 2 (Operational Components)

Figures of the monthly range of tidal level and tidal flow are shown for four of the selected impact assessment locations. Tidal figures for other locations and for the DSM2 results for the 2020 simulations are available from the SDIP website. The simulated changes in south Delta tidal level and tidal flow conditions are primarily the result of constructing and operating the head of Old

River tidal gates. Some differences in minimum tidal levels in channel upstream of the temporary barriers are simulated.

Impact HY-1: Effects on Tide Level and Flow in Old River at State Route 4 Bridge. The simulated changes in the monthly tidal level in Old River at the SR 4 Bridge under Alternative 4B are small. The simulated changes in both the downstream and the upstream tidal flows are also small. There are no significant tidal level or flow effects in Old River at the SR 4 Bridge from Alternative 4B. No mitigation is required.

Impact HY-2: Effects on Tide Level and Flow in Old River at Clifton Court Ferry. Figure 5.2-77 shows the 16-year period of monthly tidal levels and tidal flows in Old River at Clifton Court Ferry for the 2001 baseline and Alternative 4B conditions. The changes in the minimum tidal level are small. The changes in simulated tidal flows under Alternative 4B were also small. Tidal flows were slightly greater during the summer because the temporary barrier in Old River at DMC was removed under Alternative 4B. No mitigation is required.

Impact HY-3: Effects on Tide Level and Flow in Old River at Tracy Boulevard Bridge. Figure 5.2-78 shows the 16-year period of monthly tidal levels and tidal flows in Old River at Tracy Boulevard Bridge for the 2001 baseline and Alternative 4B conditions. Alternative 4B resulted in minimum tidal level of between –1.0 and -1.5 feet msl.

Although the minimum tide elevations would be below the SDIP objective of 0 feet msl, the impacts on agricultural water supply are not expected to be significant. Because most of the agricultural diversion pumps in Old River are relatively large with well-constructed pump platforms that allow the pump intakes to be located away from the levee banks, a minimum tide elevation of -1.5 feet msl is not expected to actually limit the continuous pumping from these pumps.

The simulated tidal flows in Old River were generally increased because there are no agricultural barriers or gates in south Delta channels to limit the tidal flows. This impact is less than significant. No mitigation is required.

Impact HY-4: Effects on Tide Level and Flow in Old River at the Head of Old River. The simulated changes in the tidal level at the head of Old River are relatively small. No mitigation is required. The reduction in diversions into Old River is considered to be beneficial for both water quality and fish protection. No mitigation is required.

Impact HY-5: Effects on Tide Level and Flow in Middle River at Mowry Bridge. The minimum tidal level was not maintained above 0.0 feet msl in all months under Alternative 4B. However, SDIP will extend agricultural diversions that would be interrupted by these lower minimum water levels, so no actual reduction in agricultural water supply would occur under Alternative 4B. The simulated tidal flows in Middle River were generally increased because there are no agricultural barriers or gates in south Delta channels to limit the tidal flows. This is considered to be a less than significant impact. No mitigation is required.

Impact HY-6: Effects on Tide Level and Flow in Middle River at Tracy Boulevard Bridge. Figure 5.2-79 shows the 16-year period of tidal levels and tidal flows in Middle River at Tracy Boulevard Bridge for 2001 baseline and Alternative 4B conditions. Alternative 4B resulted in minimum tidal levels of between –1.0 and –1.5 feet msl.

Although the minimum tide elevations would be below the SDIP objective of 0 feet msl, the impacts on agricultural water supply are not expected to be significant because Middle River would be dredged and diversion pumps or siphons would be extended as part of Alternative 4B.

The simulated tidal flows in Middle River were generally increased because there are no agricultural barriers or gates in south Delta channels to limit the tidal flows. This is considered to be a less than significant impact. No mitigation is required.

Impact HY-7: Effects on Tide Level and Flow in Grant Line Canal at Tracy Boulevard Bridge. Figure 5.2-80 shows the 16-year period of monthly tidal levels and tidal flows in Grant Line Canal at Tracy Boulevard Bridge for the 2001 baseline and Alternative 4B conditions. Alternative 4B resulted in minimum tidal levels of between about –1.0 and -1.5 feet msl.

Although the minimum tide elevations in Grant Line Canal would be below the SDIP objective of 0 feet msl, the actual impacts on local agricultural water supply are not expected to be significant. Because the agricultural diversion pumps in Grant Line Canal are relatively large with well-constructed pump platforms that allow the pump intakes to be located away from the levee banks, a minimum tide elevation of –1.5 feet msl is not expected to actually limit the continuous pumping from these pumps. Most of these pumps are downstream of the temporary barrier that is located near Tracy Boulevard Bridge and already experience these low tidal levels under existing conditions.

The simulated tidal flows in the downstream direction were generally increased in the summer, because the temporary barriers that reduce tidal flows under baseline conditions are removed under Alternative 4B. This impact is less than significant. No mitigation is required.

2020 Conditions

The simulated tidal hydraulic impacts for Alternative 4B under 2020 conditions would be similar to those simulated for Alternative 4B under 2001 baseline conditions, because the simulated pumping patterns are similar (see Figure 5.2-63). These 2020 simulated tidal hydraulic results for Alternative 4B are available in an Excel file from the SDIP Web site.

5.3 Water Quality

Introduction

The maintenance of beneficial uses of Delta waters depends on several key water quality variables (e.g., salinity, water temperature, dissolved oxygen, and dissolved organic carbon) in Delta waters. This chapter describes these key water quality variables, the objectives associated with maintaining beneficial uses of Delta waters, existing Delta water quality conditions, and impacts of the SDIP project on selected water quality variables in Delta channels and exports. Information is also presented on the historical Delta water quality conditions to provide a context for assessing water quality effects of the No Action Alternative.

Exporting more water at SWP Banks could reduce Delta outflows and could increase salinity in Delta channels or exports. Higher exports may also shift the movement of water from the San Joaquin River and from agricultural drainage discharges in the Delta, so that more of these lower-quality waters may be exported at the CCWD intakes, or at CVP Tracy and SWP Banks. Two important variables that could be adversely affected are salinity and concentrations of dissolved organic carbon (DOC). Increases in DOC and salinity could indirectly increase trihalomethanes (THMs) and other disinfection by-products in treated drinking water supplies that are exported from the Delta. Dissolved oxygen (DO) concentrations in the San Joaquin River downstream of the Stockton DWSC may be affected by changes in flows that the SDIP facilities and pumping patterns may produce.

The impacts of salinity increases on water quality were assessed for Emmaton and Jersey Point. Salinity and DOC changes were evaluated at Old River at Rock Slough (representative of diversions at CCWD Rock Slough), Old River at SR 4 (Los Vaqueros intake) and SWP Banks and CVP Tracy. Salinity was evaluated in the south Delta channels upstream of the proposed tidal gates. Salinity was not assessed in the San Joaquin River downstream of the head of Old River at Brandt Bridge. Although this is a D-1641 salinity compliance location, the SDIP alternatives will not change salinity at Brandt Bridge substantially, because Brandt Bridge salinity is largely dependent on the upstream San Joaquin River salinity at Vernalis and the agricultural drainage that enters the river between Vernalis and Brandt Bridge. Because only a small amount of agricultural drainage is downstream of the head of Old River, reduced flows between the head of Old River and Brandt Bridge (about 6 miles) caused by SDIP head of Old River tidal gate operations will not have a substantial effect on the Brandt Bridge salinity. DO effects in the Stockton DWSC were evaluated indirectly through an analysis of the net flow changes caused by the SDIP facilities and shifted export pumping patterns.

The overall potential effects of SDIP tidal gate operations on salinity in south Delta channels and at the CCWD diversions and SWP and CVP pumping plants are described. The SDIP consists of several projects intended to improve water quality in the Delta, including two agricultural drainage management projects that are expected to reduce salinity at CCWD intakes. CCWD has agreed that these benefits will be considered along with the potential impacts from operating the tidal gates and pumping additional water at SWP Banks when judging the overall protection of water quality as described in the CALFED ROD.

All salinity impacts were found to be less than significant because changes would be within the large variations that are characteristic of the no action baseline conditions in the Delta. Salinity changes in many south Delta channels were found to be significantly beneficial, because the reductions were greater than 5% of the baseline value. These salinity benefits are the result of tidal gate operations that produce a tidal circulation of Sacramento River water that is drawn toward the CVP Tracy and SWP Banks. The changes in DOC at drinking water intakes were also found to be less than significant compared with the no action baseline conditions, which are dominated by high DOC during storm inflows and from Delta agricultural drainage. Because the SDIP would not change the DOC loading patterns, the simulated changes from shifting the Delta channel flows and the corresponding fraction of high DOC inflows (i.e., agricultural drainage, San Joaquin River) that are exported were found to be relatively small.

The changes in DWSC flows resulting from the SDIP alternatives would have a beneficial effect on the DO conditions in the Stockton DWSC during the summer, because the head of Old River tidal gate will be operated to reduce the diversions of San Joaquin River water into the south Delta channels. Water quality impacts under cumulative conditions would be similar to the direct and indirect impacts described for SDIP alternatives.

Summary of Significant Impacts

There are no significant impacts on water quality as a result of implementation of the project alternatives. Operation of the tidal gates provides substantial improvements in salinity in the south Delta channels. There are occasional slight increases in salinity occur in the CCWD intakes and at SWP Banks, but these are less than 5% of the baseline values. The water quality benefits are less under Alternative 4B, which includes constructing only the head of Old River gate.

Affected Environment

Delta waters serve several beneficial uses, each of which has water quality requirements and concerns associated with it. The Delta is a major habitat area for important 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 influence habitat and food-web relationships in the Delta are temperature, salinity, suspended sediments (SS) and associated light levels for photosynthesis, DO, pH, nutrients (nitrogen and phosphorus), DOC, and chlorophyll. Other key constituents that are monitored in water for municipal use are bromide (Br^-) concentrations (measured in raw water) and concentrations of THMs or other chemical by-products formed during the disinfection of water (measured in treated water).

Sources of Information

This chapter is supported by a technical appendix that provides an evaluation of available Delta water quality data and describes the DSM2 modeling methods and results used in this chapter. Technical Appendix D, "DSM2 Delta Tidal Hydraulic and Water Quality Modeling Methods and Results," describes the available Delta salinity (electrical conductivity, EC) data and the results of the DSM2 Delta tidal hydraulic and water quality modeling of Delta salinity conditions for the SDIP alternatives. DSM2 is the primary source of specific water quality impact assessment information.

Agency Water Quality Sampling Programs in the Delta

State and federal agencies have conducted various ongoing water quality sampling programs in the Delta. The following sections review studies that provided data on key water quality variables used for impact assessment of the SDIP alternatives.

Interagency Ecological Program of the Sacramento–San Joaquin Estuary

The Interagency Ecological Program (IEP), previously the Interagency Ecological Study Program (IESP), was initiated in 1970 by DWR, DFG, Reclamation, and USFWS to provide information about the effects of CVP and SWP exports on fish and wildlife in the Bay-Delta estuary. Other agencies (e.g., State Water Board, EPA, the Corps, and USGS) have joined IEP and provide staff members and funding to assist in obtaining biological, chemical, and hydrodynamic information about the Bay and Delta.

The fishery and water quality components of IEP were combined in 1985 to better coordinate investigations of the Delta food web. Further reorganization of IEP occurred in 1993. Fishery components of IEP were initially designed to document habitat requirements and general food-web relationships of estuarine and migratory species. Water quality components were focused on salinity and algal productivity (nutrient) effects.

Agencies participating in IEP conduct extensive programs of routine sampling, as well as more intensive special studies, in the Delta. IEP maintains its data in an extensive centralized database (California Department of Water Resources Interagency Ecological Program 2003) to allow access to and analysis of collected data. Annual IEP reports are issued, and newsletters and annual meetings provide participants and the interested public with timely information about study results.

Municipal Water Quality Investigations Program

DWR's Municipal Water Quality Investigations Program (MWQI) program encompasses the previous Interagency Delta Health Aspects Monitoring Program (IDHAMP) and Delta Island Drainage Investigations (DIDI). IDHAMP was initiated by DWR in 1983 to provide a reliable and comprehensive source of water quality information for judging the suitability of the Delta as a source of drinking water (California Department of Water Resources 1989). The major issue of concern was the potential formation of disinfection by-products such as THMs and bromate in treated drinking water from the Delta.

MWQI studies have documented that Delta exports contain relatively high concentrations of DOC, a THM precursor. Agricultural drainage discharges containing natural decomposition products of peat soil and crop residues are considered dominant sources of DOC in Delta waters (California Department of Water Resources 1994a). Additionally, DOC is contributed to Delta waters by Delta inflows.

The MWQI program has determined that Br^- in Delta water contributes significantly to formation of the THMs observed in treated drinking water from the Delta. Sources of Br^- in Delta water are seawater intrusion, San Joaquin River inflow containing agricultural drainage, and possible groundwater sources.

The Delta agricultural drainage component of the MWQI program has located and sampled discharge points of irrigation drainage water in the Delta since 1985. The program initially focused on Empire Tract, Grand Island, and Tyler Island, collecting monthly samples from agricultural drains on these islands. Several new monitoring stations were added to the program in 1987, allowing a much broader interpretation of patterns among islands with different soil and farming practices). In general, intensive surveys of agricultural drains on Delta islands have shown high DOC concentrations that may represent a significant contribution to DOC concentrations in Delta waters (California Department of Water Resources 1990a). The salt content of the drainage water is found to be greatest during October–March as a result of the leaching of salts from Delta island soils between growing seasons.

Monitoring Program for Delta Standards

D-1485 (State Water Resources Control Board 1978), issued by the State Water Board in August 1978, amended previous water right permits of DWR and Reclamation for the SWP and CVP facilities, respectively. D-1485 also set numerical water quality objectives and requirements for Delta outflow, export pumping rates, salinity as measured by EC, and chloride (Cl^-) to protect three broad categories of beneficial uses: fish and wildlife, agriculture, and municipal and industrial water supply. The standards included adjustments to reflect hydrologic conditions under different water-year types.

D-1485 required DWR and Reclamation to conduct comprehensive water quality monitoring of the Delta. Annual reports have been prepared on observed water quality conditions in the Delta and compliance with limits set in D-1485. Similar monitoring requirements are included in the 1995 WQCP (Implemented in D-1641). DWR and Reclamation are responsible for adjusting their operations to satisfy the applicable objectives. Most of these stations have continuous EC monitors; others are sampled routinely for chemical and biological measurements. D-1641, which updates the D-1485 monitoring program, is the current State Water Board water rights decision controlling CVP and SWP Delta operations. Photograph 5.3-1 shows the EC monitoring station at Collinsville, located upstream of the Montezuma Slough entrance to Suisun Marsh. Collinsville is the most upstream location for X2 (2 ppt salinity) that is regulated in the 1995 WQCP and D-1641.

EC monitors at Jersey Point and Emmaton are especially important for managing the linkage between upstream reservoir releases (i.e., Delta inflows) and export pumping limits needed to satisfy Delta water quality objectives. The CVP and SWP operations staffs have access to telemetered data from these and several other EC monitors. The DWR SWP Operations Compliance and Studies Section prepares and distributes a daily report of data on flows and EC to assist in decision making on Delta water project operations. Photograph 5.3-2 shows the EC monitoring station on Old River at the head of Middle River (Union Island), operated by Reclamation. This station indicates the salinity of water from the San Joaquin River as it flows toward the export pumps.

Clean Water Act Section 305(b) Water Quality Impairment Reports

The State Water Board, in fulfilling requirements of Section 305(b) of the CWA, prepares biennial reports on water quality conditions in California. The State Water Board’s 1986 report first identified approximately 40 miles of the lower San Joaquin River from Vernalis to Stockton as a segment that did not fully support fishery-related designated uses because of water quality limitations. Several recent reports have listed the 14-mile Stockton to Turner Cut reach as water-quality limited for DO. A total maximum daily load (TMDL) staff report has been prepared by Sacramento Valley RWQCB staff and submitted to EPA (Central Valley Regional Water Quality Control Board 2003).

The RWQCB provided an opportunity for a TMDL steering committee and research effort to begin in 1999. CALFED funding has been used to complete several monitoring and evaluation studies related to this DO impairment. Results from these studies have been used to evaluate SDIP effects on Stockton flow and DO conditions.

Delta Water Quality Issues

Water quality requirements and concerns are associated with each beneficial use of Delta water. Beneficial uses include agriculture, municipal (e.g., drinking) and industrial water supply, fish and wildlife, and recreation (State Water Resources Control Board 1975). Water is diverted for agricultural crop and livestock production at more than 1,800 siphons. Drainage water is returned to the Delta through pumping stations operated independently by farmers and reclamation districts.

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 M&I users and also some wildlife uses (water supply for refuges). 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.

Photograph 5.3-3 shows an aerial view of the mouth of Rock Slough at Old River, west of Bacon Island. Photograph 5.3-4 shows the mouth of Rock Slough looking across Old River from above Bacon Island. Photograph 5.3-5 shows an aerial view of the center section of Rock Slough, with Indian Slough connecting to the south and San Mound Slough connecting to the north. Photograph 5.3-6 shows the head of San Mound Slough. A dam with tidal flap-gates was installed here to protect the CCC water supply from seawater intrusion from Dutch Slough. At the western end of Rock Slough, the CCC, constructed by Reclamation as part of the CVP, diverts water to Pumping Plant #1, located about 4 miles northwest at Oakley (See Photograph 5.2-9). The CCC is about 50 miles long and supplies water to Antioch, Pittsburg, Concord, and other Contra Costa County towns.

Photograph 5.3-7 shows the CCC Pumping Plant #1, located in Oakley. CCWD operates two water treatment plants along the CCC. The Randall-Bold treatment plant uses pre- and post-ozonation to disinfect and remove organic compounds from the Delta diversions. Photograph 5.3-8 shows the sedimentation basins and Mallard Reservoir at the Bollman treatment plant, located in Concord near the western end of the CCC. The Bollman treatment plant was recently (1999) converted to ozonation as the disinfection process to reduce the formation of disinfection by-products (i.e., THMs).

Recognized Delta water quality issues include the following:

- High-salinity water from Suisun Bay intrudes into the Delta during periods of low Delta outflow. Salinity adversely affects agricultural, municipal, recreational, and industrial uses.
- Delta exports contain elevated concentrations of disinfection by-product precursors (e.g., DOC), and the presence of Br^- increases the potential for formation of brominated compounds in treated drinking water.

- Agricultural drainage in the Delta contains high levels of nutrients, SS, DOC, and minerals (salinity), as well as traces of agricultural chemicals (pesticides).
- Synthetic and natural contaminants have bioaccumulated in Delta fish and other aquatic organisms. Synthetic organic chemicals and heavy metals are found in Delta fish in quantities occasionally exceeding acceptable standards for food consumption.
- The San Joaquin River delivers water of relatively poor quality to the Delta, with agricultural drainage to the river being a major source of salts and pollutants (i.e., boron, selenium, pesticides). Because the south Delta receives a substantial portion of its water from the San Joaquin River, the influence of this relatively poor San Joaquin River water quality is greatest in the south Delta channels and in the SWP and CVP exports.

Photograph 5.3-9 shows a siphon diversion pipe that supplies irrigation water to the Delta agricultural islands (or tracts) that are lower than the channel water surface elevation. Many Delta agricultural diversions now use pumps. Either method of diversion results in some of the water returning to the channels during the irrigation season. Salt-leaching from the fields occurs naturally during the rainy season, or may be managed by applying water in the fall or winter to maintain the soil salinity within acceptable bounds. Photograph 5.3-10 shows a relatively large agricultural drainage pump station that drains the entire 3,500-acre Twitchell Island. All of the Delta islands and tracts use drainage pumping stations. Stormwater runoff as well as seepage during the winter is pumped off the Delta islands into the Delta channels using these pump stations.

Delta Water Quality Variables

Water quality conditions in the Delta are influenced by natural environmental processes, water management operations, and waste discharge practices. The SDIP would shift water management in the Delta and thus would influence Delta water quality. This section describes water quality variables that might be affected by SDIP operations and identifies several variables 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 are therefore discussed qualitatively. Variables that have not been identified with current problems in the Delta and those that are not likely to be affected by SDIP operations were not selected as impact assessment variables.

Delta water quality conditions can vary dramatically because of year-to-year differences in runoff and water storage releases, and seasonal fluctuations in Delta flows. Concentrations of materials in the river inflows 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 cooling water flows. An accurate assessment of possible Delta water quality effects therefore requires consideration of the patterns of Delta channel tidal and net flows (see Section 5.2, Delta Tidal Hydraulics). Net channel flows are used to evaluate potential water quality impacts, such as salinity impacts from changes in Delta outflow and DO impacts from changes in the DWSC flows.

Temperature

Temperature governs rates of biochemical processes and is considered a major environmental factor in determining organism preferences and behavior. Fish growth, activity, and mortality are related to temperature. The maximum (saturated) concentration of DO in water is lower at higher temperatures.

Water temperatures are determined predominantly by surface heat exchange processes, which are a function of weather. Delta temperatures are only slightly influenced by water management activities. The most common environmental impacts associated with water temperatures are localized effects of discharges of water at substantially elevated temperatures. Temperature measurements from the temporary barriers program in the south Delta are used to qualitatively discuss the small changes that are expected from the SDIP. In comparison to the no action conditions that include the temporary barriers during the summer, no significant temperature impacts are expected from the SDIP alternatives.

Suspended Sediments

The presence of SS (often measured as turbidity) is a general indicator of surface erosion and runoff into water bodies or resuspension of bottom sediment materials. Following major storms, water quality is often degraded by inorganic and organic solids and associated adsorbed contaminants, such as metals, nutrients, and agricultural chemicals that are resuspended or introduced in runoff. Such runoff and resuspension episodes are relatively infrequent, persist for only a limited time, and, therefore, are not often detected in regular sampling programs.

The attenuation of light in Delta waters is controlled by SS concentrations (with some effects from chlorophyll). SS concentrations are often elevated in the entrapment zone as a result of increased flocculation (i.e., aggregation of particles) in the estuarine salinity gradient. High winds and tidal currents also contribute to increased SS in the estuary. The SDIP would not change these storm-related and entrapment zone effects of SS and associated contaminants.

Dissolved Oxygen

DO is often used as an indicator of the balance between sources of oxygen (e.g., aeration and photosynthesis) and the consumption of oxygen in decay and respiration processes. The DO saturation concentration changes with temperature, and DO concentration often varies diurnally. DO concentrations in

Delta channels are not generally considered to be a problem, except near Stockton and in some dead-end sloughs. Low DO in the DWSC is attributed to low flows, high organic loading, and deep channel geometry. However, DO impacts from SDIP alternatives are evaluated qualitatively, based on simulated changes in the DWSC flow and the historical flow-DO relationships observed in the DWSC.

Electrical Conductivity

EC is a general measure of dissolved minerals (i.e., salinity) and is the most commonly measured variable in Delta waters. Several water quality objectives have been established for EC values at specific locations in the Delta. High salinity can have a detrimental effect on agricultural production and can cause unpleasant taste and health concerns in drinking water. EC is generally considered a conservative parameter, not subject to sources or losses internal to a water body. Therefore, changes in EC values can be used to interpret the movement of water and the mixing of salt in the Delta. EC values increase with evaporation, decrease with rainfall, and may be elevated in agricultural drainage flows in the Delta. Because EC changes with temperature, Delta EC measurements are standardized to 25°C.

Seawater intrusion from the modeled downstream boundary of the Delta at Martinez (i.e., Benicia) has a large effect on salinity in the Suisun Bay portion of the estuary. The estuarine entrapment zone, an important aquatic habitat region associated with high levels of biological productivity, is defined by the mean daily EC range of about 2–10 milliSiemens per centimeter (mS/cm) (Arthur and Ball 1980). The location of the estuarine salinity gradient and associated entrapment zone is estimated from EC monitoring data and is directly related to Delta outflow. D-1641 includes objectives for the location of the 2 ppt salinity gradient in the estuary, which is measured with a series of EC stations (i.e., Collinsville, Mallard Slough, Port Chicago). The SDIP alternatives may shift the Delta outflow and thereby change the EC at Emmaton or Jersey Point. Salinity in the south Delta channels and export locations may change if the channel flows shift and transport different portions of San Joaquin River or agricultural drainage to the export locations.

Dissolved Minerals

Determining concentrations of specific anions or cations may be important for particular water uses. Cl^- and Br^- concentrations are important in evaluating domestic water supply quality, and sodium concentration is important for both agricultural and domestic water quality. The ratio of Cl^- to EC (using units of mg/l for Cl^- and microSiemens per centimeter [µS/cm] for EC) can be used to distinguish between sources of water from different inflows (e.g., Sacramento River, San Joaquin River, and seawater) sampled at different Delta locations.

SDIP operations would influence relative contributions of water from different Delta inflow sources. Therefore, the project could affect mineral concentrations in the Delta. EC is the only surrogate mineral variable evaluated. DSM2 was used to simulate EC values throughout the Delta. These EC simulations were compared with historical EC measurements and were then summarized to provide estimates of salinity impacts of the SDIP alternatives.

Dissolved Organic Carbon

DOC concentration is one of the primary variables that influence the potential for formation of disinfection by-products. The most common disinfection by-products are THM compounds formed during chlorination of DOC in drinking water supplies. EPA established a maximum contaminant level (MCL) of 80 micrograms per liter (µg/l) or parts per billion (ppb) for THMs in finished (treated) drinking water. DOC has been found by MWQI to be the major fraction of total organic carbon (TOC), which includes particulate organic carbon. DOC is generally considered to be conservative (non-reactive) once introduced into the Delta channels.

THM levels in drinking water can be reduced through the use of alternatives to chlorination in treating water for human consumption (e.g., ozonation or chloromines), although other potentially harmful compounds may be formed during these other disinfection processes. Disinfection itself is being more carefully regulated by EPA to avoid problems from various pathogens (i.e., viruses). Reducing DOC concentrations in raw water before chlorination with flocculation or granular activated carbon adsorption can reduce all disinfection by-product levels, but may be quite expensive.

Another disinfection by-product associated with ozone treatment is bromate. Bromate is formed during ozonation in the presence of Br^- ions. Bromide is directly proportional to the chloride concentration, and so a slight increase in bromate may occur if the salinity is increased in a drinking water source.

Minimizing DOC and salinity (i.e., Br^-) concentrations in the raw water source is therefore a major water quality goal for drinking water uses. SDIP may indirectly influence DOC concentrations in Delta exports by shifting the fraction of San Joaquin River and agricultural drainage that is diverted or exported. DOC was selected as a variable for impact assessment. DSM2 was used to estimate the potential impacts of SDIP operations on export DOC concentrations.

Water Quality of Delta Inflows and Exports

Concentrations of many water quality constituents are often higher in Delta exports than in Sacramento River inflow. Possible sources of water quality constituents in the Delta are seawater intrusion, inflows from the San Joaquin

River and eastside streams, biological production in Delta channels, agricultural drainage from Delta islands, and wastewater treatment plant effluents.

Historical water quality data from the Delta inflows (Sacramento and San Joaquin Rivers) and the export locations (CCWD Rock Slough, SWP Banks, and CVP Tracy) were used to characterize Delta water quality and to confirm the simulations of historical EC conditions performed using DSM2. Selected historical water quality data are briefly summarized in the following sections.

Temperature and Suspended Sediments

USGS operates monitoring stations for daily measurements of temperature and SS on the Sacramento River at Freeport and on the San Joaquin River at Vernalis. Data from these measurements indicate the seasonal and storm-event patterns of temperature and SS.

DWR operates a series of water quality stations in the Delta channels that records hourly water temperatures. Figure 5.3-1 shows daily average temperatures at several south Delta locations for calendar year 2000 and 2001. The temperatures in the DWSC are the least variable because of the channel is relatively deep. Temperature variations in the Old River and Middle River (California Department of Water Resources data) are similar to the temperatures entering the Delta at Mossdale. Variations in the water temperatures in the San Joaquin River and in the south Delta channels are primarily controlled by meteorological conditions. The SDIP changes in south Delta channel flows are not expected to modify these temperature patterns, because they are dominated by meteorological conditions.

Figure 5.3-2 shows SS in the San Joaquin River at Vernalis and corresponding daily turbidity measurements in the south Delta channels during 2000 and 2001. The SS concentrations at Vernalis are highest (i.e., greater than 100 mg/l) during the beginning of storm runoff periods, and turbidity generally declines in the south Delta channels following these storms. At relatively low SS concentrations (i.e., fine particle size) the SS (mg/l) and turbidity values are assumed to be similar. Tidal flow velocities in the south Delta may resuspend fine particles and maintain elevated turbidity. The average turbidity in the south Delta channels ranges from 25 nephelometric turbidity units (NTU) to 75 NTU. Over time, there is a considerable deposition of sand and coarse sediment in the south Delta channels and inside CCF, where velocities are relatively low (see Section 5.4, Flood Control, for additional discussion of storm event sediment and deposition).

Electrical Conductivity Data

Figure 5.3-3 shows monthly average EC measurements from the Sacramento River at Greene’s Landing (i.e., downstream of Freeport) for water years 1968–1991. Average EC is generally in the range of 100–200 µS/cm. Sacramento River EC measurements decrease with higher flows, exhibiting a typical flow-dilution relationship that can be approximated with the following equation, estimated from the 1968–1991 monthly data:

$$\text{Sacramento River EC } (\mu\text{S/cm}) = 5{,}000 * \text{flow (cfs)}^{-0.35}$$

The equation predicts that EC values would be greater than 200 µS/cm only when Sacramento River flows are less than 10,000 cfs. Some measured values were greater than 200 µS/cm when flows were higher than 10,000 cfs because of variations in the sources of minerals (EC) in the Sacramento River watershed.

Figure 5.3-4 indicates that EC measurements from the San Joaquin River at Vernalis also generally decrease with increases in flow, exhibiting a flow-dilution relationship. The monthly average EC values for the San Joaquin River are usually higher than EC values for the Sacramento River, with typical values varying between 200 µS/cm and 1,000 µS/cm. The San Joaquin River EC can be approximated with the following equation, estimated from the historical monthly data:

$$\text{San Joaquin River EC } (\mu\text{S/cm}) = 25{,}000 * \text{flow (cfs)}^{-0.5}$$

Several San Joaquin River monthly average EC values above 1,000 µS/cm were observed during winter. These values are higher than EC values estimated with the flow-dilution equation. For impact assessment purposes, however, a similar flow-regression equation was used in CALSIM to estimate monthly San Joaquin River EC values. Because the simulated inflows will be different from historical inflows (because of differences in reservoir operations and diversions), the historical EC values cannot be used directly.

Concentrations of Dissolved Organic Carbon

DOC concentrations in Sacramento River inflow are generally the lowest measured in the Delta, usually approximately 2.0 mg/l. Sacramento River DOC concentrations sometimes exceed 3.0 mg/l, however, as the result of the presence of DOC material in surface runoff. DOC concentrations in the San Joaquin River generally range between 3.0 mg/l and 6.0 mg/l and are therefore higher than Sacramento River DOC concentrations.

Figure 5.3-5 shows the daily measurements of TOC and DOC for 2003 from the Sacramento River at Hood (downstream from Freeport flow gage) and from SWP Banks in the south Delta. These measurements are made with two automated instruments operated by DWR and are the daily average of hourly data. The TOC and DOC measurements in the Sacramento River were highest in December–March and again in December, perhaps because of elevated flows (i.e., runoff) carrying TOC and DOC loads from the watershed (i.e., vegetative materials). The TOC averaged 0.5 to 1.0 mg/l higher than DOC. The summer DOC values were generally between 1 mg/l and 2 mg/l in the Sacramento River.

The TOC was about 0.5 to 1.0 mg/l higher than the DOC measured at SWP Banks. The DOC was highest (4 to 6 mg/l) in the January-February period, and lowest (3 to 4 mg/l) during the summer. DOC values were apparently just 2 to 3 mg/l in October and November, although the discontinuity between September and October is unexplained. The San Joaquin River flow at Vernalis is shown to indicate that the contribution of flow from the San Joaquin River was relatively constant during 2003, without any major runoff events. Previous DOC measurements from the San Joaquin River (no daily DOC data are available for 2003) are generally higher than the Sacramento. The contribution from Delta island drainage is generally implied from the higher DOC concentrations at SWP Banks than at Hood.

Flow regressions were estimated for assumed river inflow concentrations of DOC using available data and were used to calculate inflow DOC concentrations for DSM2 (See Appendix D). These estimated river inflow DOC concentrations did not change for the different SDIP operational scenarios.

San Joaquin River and South Delta Salinity

Because salinity in the south Delta channels is a very important water quality issue, some recent historical salinity (EC) measurements from the south Delta are shown and described here.

Figure 5.3-6 shows daily EC values for the San Joaquin River at Vernalis and in the south Delta at Old River near the Tracy Boulevard Bridge and in Middle River at Howard Road Bridge. The EC at Vernalis shows a definite dilution effect as flow rises, indicating that the source of salinity from the San Joaquin River watershed (i.e., agricultural drainage) does not change rapidly with storm runoff. The daily EC values at Vernalis are generally less than 750 µS/cm during the summer irrigation season, and are usually less than 1,000 µS/cm for the remainder of the year. The south Delta EC values are higher than the Vernalis EC because additional salinity from agricultural drainage enters the south Delta channels downstream of Vernalis. Additional salt is added by the Stockton wastewater treatment plant discharge near the Stockton DWSC and by the Tracy wastewater discharge into Old River.

The 1995 WQCP salinity objectives at Vernalis (incorporated in D-1641) specify that the maximum EC will be 700 µS/cm during the irrigation season of April–August (30-day moving average). The maximum EC objective is 1,000 µS/cm during the remainder of the months. Releases from New Melones Reservoir are used by Reclamation to control the salinity at Vernalis, but there is a maximum specified volume of water reserved for this purpose. CALSIM attempts to meet the EC objectives, but because the salinity control water volume may be depleted at the end of the water year, the simulated Vernalis EC is often higher than the 1,000 µS/cm objective in September. The SDIP alternatives are not expected to change the San Joaquin River flows and therefore would not affect the Vernalis EC values.

D-1641 also specifies a maximum 30-day running average of 1,000 µS/cm at three south Delta locations—San Joaquin River at Brandt Bridge (located 6 miles downstream of the head of Old River), Old River at Middle River (Union Island), and Old River at Tracy Boulevard Bridge. D-1641 states (footnote [5] to Table 2 of D-1641) that the 700-µS/cm objective for April-August applies at these three south Delta locations beginning in April 2005. The footnote also states

> The 0.7 EC objective is replaced by the 1.0 EC objective from April through August after April 1, 2005 if permanent barriers are constructed, or equivalent measures are implemented, in the southern Delta and an operations plan that reasonably protects southern Delta agriculture is prepared by DWR and the USBR and approved by the Executive Director of the SWRCB.

The existing objective of 700 µS/cm for April-August and 1,000 µS/cm for September–March will be used for impact assessment at these locations.

Because the salinity at these three south Delta locations is governed largely by the San Joaquin River salinity at Vernalis, violations of the EC objective at Vernalis may cause similar violations at these south Delta locations. The SDIP alternatives would have some ability to provide slightly lower EC water (i.e., Sacramento River water moving across the Delta to the CVP and SWP export pumps) to the channels upstream of the tidal gates on Old River, Middle River, and Grant Line Canal, but cannot influence the Brandt Bridge EC values. Brandt Bridge EC values are slightly higher than Vernalis EC during low-flow periods, because of the influence of agricultural drainage to the San Joaquin River between Vernalis and Brandt Bridge. Because most of this drainage is located upstream of the head of Old River, SDIP changes in the San Joaquin River flows downstream of the head of Old River will not have any substantial effect on the Brandt Bridge EC.

The potential indirect effects of the SDIP providing increased CVP deliveries that would add to the salt load at Vernalis were considered in the CALSIM salinity estimates at Vernalis that were used in DSM2. However, most of the additional CVP deliveries would be made to the CVP San Luis Unit contractors (e.g., Westlands Water District). Most of the CVP deliveries to water districts along the San Joaquin River are DMC exchange contractors who already receive their full allocation of Delta water in almost all water years. Changes in the Vernalis EC estimates caused by the SDIP were negligible.

San Joaquin River and Stockton Dissolved Oxygen

Because the DO concentrations in the DWSC and other south Delta channels are a very important water quality issue, some recent historical DO measurements from the San Joaquin River at Mossdale, Stockton DWSC, and other south Delta channels are shown and described here.

Figure 5.3-7 shows the daily average DO concentrations in the San Joaquin River at Mossdale and in the Stockton DWSC for 2000 and 2001. DO concentrations from other south Delta locations are also shown. The DO concentrations in the San Joaquin River upstream of Mossdale are generally near DO saturation values (i.e., minimum of about 8 mg/l at 25ºC), because the re-aeration from the river turbulence is strong enough to maintain relatively high DO concentrations. The DO concentrations in the Stockton DWSC are generally the lowest, with several episodes of DO concentrations of less than 5 mg/l.

The causes of these low DO episodes in the DWSC have been under investigation by the CVRWQCB and the San Joaquin River DO TMDL steering committee for the past several years (Central Valley Regional Water Quality Control Board 2003). Because reduced flows are thought to be one of the primary factors influencing low DO in the DWSC, the potential impact of SDIP alternatives on DO in the DWSC were evaluated. The SDIP alternatives may influence the flow in the DWSC and could therefore impact DO concentrations.

The DO measured in south Delta channels was generally higher than in the Stockton DWSC, although several episodes of reduced DO were recorded. Because the tidal flow velocities in the south Delta channels are relatively high, the severe DO depletion that has been measured in the DWSC is not expected to occur regularly in the south Delta channels.

Environmental Consequences

Assessment Methods

SDIP project operations may cause water quality effects in the Delta by three primary mechanisms:

- Increased SWP Banks pumping may produce lower Delta outflow and thereby increase the concentrations of EC levels and mineral constituents, such as Cl^- and Br^- that are associated with salinity intrusion from Suisun Bay.
- SDIP changes in exports or operation of tidal gates in the south Delta may change the mixture of San Joaquin River water and agricultural drainage in south Delta channels, which might change the EC levels and concentration of water quality constituents, such as Cl^-, Br^-, and DOC at municipal and agricultural diversions and export locations.
- SDIP changes in San Joaquin River flows moving past the head of Old River into the Stockton DWSC may cause changes in the concentrations of DO in the portion of the DWSC near Stockton. This portion of the DWSC is identified by the RWQCB as being out-of-compliance with the DO objective, which is 5 mg/l from December to August, and 6 mg/l from September through November (to protect migrating adult Chinook salmon). A technical TMDL report has been submitted to EPA describing the major reasons for the low DO conditions; low river flow has been identified as one of the major causes for the low DO.

This section provides an overview of the application of DSM2 for the water quality impact assessment of the SDIP alternatives. DSM2 provides an accurate simulation of the Delta channel tidal flows, which allows the accurate simulation of salt transport and mixing in the Delta.

The DWR-Reclamation CALSIM was used to determine likely future monthly Delta inflows and exports associated with the baseline and the SDIP 8,500 cfs pumping alternatives. DSM2 was used to simulate tidal and net channel flows in the major Delta channels for a 16-year sequence of water years 1976–1991. The DSM2 water quality module was used to simulate EC and DOC for this same 16-year sequence. These water quality results are described and compared in this chapter. Appendix D provides more details about the assumptions used for the DSM2 water quality (EC and DOC) modeling of SDIP alternatives.

There are many unpredictable processes and events that may affect water quality in the Delta that are not simulated with DSM2 to identify likely effects of the SDIP tidal gates and increased SWP Banks pumping patterns. Examples of unpredictable factors that are expected to influence Delta water quality conditions include occasional periods of relatively high-salinity pulses of San Joaquin River inflows, intensive agricultural salt leaching following periods of drought, and short-term increases in DOC concentrations in storm runoff. These short-term fluctuations in water quality are expected to occur with or without the SDIP, and are therefore not considered environmental impacts from the SDIP.

Methods for Assessing Impacts on Salinity

There are extensive historical EC data from about 20 Delta locations. These measurements allow the Delta water quality model to be calibrated and tested. Comparisons of EC data and DSM2 simulation results are described in detail in Appendix D. The simulated end-of-month EC patterns are quite similar to the patterns of measured mean monthly EC at most of the available measurement locations most of the time. There is some variation between the simulated and measured average monthly EC patterns because the model simulations use mean monthly flows and exports rather than the actual daily flows. During periods of salinity intrusion caused by low Delta outflow, there are additional differences between measured and simulated EC patterns caused by uncertainties in estimated Delta channel depletion and the corresponding estimates of Delta outflow.

DSM2 simulates the 15-minute variations in EC that are caused by tidal flows in the Delta. It is expected that neither these short-term tidal variations nor short-term extreme conditions would be changed by the SDIP operations. Only the monthly (i.e., seasonal) patterns of EC and other water quality variables are expected to be shifted slightly by the SDIP operations.

DSM2 was used to simulate the mean monthly contributions of each Delta inflow source (Sacramento and San Joaquin Rivers, Yolo Bypass and eastside streams, agricultural drainage, and tidal mixing from the downstream model boundary) at selected Delta channel and export locations. These simulated mean monthly source contribution percentages (called “fingerprinting” of sources in

Appendix D) are summarized and used to help interpret the water quality patterns simulated at various Delta locations.

Water quality impacts of salinity increases related to the operational component of the SDIP alternatives were assessed for several selected locations in the Delta. Impacts were measured based on changes in the monthly EC values compared to the monthly values simulated for the No Action Alternative. The monthly EC results for the 1976–1991 period simulated by DSM2 are used for all of the locations

Figure 5.3-8 shows the DSM2 EC boundary conditions for the San Joaquin River at Vernalis for the 1976–1991 period compared to the historical EC measured at Vernalis during the same period. The relationship between EC and flow at Vernalis is generally matched with the DSM2 boundary EC conditions that are actually obtained from CALSIM. However, the historical monthly pattern of EC, which is generally highest in the winter months, was not always reproduced in the CALSIM-estimated EC values that were used in the DSM2 modeling. The DSM2 Vernalis boundary conditions show highest EC values in the months of August and September, apparently because the CALSIM-simulated salinity control account in New Melones Reservoir is depleted. CALSIM results (used in DSM2) show several years with a violation of the 1,000-µS/cm EC objective at Vernalis in September. Recent technical work by Reclamation on the Vernalis salinity estimates in CALSIM may resolve this issue. The high Vernalis EC from CALSIM produces a subsequent problem in DSM2 simulations of the SDIP alternatives, because the simulated complete closure of the head of Old River fish control gate in October and November tends to trap high EC water in the south Delta channels. Violations of the south Delta EC objectives that may be simulated in the baseline conditions are not considered to be an impact from the SDIP if the cause was the high Vernalis EC.

Methods for Assessing Impacts on Dissolved Organic Carbon

The simulated effects of SDIP alternatives on DOC concentrations depend on the estimated inflow concentrations and inflow source contributions, and on the assumed sources of DOC from Delta agricultural drainage. The likely effects of DOC and Br^- concentrations on THM or bromate concentrations in drinking water were considered when selecting impact assessment criteria for DOC and EC changes.

The DWR MWQI program has collected water samples from Delta channel, export, and agricultural drainage locations. The MWQI program measurements are the primary water quality measurements used to estimate changes in DOC between the Delta inflows and the Delta export locations and the contribution of DOC from Delta agricultural drainage. DSM2 simulations of EC and DOC were used directly to estimate changes in EC and DOC at the SWP, CVP, and CCWD export locations.

Because there are no measurements of agricultural drainage flows in the Delta, the MWQI measurements of DOC concentrations cannot be used directly to estimate the relative contributions of DOC from Delta agricultural land. Possible contributions of DOC from crop residue, wetlands plants, and peat soil leaching have not been directly measured. Several water quality experiments have been conducted to estimate these potential DOC source contributions for impact assessment purposes (Marvin Jung and Associates 1999). Results of these experiments are incorporated into the Delta Island Consumptive Use module of DSM2, which includes assumed monthly drainage volumes for each node in the model along with monthly estimates of drainage EC and DOC concentrations. These assumed drainage flows and EC values and DOC concentrations (see Appendix D) are assumed to hold constant between the 2001 and 2020 baselines, and to be the same for all SDIP alternatives. SDIP alternatives may, however, shift the contributions from the agricultural drainage DOC sources at the water supply intakes.

Methods for Assessing Impacts on Dissolved Oxygen

The simulated effects of SDIP alternatives on DO concentrations in the Stockton DWSC depend on the DSM2 simulated Stockton flows. The lower San Joaquin River is listed by the CVRWQCB as a Clean Water Act Section 303 impaired water body. The CVRWQCB initiated the preparation of a TMDL analysis in early 1999 and organized a forum for stakeholder involvement. A substantial amount of data collection has been conducted through CALFED stakeholders and funding.

The CVRWQCB has produced a series of reports on the Stockton DWSC low DO problem (Central Valley Regional Water Quality Control Board 2002). This report includes a comprehensive analysis of the seasonal data collected in the fall by DWR (boat surveys) and by the City of Stockton (NPDES weekly compliance monitoring) as well as the hourly data collected by DWR at the Rough & Ready Island water quality monitoring station since 1983. The tidal flow at Stockton has been measured by a UVM device since 1995.

Daily minimum DO concentrations from each of these data sources from 1996 to 2001 correlated with flow (during the late-summer and fall period). The general relationship suggests that the DWSC minimum DO concentration will increase as the flow is increased to about 1,500 cfs. The average DO increase is apparently about 0.15 to 0.20 mg/l for each 100 cfs of increased flow.

For impact evaluation purposes, the assumed change in DO is 0.2 mg/l for each 100-cfs increase in flow. A reduction in DO of 0.2 mg/l will also be assumed for any 100-cfs reduction in flow, within the range of 0 cfs to 1,500 cfs of Stockton flow. The DO concentration at a flow of 1,500 cfs is estimated from the available data to be about 6.0 mg/l. A flow of 1,000 cfs will therefore correspond to a minimum DO of about 5.0 mg/l. A flow of 500 cfs will correspond to a minimum DO of 4.0 mg/l. A monthly summer flow of 0 cfs is assumed to produce a DO of just 3.0 mg/l.

There are several other sources of variation for the DO in the DWSC (see Figure 5.3-7), but this simple DO trend-line with flow will be used for this preliminary evaluation of SDIP alternatives on Stockton DWSC DO concentrations. A general review of the factors affecting low DO in the DWSC prepared for the San Joaquin River-DO TMDL technical advisory committee (Van Nieuwenhuyse 2002) found only a weak correlation with flow when the entire period of monthly average DO and monthly flow were evaluated with multiple-regression. A separation of the summer-fall data might have provided a stronger relationship with flow. The assumed impacts may be slightly larger than actual measured impacts as a result.

Methods for Assessing Impacts Attributable to Dredging Activities

Based on information from hydraulic dredging and suspended sediment measurements (Hayes et al. 2000), less than 0.1% of the dredged sediment mass or any constituent mass measured in the dredged sediment (or pore water) would be introduced into the water column during dredging operations. Figure 5.3-2 shows that the existing turbidity values (assumed similar to suspended sediment concentrations) in the south Delta channels are between about 25 NTU and 50 NTU throughout the year. Mass-balance calculations of the likely effects from SDIP dredging operations suggest that the background turbidity values would not be elevated substantially by hydraulic dredging operations. Dredging operations will have appropriate permits that will identify monitoring requirements and allowable turbidity and other water quality changes.

Analytical Approach and Impact Mechanisms

Assessment of water quality impacts requires establishing a point of reference with which conditions under SDIP alternative pumping and tidal gate operations can be compared. The two points of reference used for the assessment of SDIP alternatives are existing conditions (no action) and future no action alternatives. The simulated No Action Alternative represents Delta water quality conditions that are likely to exist in the absence of SDIP, with a repeat of the hydrologic conditions represented by the California Central Valley hydrologic record, but with existing facilities, existing (2001) water demands, and existing (D-1641) Delta flow and salinity standards. A comparison of the historical EC conditions and the DSM2-simulated No Action (2001) Alternative EC conditions for the 1976–1991 period is shown and discussed in Appendix D.

The 1976–1991 (16-year) period was used to demonstrate these EC relationships with Delta outflow and simulate potential impacts of SDIP alternatives because:

- the range of hydrologic conditions of the 16-year period is similar to those of the 73-year 1922–1994 period simulated with the monthly model CALSIM,
- most existing CVP and SWP reservoirs and major diversion facilities were operational during this period, and

- historical EC data are available for this period.

The following locations in the Delta were selected for assessment of impacts related to Delta salinity conditions:

- Emmaton, one of the locations for Delta agricultural salinity objectives located on the Sacramento River downstream of Decker Island and Threemile Slough;
- Jersey Point, one of the locations for Delta agricultural salinity objectives, and an important location for monitoring effects of salinity intrusion into the central Delta;
- Rock Slough (at Contra Costa Canal), assumed to be representative of CCWD diversions at CCC pumping plant #1, where historical EC and Cl^- measurements are made and where a water quality objective in D-1641 is applied;
- Old River at SR 4, which is near the location of the CCWD pumping plant for the Los Vaqueros Reservoir;
- CCF, which is the location of SWP Banks;
- CVP Tracy, where Delta water is diverted from Old River into the DMC;
- Old River at Tracy Boulevard Bridge, which is a D-1641 water quality objective compliance location and represents water quality in the south Delta channels upstream of the agricultural barriers and tidal gates;
- Grant Line Canal at Tracy Boulevard Bridge, which is not a compliance location for D-1641, but does indicate the water quality of a major south Delta channel; and
- Middle River at Mowry Bridge, which is near the D-1641 compliance location in Old River at the head of Middle River (i.e., Union Island).

Impacts related to DOC were assessed for Delta diversions by CCWD at Rock Slough and near SR 4, and for exports by SWP and CVP. Agricultural diversions are not impacted by DOC concentrations. Impacts related to DO were assessed for the San Joaquin River in the DWSC at the Rough & Ready Island DO monitoring station.

Significance Criteria

The impact significance criteria for water quality variables that have regulatory objectives or numerical standards, such as those contained in the 1995 WQCP, are developed from the following general considerations:

- Numerical water quality objectives have been established to protect beneficial uses, and therefore represent concentrations or values that should not be exceeded; violation of the limits would be significant.

- Natural variability caused by tidal flows, river inflows, agricultural drainage, and biological processes in the Delta channels is sometimes quite large relative to the numerical standards or mean values of water quality variables.
- Changes in water quality variables that are greater than natural variations, but are within the limits established by numerical water quality objectives, may cause significant impacts; a criterion for determining significant monthly changes is necessary.
- Monthly changes in a water quality variable that are greater than natural variations, but which occur infrequently enough such that the long-term average value is not raised by more than a specified percentage of the baseline value are considered to be less than significant; a criterion for determining significant long-term changes is necessary.

For variables with numerical water quality criteria, the numerical limits are assumed to adequately protect beneficial uses and provide the basic measure of an allowable limit that will adequately protect beneficial uses. Any increase in the variable that causes the variable to exceed the numerical objective is considered to be a significant impact. No change is allowed if the baseline value exceeds the maximum objective. Variables without numerical limits would not have a maximum significance criterion.

Natural variability is difficult to describe with a single value, but it is assumed that 10% of the specified numerical criterion (for variables with numerical criteria) or 10% of the mean value (for variables without numerical criteria) would be a reasonable representation of natural variability that would be expected to occur without causing a significant impact. Appendix D discusses the observed variability in historical Delta salinity (EC) measurements. Simulated monthly changes that are less than 10% of the numerical criterion or less than 10% of the measured or simulated mean value of the variable would not be considered significant water quality impacts because the simulated change would not be greater than natural variability.

A monthly significance criterion is based on the assumption that some changes may be substantial in comparison with natural variability of the water quality variable, and could result in significant impacts. Because the change in water quality that should be considered substantial is not known, judgment must be applied to establish an appropriate significance threshold. Based on professional experience and the measured range of natural variability, the monthly significance criterion has been selected to be 10% of the numerical limits (for variables with numerical limits). It is assumed that this 10% change criterion would prevent relatively large changes that may have potentially significant impacts on beneficial uses. For variable without a numerical limit (e.g., DOC), a monthly change criterion of 10% of the mean value is used as the monthly criterion.

The allowable long-term average increase in a water quality variable that is less than significant is also difficult to determine from purely scientific evidence. The maximum allowable value has been determined by a regulatory agency to protect the beneficial uses that are dependent on the water quality variable. Therefore, it is generally assumed that raising the average value by some small percentage will not cause significant harm to the protected beneficial uses. A 5% long-term increase in the baseline average salinity has been selected as a significant impact. Although there may be monthly significant changes, the overall impact on salinity of DOC was considered less than significant if the long-term increase remains less than 5% of the baseline average salinity of DOC.

Criteria for Electrical Conductivity

EC values are directly controlled by existing (1995 WQCP) Delta objectives for agricultural, fishery, and water supply uses and Suisun Marsh standards for estuarine and fish and wildlife habitat uses that are incorporated in D-1641. Delta EC objectives vary with month and water-year type. The 1995 WQCP objectives may only apply for some months and at some locations. Applicable EC objectives are specified for the February–June X2 period at Chipps Island and Collinsville, and during the agricultural diversion season of April–August at Emmaton and Jersey Point, and during the entire year at each of the export locations and three south Delta locations (1,000 µS/cm maximum). Significance criteria for EC may therefore be different for each month at each Delta location.

Increases in EC values that result in exceedance of the maximum objective at specified locations in the Delta are considered to be significant water quality impacts. Monthly changes in EC values are also considered to be significant if they exceed 10% of the applicable objective.

The selected thresholds for impact significance for EC values may vary with month and water year type at locations with applicable Delta objectives. For example, estuarine EC objectives (i.e., X2) specified in the 1995 WQCP are applicable at Chipps Island during several months (February–June of most years). The maximum EC objective at Chipps Island is about 2,640 µS/cm (corresponding to a 2-ppt salinity at Chipps Island) and must be satisfied for a specified number of days each month, depending on the previous month’s runoff. The 1995 WQCP agricultural objectives for EC, ranging from 450 µS/cm to 2,200 µS/cm, are applicable at Jersey Point from April through August 15. Similar EC objectives are applicable at Emmaton. The 1995 WQCP contains an EC objective for Delta exports of 1,000 µS/cm for all months. Three south Delta locations have 30-day moving average EC objectives of 1,000 µS/cm.

The selected monthly significance threshold of a 10% change relative to the EC objective also applies at these locations. For Chipps Island, the threshold of 10% change is equivalent to an allowable increase of 264 µS/cm when the 2,640-µS/cm estuarine objective is applicable (as long as the EC objective is not exceeded). At Emmaton and Jersey Point, the threshold of 10% change is equivalent to an allowable increase of 45 µS/cm when the 450-µS/cm EC objective is applicable. The threshold of a 10% change is equivalent to an allowable increase of 100 µS/cm in Delta exports and at the three south Delta locations. The long-term change of 5% of the No Action average EC value applies at all stations.

There are also applicable objectives of 250-mg/l Cl^- concentration at the four south Delta export locations (CCWD Rock Slough, CCWD Old River, SWP Banks, and CVP Tracy). The CCWD at Rock Slough chloride is also subject to a 150-mg/l objective for about half of each calendar year (5 months in critical year, 8 months in wet years). These chloride objectives are considered and the necessary Delta outflow to meet these chloride objectives is calculated within the CALSIM model (e.g., ANN module). These chloride objectives are therefore assumed to be satisfied with the simulated Delta outflow values from the CALSIM model. Chloride concentrations were not simulated with DSM2, and chloride was not evaluated as a salinity variable for the SDIP alternatives. Appendix D contains additional comparisons of chloride and EC values at the CCWD Rock Slough intake.

Criteria for Dissolved Organic Carbon

DOC concentrations in the Delta exhibit relatively large fluctuations (see Figure 5.3-5). Although no numerical water quality objectives have been developed for DOC concentrations, criteria for DOC can be determined from average data on Delta DOC and the estimated effects of DOC concentrations on THM concentrations in treated drinking water. Increases in monthly export DOC of more than 10% of the mean DOC concentration (assumed to be about 4 mg/l), or about 0.4 mg/l, are considered to be significant water quality impacts. Because THM standards involve annual average criteria, the significance criterion for the estimated long-term increase in export DOC concentrations should apply. The average DOC concentrations in the exports should be limited to a change that is small enough to prevent a change in long-term THM concentration of more than 8 µg/l (because 8 µg/l is 10% of the current THM standard of 80 µg/l).

A general correlation between DOC concentration and THM concentration suggests that about 10 to 20 µg/l of THM will result from each 1 mg/l of DOC in the raw water supply (State Water Resources Control Board 1995b). Therefore limiting the long-term DOC increases to about 0.4 mg/l would also likely limit the increase in long-term THM to less than 8 µg/l. Simulation of THM concentrations in treated water obtained from the Delta was not part of the SDIP impact evaluation because the simulated changes in EC and DOC can be used as surrogates for the potential effects on THM and other disinfection by-products at specific treatment plants using Delta water.

Criteria for Dissolved Oxygen

The minimum DO objectives in the Stockton DWSC are 5 mg/l from December through August and 6 mg/l from September through November (to protect adult migration of Chinook salmon). Any monthly estimated DO concentration less than the applicable objective is considered to be a significant impact. Any reduction in a monthly estimated DO concentration that is more than 10% of the applicable objective (0.5 mg/l) is also considered to be a significant impact.

CALFED Programmatic Mitigation Measures

The maintenance and improvement of Delta water quality are a major purpose for the CALFED Program. There are, however, no programmatic mitigation measures for water quality that will be employed for the SDIP.

Adaptive Operations of South Delta Tidal Gates for Water Quality Improvement

Section 5.2, Delta Tidal Hydraulics, includes a discussion about how tidal gate operations will affect tidal level and tidal flow in the south Delta channels. This section describes the general influences of the tidal gate operations on south Delta salinity (EC) and gives some general water quality guidelines that will be incorporated into the adaptive management operations of the tidal gates. This section presents a description of what controls existing conditions of salinity in south Delta channels (with temporary barriers), and how tidal gate operations can provide beneficial effects for water quality improvement.

Sources of South Delta Salinity

Figure 5.3-9 shows the DSM2-simulated EC for the four sources of water for south Delta channels, and the resulting EC for the CVP and SWP exports for the 2001 baseline conditions, with temporary barriers. The highest EC line in the top graph is the assumed EC for agricultural drainage return flows in the south Delta. These EC values are general estimates based on drainage EC measurements collected by DWR as part of the Municipal Water Quality Investigations. The assumed EC values are highest in winter (about 1,250 µS/cm) during the months of salt leaching and winter storm pumping of drainage. The EC values in the summer are lower (about 750 µS/cm) because the drainage water originates from agricultural diversions that have not contacted the soils for long enough to dissolve much salt. The south Delta water generally contains less than 15% agricultural drainage, so the effects of the drainage EC are relatively small. However, the fraction of agricultural drainage in south Delta channels depends on the agricultural diversions from these channels and the net tidal flows (i.e., tidal flushing) in the south Delta channels.

The water source with the next highest EC value is the San Joaquin River at Vernalis. These CALSIM-estimated Vernalis EC values have been compared to the historical data in Figure 5.3-8. The D-1641 water quality objective at Vernalis is 1,000 µS/cm during the winter and 700 µS/cm during the irrigation season of April through August (measured as the 30-day running average value).

The CALSIM-estimated EC values, which are used in DSM2 simulations of EC, exceed these salinity objectives in September of several years. The high EC values from CALSIM that are above the water quality objectives in September do not occur in the historical record. There is no reason to believe that the Vernalis EC in September will exceed the EC objective in the future. The high EC values estimated by CALSIM in March are more likely to occur because there has been high salinity at Vernalis during the winter of low-flow years. Technical work currently being prepared by Reclamation to revise and improve the EC estimates in the CALSIM model may help resolve this issue. The revised Vernalis EC estimates are generally lower and suggest that water quality objectives at Vernalis and in the south Delta channels may be met more frequently.

Figure 5.3-9 also shows the Old River at SR 4 EC values and the Victoria Canal EC values. The Victoria Canal is the south Delta water source with the lowest EC values, because it is predominantly Sacramento River water. The Old River at SR 4 EC values generally are highest in the summer months, indicating the influence of seawater intrusion from the western Delta. Although the Sacramento River EC remains below 200 µS/cm year-round (see Figure 5.3-3) the Old and Middle River EC values are generally between 500 µS/cm and 750 µS/cm during the summer months. This is the source of water for the tidal flushing of south Delta channels. Priority 3 operation of CCF will have a beneficial effect on EC in the south Delta channels.

Simulated Salinity in South Delta Channels

The bottom graph in Figure 5.3-9 shows the DSM2-simulated EC for CVP Tracy and SWP Banks for the 2001 baseline conditions with temporary barriers. The EC objective at the SWP and CVP exports is 1,000 µS/cm. CVP Tracy EC values are sometimes about the same as the Vernalis EC values because the CVP exports can pump a majority of the San Joaquin River water that is diverted at the head of Old River. SWP Banks EC values are usually lower than the Vernalis EC values, because the SWP exports are usually a mixture of water from Old River at SR 4 and Victoria Canal (i.e., Middle River). The EC of the SWP exports is usually between about 500 µS/cm and 750 µS/cm during the summer months.

Figure 5.3-10 shows the DSM2-simulated EC values in the south Delta channels for the 2001 baseline conditions with temporary barriers. Because the majority of the San Joaquin River flow can be diverted into the south Delta channels at the head of Old River, the Vernalis EC values can have a strong influence on south Delta channel EC values. The simulated EC of Grant Line Canal (at Tracy Boulevard Bridge), the simulated EC of Middle River (at Mowry Bridge), and the simulated EC of Old River (at Tracy Boulevard Bridge) are all usually about the same as the simulated Vernalis EC. The simulated Middle River EC (at Tracy Boulevard Bridge) is usually about equal to the simulated Victoria Canal EC. The simulated EC of Grant Line Canal at the western end is usually about equal to the simulated EC of the SWP exports, and the simulated EC of Old River at the western end is usually equal to the simulated EC of the CVP exports.

Measured San Joaquin River Salinity

Figure 5.3-11 shows San Joaquin River EC measured at Vernalis, Mossdale, and Brandt Bridge in 2001 and 2003 (recent low-flow years). During the summer months, San Joaquin River flow at Vernalis was less than 1,500 cfs, and the measured Vernalis EC was above 600 µS/cm, but below the 700-µS/cm objective. The measured Mossdale EC values were slightly higher than the measured Vernalis EC, indicating the influence of agricultural drainage that contributes higher EC to the San Joaquin River. The measured Brandt Bridge EC was usually similar or slightly higher than the measured Vernalis and Mossdale EC for the same reason. There were some periods when Mossdale EC was lower than Vernalis EC or higher than Brandt Bridge EC. It may be difficult on a day-by-day basis to accurately determine the relative EC values because of measurement variability at the three stations. Additional field verification of the EC measurements will be required when these EC measurements are used to govern the adaptive management of the south Delta tidal gates.

Daily Operations of the South Delta Tidal Gates

The head of Old River fish control gate operations will not have any substantial effect on the EC in the San Joaquin River at Brandt Bridge, located 6 miles downstream. However, partially closing the head of Old River fish control gate during most months can reduce the diversion of high-EC San Joaquin River water into the south Delta channels. The south Delta channels can be more effectively flushed, when the Vernalis EC is lower, by maintaining a minimum head of Old River diversion of about 500 cfs. Circulation tidal gate operations (flood-tide flows only) can provide more net tidal flows from Victoria Canal into Middle River and from Old River at Clifton Court Ferry into the Old River channel upstream of CVP Tracy. This will lower the EC of the western portion of these channels. However, the tidal gate that can have the largest effect on south Delta salinity is the head of Old River fish control gate. The salinity in the south Delta channels can be reduced to approach the EC of the SWP exports if the San Joaquin River diversion flow into the head of Old River is reduced to about 500 cfs and the tidal flushing is increased by circulation gate operations.

Based on these simulated tidal hydraulic effects and the anticipated water quality effects, the major decisions (choices) for operating each of the tidal gates must be considered within an adaptive management framework to satisfy the several interrelated purposes of these gates. Adaptive operations procedures for the south Delta tidal gates can be developed from three major gate operation choices to provide maximum benefits from the tidal gate operations:

1. The CCF intake gates have two somewhat contradictory effects that must be balanced: If the gates are closed during the flood-tide flows prior to the high tide each day, the tidal flushing in south Delta channels can be maximized, and levels at high tide throughout the south Delta channels are preserved. This will allow Tom Paine Slough siphons to operate and provide the maximum tidal flushing upstream of the tidal gates. The CCF intake gates,

however, must be opened for a sufficient period each day to maintain the CCF elevations above -2.0 feet msl to prevent pump cavitation problems at SWP Banks, which is often used for maximum off-peak (nighttime) pumping. The CCF priority 3 schedule will be used to achieve this balance.

2. The head of Old River fish control gate can be operated to reduce the San Joaquin River diversions into Old River. This will increase the San Joaquin River flow past Stockton and improve DO conditions in the DWSC. This may be beneficial for adult up-migrating Chinook salmon during the months of September through November. Closure in April and May will reduce the juvenile Chinook that are diverted towards the CVP and SWP pumping plants. However, reduced diversions will cause more water to be drawn from the central Delta to supply the CVP and SWP pumping, which may increase entrainment of some larval or juvenile fish (e.g., delta smelt). Reduction of the head of Old River diversions will also reduce the inflow of higher-salinity San Joaquin River water into the south Delta channels. Partial closure of the head of Old River gate will shift the distribution of San Joaquin River salinity away from the CVP Tracy facility toward the CCWD intakes and the SWP Banks facility.
3. The tidal gates at Grant Line Canal, Old River at DMC, and Middle River can be used to control the water levels in the south Delta channels. In addition, ebb-tide closure of the Old River and Middle River tidal gates can produce a net circulation upstream on Old River and Middle River and downstream in Grant Line Canal. This ebb-tide closure of Old and Middle River tidal gates has been simulated to have a beneficial effect on salinity in these south Delta channels and is the proposed operation for these gates. The ebb-tide closure of the tidal gates is not anticipated to substantially change the fish movement patterns that are triggered by or associated with tidal flows.

The operations of the tidal gates will vary on a day-by-day basis depending on the inflows, export pumping, and water quality conditions measured at Vernalis and in the south Delta. The adaptive management of the south Delta gates will be reviewed and guided by the Gate Operations Review Team (GORT) as described in Chapter 2. The general features of these gate operations have been simulated for each SDIP alternative that are compared to the existing conditions baseline with temporary barriers in the following sections.

Alternative 1 (No Action)

Under the No Action Alternative, the SDIP project components, including dredging activities in Old River, Middle River and West Canal and the operable fish control and tidal gates would not be constructed or operated; diversion and pumping would not increase. SWP and CVP operations would remain the same. There would be no impact on surface water resources from dredging activities or placement, and existing conditions as described above would remain.

The existing conditions baseline does include the seasonal installation of the fish control barrier at the head of Old River and the temporary agricultural barriers in the south Delta channels. These temporary barrier installation and removal activities may result in localized temporary water quality changes, but these are considered to be the existing conditions, and are not identified as impacts.

2020 Conditions

Under Alternative 1 for 2020 conditions, the SDIP project components would not be built or operated; diversion and pumping would not increase. SWP and CVP operations would remain nearly the same. There would be no impact on water quality from dredging activities or placement of the temporary barriers, and existing conditions as described above for 2001 conditions would remain nearly the same.

Alternative 2A

Stage 1 (Physical/Structural Component)

Construction of the tidal gates will influence water quality only temporarily in the south Delta channels. Localized effects during construction and dredging of channels will be minimized with appropriate dredging procedures. The construction impacts may be comparable to those created by the installation and removal of the four temporary barriers each year. Operation of the tidal gates during Stage 1 of Alternative 2A will provide substantial water quality benefits at many south Delta channel locations. The simulated effects on EC are shown for nine selected impact assessment locations.

Impact WQ-1: Short-Term Near-Field Effects on Dissolved Oxygen as a Result of Dredging Activities. Information gathered from the Corps maintenance dredging activities, the Port of Stockton’s 2001 dredging program, and previous dredging in the south Delta is useful for characterizing potential DO impacts from SDIP dredging. These monitoring programs did not detect any adverse reduction in DO at monitoring locations downstream of these hydraulic dredging operations. While clamshell dredging does have higher potential impacts, it will likely be used only for specific application or small portions of the total SDIP dredging operations.

Dredging may release materials with an oxygen demand to the water. DWR will demonstrate compliance with water quality objectives in order to obtain a permit from the RWQCB. DWR will demonstrate that sufficient control and containment techniques are used to prevent exceedances of water quality objectives. Monitoring requirements will be specified in the permit.

Decant water discharges from the dredge placement sites (DPS) to Old River, Middle River, and West Canal may also contribute oxygen demand to the same general area affected by the dredging. The DPS will provide sufficient residence time such that the oxygen demand of the readily available oxidizable material would largely be satisfied. Therefore, the decant water is not expected to appreciably change DO levels within the immediate near-field mixing zone of the discharge. This is considered to be a less-than-significant impact. No mitigation is required.

Impact WQ-2: Impacts on Water Quality as a Result of Suspending Sediments and Contaminants into the Water Column during Dredging. Measured sediment plumes from hydraulic dredging operations (Hayes et al. 2000) suggest that less than 0.1% of all disturbed sediments and associated contaminants will be resuspended as a result of hydraulic dredging cutterhead operations. This impact is considered less than significant because DWR will demonstrate compliance with the turbidity and other appropriate standards during dredging operations. No mitigation is required.

Impact WQ-3: Impacts on Water Quality Resulting from Return Flows from the Dredge Placement Sites. SDIP dredging may result in the return flow of decant water from the DPS into Old River, Middle River, and West Canal. These flows may contain a number of constituents at levels considered potentially toxic to organisms. Although these constituents are already present in the Delta waterways, they are present in the water within the sediments (i.e., pore water) and they are not readily available in the water column above the sediments. The sediments and associated constituents in the water will be removed and placed at the upland location as part of this alternative.

At the spoils pond, most of the solids will settle out of the water. A small portion may remain in suspension. Elutriate sampling will be used to monitor and control, if necessary, this potential impact on water quality (i.e., toxicity). DWR or its designated contractor will sample and then hold all decant water until it has been determined through analysis that the water will meet all water quality objectives and will not pose a threat to aquatic biota.

Based on these monitoring and holding of decant water requirements, this is assumed to be a less-than-significant impact. No mitigation is required.

Table 5.3-1 gives a summary of the simulated average EC values at the nine selected impact assessment locations for the 1976–1991 DSM2 simulation of the 2001 and 2020 baseline conditions and during Stage 1 of Alternative 2A for 2001 and 2020 conditions. The general improvement in south Delta EC values is evident.

Impact WQ-4: Salinity Changes at Emmaton. Figure 5.3-12 shows the monthly EC values for the 2001 baseline and Alternative 2A Stage 1 at Emmaton for 1976–1991 as simulated by DSM2. The bottom graph indicates the changes in EC, with the Alternative 2A Stage 1 EC values plotted against the No Action EC values. No changes in pumping or Delta outflow are simulated during Stage 1. The simulated changes in EC were negligible. Table 5.3-1A indicates that the average EC at Emmaton for the 2001 baseline for the 16-year period simulated with DSM2 was 1,074 µS/cm. The average for Alternative 2A Stage 1 was 1,075 µS/cm. The average increase at Emmaton was therefore 1 µS/cm (0.1% of the baseline average). No mitigation is required.

Table 5.3-1. DSM2-Simulated Electrical Conductivity Changes for Alternative 2A Stage 1 under 2001 and 2020 Conditions for the 1976–1991 Period

	EC Base Average	EC Alternative Average	EC Change	EC % Change	Number of Increases >10% Base	Average >10% Increase	Number of Increases >100 µS/cm	Average of Increases >100 µS/cm
A. 2001 Conditions								
Emmaton	1,074	1,075	1	0.1	0		0	
Jersey Point	1,079	1,081	2	0.2	0		0	
Rock Slough	532	531	-1	-0.2	0		0	
Old River at SR 4	468	470	2	0.5	1	27	0	
SWP Banks	447	450	4	0.8	2	34	0	
CVP Tracy	530	473	-57	-10.8	6	82	1	121
Old River at Tracy Blvd	595	491	-104	-17.5	11	102	5	147
Middle River at Mowry Bridge	601	445	-155	-25.9	8	57	0	
Grant Line Canal at Tracy Boulevard	595	560	-35	-5.9	14	61	0	
B. 2020 Conditions								
Emmaton	1,072	1,073	1	0.1	0		0	
Jersey Point	1,081	1,083	2	0.2	0		0	
Rock Slough	539	538	-1	-0.2	0		0	
Old River at SR 4	469	471	3	0.6	1	25	0	
SWP Banks	446	452	5	102	2	34	0	
CVP Tracy	526	474	-52	-9.9	8	83	2	109
Old River at Tracy Blvd	595	493	-102	-17.2	12	117	5	192
Middle River at Mowry Bridge	603	530	-72	-12.0	9	63	1	101
Grant Line Canal at Tracy Boulevard	601	561	-40	-6.6	11	69	1	124

EC = electrical conductivity (in µS/cm).
SR = State Route.
µS/cm = microSiemens per centimeter.

Impact WQ-5: Salinity Changes at Jersey Point. Figure 5.3-13 shows the monthly EC values for Alternative 2A Stage 1 at Jersey Point and the EC values for the 2001 baseline No Action Alternative for 1976–1991 as simulated by DSM2. The bottom graph indicates the changes in EC, with the Alternative 2A Stage 1 EC values plotted against the No Action EC values. The changes in EC were negligible. Table 5.3-1A indicates that the average EC at Jersey Point for the 2001 baseline for the 16-year period simulated with DSM2 was 1,079 µS/cm. The average simulated EC for Alternative 2A Stage 1 was 1,081 µS/cm. No mitigation is required.

Impact WQ-6: Salinity Changes in Rock Slough. Figure 5.3-14 shows the monthly EC values for Alternative 2A Stage 1 in Rock Slough (at entrance to CCC) and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. Simulated Rock Slough EC above the 1,000-µS/cm objective is not expected because it is assumed that CVP and SWP Delta management operations will maintain the D-1641 salinity objectives. Table 5.3-1A indicates that the average EC at Rock Slough for the 2001 baseline was 532 µS/cm. The average simulated EC for Alternative 2A Stage 1 was 531 µS/cm. No mitigation is required.

Impact WQ-7: Salinity Changes in Old River at State Route 4 Bridge. CCWD constructed the Los Vaqueros intake and pumping plant just upstream of the SR 4 Bridge. Photograph 5.3-11 shows the Los Vaqueros intake, located just upstream (i.e., south) of the SR 4 Bridge on the western bank of Old River. Because the Los Vaqueros intake is several miles upstream from the mouth of Rock Slough, and because it is located directly on Old River, the EC measurements at the Los Vaqueros intake are usually lower than corresponding EC measurements at CCC Pumping Plant #1. Some of the water pumped at the Los Vaqueros intake supplies the CCC through a connecting pipeline. Photograph 5.3-12 shows the Los Vaqueros Reservoir, located southwest of the Los Vaqueros intake. The Los Vaqueros Reservoir provides emergency storage and water quality “blending” water to reduce the CCWD delivered chloride concentrations.

Figure 5.3-15 shows the monthly EC values for Alternative 2A Stage 1 in Old River at the SR 4 Bridge and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. The bottom graph indicates the changes in EC at CCF, with the Alternative 2A EC values plotted against the No Action EC values. The applicable EC objective is 1,000 µS/cm. The monthly change criterion (10% of maximum) is therefore 100 µS/cm. The red line on the graph indicates a 100-µS/cm increase from the baseline EC value.

Table 5.3-1A indicates that the average EC in Old River at the SR 4 Bridge for the 2001 baseline for the 16-year period simulated with DSM2 was 468 µS/cm. This is slightly lower (13%) than the average Rock Slough EC. The average simulated EC for Alternative 2A was 470 µS/cm. The average increase at SR 4 was therefore 2 µS/cm (0.5% of the baseline average). No mitigation is required.

Impact WQ-8: Salinity Changes at Clifton Court Forebay (SWP Banks Pumping Plant). Photograph 5.3-13 shows SWP Banks, which supplies drinking water to the South Bay Aqueduct and the SWP California Aqueduct.

Figure 5.3-16 shows the monthly EC values for Alternative 2A Stage 1 at CCF, which provides the water for export at SWP Banks, and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. Table 5.3-1A indicates that the average EC at CCF for the 2001 baseline was 447 µS/cm. The average simulated EC for Alternative 2A Stage 1 was

450 µS/cm. The average increase at SWP Banks was therefore about 4 µS/cm (0.8% of the baseline average). No mitigation is required.

Impact WQ-9: Salinity Changes at CVP Tracy Pumping Plant. Photograph 5.3-14 shows the intake to the CVP DMC. The DMC supplies drinking water to the City of Tracy and other communities. The CVP Tracy facility is located about 2.5 miles to the south.

Figure 5.3-17 shows the monthly EC values for Alternative 2A Stage 1 at CVP Tracy and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. Table 5.3-1A indicates that the average EC at CVP Tracy for the 2001 baseline was 530 µS/cm. This EC is higher than the average SWP Banks EC because CVP Tracy pumps more of the San Joaquin River water that is diverted down Old River and Grant Line Canal. The average simulated EC for Alternative 2A Stage 1 was 473 µS/cm. The average EC at CVP Tracy was therefore reduced by 57 µS/cm (10.8% of the baseline average) because of the tidal gate operations that reduced the diversions of San Joaquin River water and provided tidal circulation past the CVP Tracy intake on Old River. Although there were a few months with simulated increases in the EC values, the overall change is considered a substantial improvement. No mitigation is required.

Impact WQ-10: Salinity Changes in Old River at Tracy Boulevard Bridge. Figure 5.3-18 shows the monthly EC values for Alternative 2A Stage 1 in Old River at the Tracy Boulevard Bridge and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. The applicable EC objective at the Old River at Tracy Boulevard Bridge is 700 µS/cm from April through August, and 1,000 µS/cm for the remaining months. The monthly change criterion (10% of objective) is therefore 70 µS/cm during the irrigation season, and 100 µS/cm for the remaining months. The bottom graph indicates the changes in EC at Old River at the Tracy Boulevard Bridge, with the Alternative 2A EC values plotted against the No Action EC values. The red line on the graph indicates a 100-µS/cm increase from the baseline EC value. EC changes of more than 100 µS/cm will be above the red line. The solid dots indicate months when the EC objective is 700 µS/cm. A change that is slightly below the red line would indicate a significant monthly change in these months.

Table 5.3-1A indicates that the average EC at Old River at the Tracy Boulevard Bridge for the 2001 baseline No Action Alternative was 595 µS/cm. This is higher than the average CVP Tracy EC because the Tracy facility pumps a higher fraction of the Sacramento River water. The average simulated EC for Alternative 2A Stage 1 was 491 µS/cm. The average reduction in EC at Old River at the Tracy Boulevard Bridge was therefore about 104 µS/cm (17.5% of the baseline average). This is a substantial improvement in water quality that was achieved by the tidal gate operations. Although there were some months with simulated increase in the EC values, the overall change is a significant improvement in the baseline EC. No mitigation is required.

Impact WQ-11: Salinity Changes in Grant Line Canal at Tracy Boulevard Bridge. Figure 5.3-19 shows the monthly EC values for Alternative 2A Stage 1 in Grant Line Canal at the Tracy Boulevard Bridge and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. There is no applicable EC objective at Grant Line Canal at the Tracy Boulevard Bridge. Grant Line EC values are evaluated to represent this important south Delta channel. Table 5.3-1A indicates that the average EC at Grant Line Canal at the Tracy Boulevard Bridge for the 2001 baseline was 595 µS/cm. This is identical to the average EC at Old River at Tracy Boulevard Bridge. The average simulated EC for Alternative 2A Stage 1 was 560 µS/cm. The average reduction was therefore 35 µS/cm (5.9% of the baseline average). Although there were some months with an increase in EC values, this was a substantial improvement in water quality achieved with the tidal gate operations. No mitigation is required.

Impact WQ-12: Salinity Changes in Middle River at Mowry Bridge. Figure 5.3-20 shows the monthly EC values for Alternative 2A Stage 1 at Middle River at the Mowry Bridge and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. The applicable EC objective at Middle River at the Mowry Bridge is 700 µS/cm during the April–August irrigation season, and 1,000 µS/cm for the remaining months. Table 5.3-1A indicates that the average EC at Middle River at the Mowry Bridge for the 2001 baseline was 601 µS/cm. This is the highest EC value of any of the south Delta channels upstream of the barriers, because the Middle River at Mowry Bridge salinity has the greatest contribution from the San Joaquin River. The average simulated EC for Alternative 2A Stage 1 was 445 µS/cm. The average reduction was therefore 155 µS/cm (25.9% of the baseline average). This very large reduction was the result of tidal gate operations that provided flushing of Middle River water upstream of Victoria Canal. Although there were some months with an EC increase, this was a substantial improvement in water quality achieved with the tidal gate operations. No mitigation is required.

Impact WQ-13: Changes in Stockton Deep Water Ship Channel Dissolved Oxygen Concentrations. Figure 5.3-21 shows the San Joaquin River at Stockton flows simulated by DSM2 for the 2001 baseline conditions and Alternative 2A Stage 1. Only flows of less than 1,500 cfs are assumed to have an effect on the DWSC DO concentrations (Central Valley Regional Water Quality Control Board 2003). Because the simulated operation of the head of Old River fish control gate assumed complete closure of the gate in April and May, the San Joaquin River Stockton flows were increased substantially during these months. A constant diversion flow of 500 cfs was simulated in the months of June–September, so the simulated Stockton flow was increased in many of these months. During some of the summer months, the 500 cfs assumed for the Old River diversion was greater than the simulated diversion under existing conditions. Therefore, slightly reduced flow at Stockton was simulated in several months compared to the existing conditions. It is important to note that actual operations of the head of Old River gate during Stage 1 could only reduce the diversions into Old River, and could only increase the flows at Stockton. Therefore, the simulated reductions in Stockton flow that produced a slight reduction in estimated DO concentrations were ignored in the assessment of DO impacts.

The bottom graph of Figure 5.3-21 indicates the relationship between CVP and SWP pumping and the fraction of the San Joaquin River that continues past the head of Old River to Stockton. At relatively low export pumping (as a fraction of San Joaquin River flow at Mossdale), the fraction of the San Joaquin River flow that continues past Stockton is about 50%. As pumping increases, the fraction of the flow continuing past Stockton decreases. Under the 2001 baseline, which includes some months with temporary agricultural barriers, the fraction of the flow continuing past Stockton is increased to about 75% of the Vernalis flow, but this fraction decreases with increasing export pumping. For Alternative 2A Stage 1, there are two months when the head of Old River fish control gate is assumed to be completely closed and exports are low to implement the VAMP. In many other months, the flow at Stockton was increased by the head of Old River tidal gate operations.

Figure 5.3-22 shows that the estimated effect of DSM2-simulated flows with Alternative 2A Stage 1 was to increase the Stockton DWSC DO by as much as 1 mg/l (equivalent to a flow increase of 500 cfs). During most of these months, the simulated flows at Stockton are increased and the DO estimates are increased. There are some months when the simulated flows at Stockton were reduced (by the 500 cfs assumed Old River diversion) and the estimated DO concentrations were reduced. This would be identified as a significant DO impact, except that this reduction in flow cannot actually occur under Stage 1 operations of the head of Old River gate. Table 5.3-2 gives the June–October average estimated DO concentrations in the DWSC for 1976–1991. The average baseline DO in these months was 4.87 mg/l, and the estimated DO for Alternative 2A Stage 1 was increased to 5.03 mg/l. This is an improvement in the simulated flow and DO conditions at Stockton that resulted from the head of Old River tidal gate operations. No mitigation is required.

Table 5.3-2. Calculated Dissolved Oxygen Concentrations in the Stockton Deep Water Ship Channel for the Months of June–October for the 1976–1991 Period

	Average DO (mg/l)	Average Change (mg/l)	Months with a Reduction of More than 0.5 mg/l	Average Reduction When More than 0.5 mg/l
A. 2001 Conditions				
Baseline	4.87			
Alternative 2A Stage 1	5.03	+0.16	4	-0.84
Alternative 2A	5.03	+0.16	4	-0.91
Alternative 2B	5.03	+0.16	4	-0.91
Alternative 2C	5.03	+0.16	4	-0.91
Alternative 3B	5.00	+0.13	6	-0.98
Alternative 4B	5.00	+0.13	6	-1.08
B. 2020 Conditions				
Baseline	4.73			
Alternative 2A Stage 1	5.06	+0.33	1	-1.05
Alternative 2A	5.07	+0.34	1	-1.12
Alternative 2B	5.06	+0.33	1	-1.13
Alternative 2C	5.06	+0.33	1	-1.13
Alternative 3B	5.04	+0.31	2	-1.05
Alternative 4B	5.03	+0.30	3	-0.98

Note: Dissolved oxygen is calculated from the Stockton Flow that is simulated by DSM2.

DO = dissolved oxygen.

mg/l = milligrams per liter.

2020 Conditions

Although simulated EC and calculated DO concentrations may be slightly different for Alternative 2A Stage 1 under 2020 Conditions (Tables 5.3-1B and 5.3-2B), the water quality impacts associated with dredging and construction and operation of the tidal gates under the 2020 conditions would be the same as described above for Alternative 2A Stage 1 under 2001 conditions. There are no significant impacts on water quality. No mitigation is required.

Stage 2 (Operational Component)

The operations of the tidal gates are the same as described and evaluated for Stage 1 of Alternative 2A. The major operational assumptions for Alternative 2A Stage 2 are described in Chapter 2. Maximum SWP pumping of 8,500 cfs is simulated by CALSIM in more months than for the No Action Alternative, because the 8,500 cfs limit applies in all months except during VAMP (April 15–May 15). However, other Delta operating criteria may limit the SWP pumping to less than 8,500 cfs in many months. During the 16-year DSM2 simulation period, Alternative 2A Stage 2 had 29 months (15% of the months) with

8,500-cfs pumping. For the entire 73-year CALSIM sequence, SWP pumping under Alternative 2A Stage 2 was 8,500 cfs in 138 months (16% of months simulated). For the 2001 baseline simulation, 8,500 cfs was simulated in some months (January and February) with 4 months (2%) during the 16-year DSM2 period, and 19 months (2%) during the 73-year simulation. The maximum pumping of 8,500 cfs was therefore simulated in about 13% more of the months for Alternative 2A than for the 2001 baseline. The additional pumping may reduce the Delta outflow and consequently increase the simulated EC values. These are the major changes expected for Stage 2 of Alternative 2A.

Impact WQ-14: Salinity Changes at Emmaton Resulting from Stage 2. Figure 5.3-23 shows the monthly EC values for the 2001 baseline and Alternative 2A Stage 2 at Emmaton for 1976–1991 as simulated by DSM2. Applicable EC objectives for Emmaton for April to August range from 450 µS/cm to 2,780 µS/cm, depending on water-year type. Many months (September–March) have no EC objectives at Emmaton. It is therefore difficult to evaluate the monthly maximum significance threshold, because many months do not have a maximum EC objective. The bottom graph indicates the changes in EC at Emmaton, with the Alternative 2A Stage 2 EC values plotted against the No Action EC values. The red line on the graph indicates a 10% increase from the baseline EC value. For those months with a maximum EC objective, CALSIM attempts to maintain the appropriate EC value (simulated as part of the ANN module). EC changes of less than 10% of the baseline value will therefore generally satisfy the 10% change limit, regardless of the monthly EC objective.

Table 5.3-3A indicates that the average EC at Emmaton for the 2001 baseline for the 16-year period simulated with DSM2 was 1,074 µS/cm. The average for Alternative 2A Stage 2 was 1,082 µS/cm. The average increase at Emmaton was therefore 8 µS/cm (0.7% of the baseline average). Because this long-term increase is less than 5% of the baseline average, the overall change in salinity is considered to be less than significant. At Emmaton, there were 24 months with a change of more than 10% of the baseline EC value. Although these relatively large monthly changes may occur under operations of Alternative 2A Stage 2, the overall changes are small enough to avoid any reductions in beneficial uses and the simulated changes at Emmaton are considered to be less than significant. No mitigation is required.

Table 5.3-3. DSM2-Simulated Electrical Conductivity Changes for Alternative 2A Stage 2 for the 1976–1991 Period

	EC Base Average	EC Alternative Average	EC Change	EC % Change	Number of Increases >10% Base	Average >10% Increase	Number of Increases >100 µS/cm	Average of Increases >100 µS/cm
A. 2001 Conditions								
Emmaton	1,074	1,082	8	0.7	24	190	23	234
Jersey Point	1,079	1,096	16	1.5	31	226	32	238
Rock Slough	532	539	7	1.3	23	97	7	157
Old River at SR 4	468	478	10	2.1	23	78	4	142
SWP Banks	447	457	10	2.2	26	61	2	151
CVP Tracy	530	479	-52	-9.7	11	92	5	116
Old River at Tracy Blvd	595	495	-99	-16.7	12	126	7	170
Middle River at Mowry Bridge	601	435	-166	-27.6	6	49	0	–
Grant Line Canal at Tracy Boulevard	595	550	-45	-7.6	11	56	1	104
B. 2020 Conditions								
Emmaton	1,072	1,092	20	1.8	25	239	25	273
Jersey Point	1,081	1,122	41	3.8	28	332	27	353
Rock Slough	539	553	14	2.7	22	141	13	200
Old River at SR 4	469	485	17	3.6	23	115	10	188
SWP Banks	446	463	17	3.8	26	88	7	184
CVP Tracy	526	486	-40	-7.5	13	115	6	158
Old River at Tracy Blvd	595	504	-91	-15.3	14	116	6	178
Middle River at Mowry Bridge	603	437	-165	-27.4	5	54	0	–
Grant Line Canal at Tracy Boulevard	601	554	-47	-7.8	11	61	0	–

EC = electrical conductivity (in µS/cm).
SR = State Route.
µS/cm = microSiemens per centimeter.

Impact WQ-15: Salinity Changes at Jersey Point Resulting from Stage 2. Figure 5.3-24 shows the monthly EC values for Alternative 2A Stage 2 at Jersey Point and the EC values for the 2001 baseline No Action Alternative for 1976–1991 as simulated by DSM2. Applicable EC objectives for Jersey Point for April to August range from 450 µS/cm to 2,200 µS/cm, depending on water-year type. Many months (September–March) have no EC objectives at Jersey Point. It is difficult to evaluate the monthly changes because the significance criteria vary with each month. The bottom graph indicates the changes in EC, with the Alternative 2A Stage 2 EC values plotted against the No

Action EC values. The red line on the graph indicates a 10% increase from the baseline EC value.

Table 5.3-3A indicates that the average EC at Jersey Point for the 2001 baseline for the 16-year period simulated with DSM2 was 1,079 µS/cm. This is almost exactly the same at the simulated EC at Emmaton. However, the peak EC values are higher at Emmaton than at Jersey Point, which are only about 75% of those at Emmaton. The average simulated EC for Alternative 2A Stage 2 was 1,096 µS/cm. The average increase at Jersey Point was therefore about 16 µS/cm (1.5% of the baseline average). Because this long-term increase is less than 5% of the baseline average, the overall change in salinity is considered to be less than significant. At Jersey Point, there were 31 months with a change of more than 10% of the baseline EC value. Although these relatively large monthly changes might occur under the Alternative 2A Stage 2 operations, the overall changes are small enough to avoid any reductions in beneficial uses and the simulated changes at Jersey Point are considered to be less than significant. No mitigation is required.

Impact WQ-16: Salinity Changes at Rock Slough Resulting from Stage 2. CCWD in cooperation with CBDA Drinking Water Program is reducing the influence of groundwater salinity on the Contra Costa Canal (CCC) and reducing the effects of agricultural drainage from Veale Tract into Rock Slough. These improvements in salinity are not included in the DSM2 modeling results used to evaluate SDIP salinity impacts. Figure 5.3-25 shows the monthly EC values for Alternative 2A Stage 2 in Rock Slough (at entrance to CCC) and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. The applicable EC objective at Rock Slough is 1,000 µS/cm, measured at the CCC Pumping Plant #1 near Oakley. The monthly change criterion (10% of maximum) is therefore 100 µS/cm. The bottom graph indicates the changes in EC, with the Alternative 2A Stage 2 EC values plotted against the No Action EC values. The red line on the graph indicates a 100-µS/cm increase from the baseline EC value.

Figure 5.3-25 indicates that DSM2 calculated that a few (four during the 1976–1991 period) of the monthly average EC values at Rock Slough were higher than the 1,000-µS/cm objective for the baseline 2001 conditions. This would not occur during actual operations because the CVP and SWP operators use the real-time EC monitoring from throughout the Delta to control salinity intrusion; CVP and SWP pumping can be reduced to increase Delta outflow and reduce the EC and chloride concentrations at Rock Slough. Because Rock Slough is the water supply intake closest to the source of seawater intrusion from the western Delta, the Rock Slough salinity is often the controlling objective for managing Delta salinity conditions.

Rock Slough EC increasing to above the 1,000-µS/cm objective would be a significant impact if it were to result from Alternative 2A Stage 2 operations. However, this would not occur in actual operations because the CVP and SWP operators manage Delta exports on a day-by-day basis to maintain the Rock Slough salinity within the allowable objectives. Table 5.3-3A indicates that the average EC at Rock Slough for the 2001 baseline was 532 µS/cm. This is only about half of the average EC at Jersey Point. The average simulated EC for Alternative 2A Stage 2 was 539 µS/cm. The average increase at Rock Slough was therefore about 7 µS/cm (1.3% of the baseline average). Because this long-term increase is less than 5% of the baseline average, the overall change in salinity is considered to be less than significant. No mitigation is required.

Impact WQ-17: Salinity Changes in Old River at State Route 4 Bridge Resulting from Stage 2. CCWD in cooperation with CBDA Drinking Water Program is reducing the influence of treated wastewater and agricultural drainage from Byron Tract near the CCWD Old River intake. These improvements in salinity are not included in the DSM2 modeling results used to evaluate SDIP salinity impacts. Figure 5.3-26 shows the monthly EC values for Alternative 2A Stage 2 in Old River at the SR 4 Bridge and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2.

Table 5.3-3A indicates that the average EC at Old River at the SR 4 Bridge for the 2001 baseline for the 16-year period simulated with DSM2 was 468 µS/cm. This is slightly lower (13%) than the average Rock Slough EC. The average simulated EC for Alternative 2A Stage 2 was 478 µS/cm. The average increase at SR 4 was therefore about 10 µS/cm (2.1% of the baseline average). Because this long-term increase is less than 5% of the baseline average, the overall change in salinity is considered to be less than significant. At SR 4, there were just 7 months with an EC change of more than 100 µS/cm. Although these relatively large monthly changes could occur under the Alternative 2A Stage 2 operations, the overall EC change is small enough to avoid any reductions in beneficial uses and the simulated changes at Old River at the SR 4 Bridge are considered to be less than significant. No mitigation is required.

Impact WQ-18: Salinity Changes at Clifton Court Forebay (SWP Banks Pumping Plant) Resulting from Stage 2. Figure 5.3-27 shows the monthly EC values for Alternative 2A Stage 2 at CCF, which provides the water for export at SWP Banks, and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. The applicable EC objective at SWP Banks is 1,000 µS/cm. The monthly change criterion (10% of maximum) is therefore 100 µS/cm. Table 5.3-3A indicates that the average EC at CCF for the 2001 baseline was 447 µS/cm. The average simulated EC for Alternative 2A Stage 2 was 457 µS/cm. The average increase at SWP Banks was therefore about 10 µS/cm (2.2% of the baseline average). Because this long-term increase is less than 5% of the baseline average, the overall change in salinity is considered to be less than significant. No mitigation is required.

Impact WQ-19: Salinity Changes at CVP Tracy Pumping Plant Resulting from Stage 2. Figure 5.3-28 shows the monthly EC values for Alternative 2A Stage 2 at CVP Tracy and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. The applicable EC objective at CVP Tracy is 1,000 µS/cm. The monthly change criterion (10% of maximum) is therefore 100 µS/cm. Table 5.3-3A indicates that the average EC at CVP Tracy for the 2001 baseline was 530 µS/cm. This EC is higher than the average SWP Banks EC because CVP Tracy pumps more of the San Joaquin River water that is diverted down Old River and Grant Line Canal. The average simulated EC for Alternative 2A Stage 2 was 479 µS/cm. The average reduction at CVP Tracy was therefore about 52 µS/cm (9.7% of the baseline average). This is a substantial improvement in EC values that results from the tidal gate operations. The additional pumping under Alternative 2A Stage 2 did not substantially increase the EC values at CVP Tracy that were achieved with Stage 1. No mitigation is required.

Impact WQ-20: Salinity Changes in Old River at Tracy Boulevard Bridge Resulting from Stage 2. Figure 5.3-29 shows the monthly EC values for Alternative 2A Stage 2 in Old River at the Tracy Boulevard Bridge and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. The applicable EC objective at the Old River at Tracy Boulevard Bridge is 700 µS/cm from April through August, and 1,000 µS/cm for the remaining months. The monthly change criterion (10% of objective) is therefore 70 µS/cm during the irrigation season and 100 µS/cm for the remaining months. The bottom graph indicates the changes in EC at Old River at the Tracy Boulevard Bridge, with the Alternative 2A EC values plotted against the No Action EC values. The red line on the graph indicates a 100-µS/cm increase from the baseline EC value. The solid dots indicate months when the EC objective is 700 µS/cm. A change that is slightly below the red line would indicate a significant monthly change in these months.

Table 5.3-3A indicates that the average EC at Old River at the Tracy Boulevard Bridge for the 2001 baseline was 595 µS/cm. This is higher than the average CVP Tracy EC because the Tracy facility pumps a higher fraction of the Sacramento River water. The average simulated EC for Alternative 2A Stage 2 was 495 µS/cm. The average reduction in EC in Old River at the Tracy Boulevard Bridge was therefore about 99 µS/cm (16.7% of the baseline average). This is a very substantial improvement in EC that was achieved with tidal gate operations. No mitigation is required.

Impact WQ-21: Salinity Changes in Grant Line Canal at Tracy Boulevard Bridge Resulting from Stage 2. Figure 5.3-30 shows the monthly EC values for Alternative 2A Stage 2 in Grant Line Canal at the Tracy Boulevard Bridge and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. There is no applicable EC objective at Grant Line Canal at the Tracy Boulevard Bridge.

Table 5.3-3A indicates that the average EC in Grant Line Canal at the Tracy Boulevard Bridge for the 2001 baseline was 595 µS/cm. This is identical to the average EC at Old River at Tracy Boulevard Bridge. The average simulated EC for Alternative 2A Stage 2 was 550 µS/cm. The average reduction in Grant Line Canal at the Tracy Boulevard Bridge was therefore 45 µS/cm (7.6% of the baseline average). This is a substantial improvement in EC that was achieved with the tidal gate operations and dredging in Middle River that allowed increased tidal flushing upstream of Victoria Canal. No mitigation is required.

Impact WQ-22: Salinity Changes in Middle River at Mowry Bridge Resulting from Stage 2. Figure 5.3-31 shows the monthly EC values for Alternative 2A Stage 2 in Middle River at the Mowry Bridge and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. The D-1641 EC objective for south Delta locations is 700 µS/cm during the April-August irrigation season, and 1,000 µS/cm for the remaining months. The monthly change criterion (10% of maximum) is therefore 70 µS/cm during the irrigation season and 100 µS/cm during the remaining months. The bottom graph indicates the changes in EC at Middle River at the Mowry Bridge, with the Alternative 2A Stage 2 EC values plotted against the No Action EC values. The simulated EC values are above the 1,000-µS/cm objective in several of the months under the No Action Alternative because of high Vernalis EC in September of several years, but these high EC values at Mowry Bridge are not considered impacts.

Table 5.3-3A indicates that the average EC at Middle River at the Mowry Bridge for the 2001 baseline was 601 µS/cm. This is the highest EC value of any of the south Delta channels upstream of the barriers, because the Middle River at Mowry Bridge salinity has the greatest contribution from the San Joaquin River. The average simulated EC for Alternative 2A Stage 2 was reduced dramatically to 435 µS/cm. The average reduction in Middle River at the Tracy Boulevard Bridge was 166 µS/cm (27.6% of the baseline average). This substantial improvement in EC in Middle River is the result of tidal gate operations and dredging of Middle River that allowed higher tidal flushing flows from the Middle River tidal gate near Victoria Canal. No mitigation is required.

Simulated Dissolved Organic Carbon Changes at Water Supply Intakes

DSM2 was used to simulate DOC concentrations at the CVP and SWP exports and CCWD diversion locations. The inflow DOC concentrations were estimated for the Sacramento and San Joaquin Rivers. Figure 5.3-32 shows the DOC concentrations used for the Sacramento River, and the correspondence with monthly river flow. There is a tendency for the first month of the year with increased flow to have a very high DOC concentration because the DOC originates from organic material (leaf litter) from the watershed that washes off during the first few major storms. The baseline DOC concentration is assumed to be about 2 mg/l, and the highest monthly DOC values for the Sacramento River were just less than 6 mg/l.

Figure 5.3-33 shows the corresponding monthly San Joaquin River DOC concentrations. A similar watershed wash-off process is assumed. The baseline DOC values are about 3.5 mg/l, and the highest monthly DOC values for the San Joaquin River were about 10 mg/l. These assumed monthly DOC concentrations do not change with any of the SDIP operational scenarios, and were the same for the 2001 and the 2020 baseline conditions.

Figure 5.3-34 shows the average monthly DOC concentrations and the total agricultural drainage flow. The assumed monthly DOC concentrations in agricultural drainage ranges from 12 mg/l in the summer to about 22 mg/l in the winter when high drainage flows can occur.

Figure 5.3-35 shows the simulated CVP and SWP export DOC concentrations, and shows the Sacramento River DOC, the San Joaquin River DOC, and the agricultural drainage contribution to the total simulated DOC at these locations for the 2001 baseline no action conditions. The DOC concentrations in the Delta will be higher than the river inflow concentrations because of the contribution from agricultural drainage DOC. The DOC in the CVP exports is often similar to the San Joaquin River inflow DOC. Periods with high agricultural drainage contributions in the summer will raise the CVP and SWP Export DOC concentrations to above the San Joaquin River concentration.

Figure 5.3-36 shows the simulated DOC concentrations at the two CCWD intakes, and shows the Sacramento River DOC, the San Joaquin River DOC, and the agricultural drainage contribution to the total simulated DOC at these locations for the baseline no action conditions. The DOC concentrations at the CCWD water supply intakes will be higher than the river inflow concentrations because of the contribution from agricultural drainage DOC. The DOC in the Rock Slough intake is closer to the Sacramento River inflow DOC than the SR 4 intake. Both of these CCWD intakes can have a high contribution from the San Joaquin River DOC at times of high San Joaquin River flow. Periods with high agricultural drainage contributions in the summer will raise the Rock Slough and SR 4 DOC concentrations to above the San Joaquin River concentration.

Table 5.3-4 gives an overall summary of the DSM2-simulated DOC concentrations at the four water supply intake locations for the existing conditions and Alternative 2A for the period of 1976–1991.

Table 5.3-4. DSM2-Simulated Dissolved Organic Carbon Values for Alternative 2A under 2001 Conditions for the 1976–1991 Period

	DOC Base Average	DOC Alternative Average	DOC Change	DOC % Change	Number of Changes >0.4 mg/l	Average Change >0.4 mg/l
2001						
Old River at Rock Slough	3.37	3.35	-0.02	-0.7	2	1.13
Old River at State Route 4	3.73	3.77	0.04	1.1	12	0.70
CVP Tracy Pumping Plant	3.71	3.68	-0.04	-1.0	3	0.98
SWP Banks Pumping Plant	3.80	3.77	-0.02	-0.6	2	0.45

DOC = dissolved organic carbon.
mg/l = milligrams per liter.

Impact WQ-23: Increases in Dissolved Organic Carbon at Contra Costa Water District Rock Slough Intake Resulting from Stage 2.

Figure 5.3-37 shows the monthly DOC concentrations at the CCWD Rock Slough intake for Alternative 2A Stage 2 compared with the 2001 baseline DOC concentrations. There are only a few months with increased DOC concentrations. There are many more months with slightly reduced (beneficial) DOC concentrations. Two monthly increases were greater than the 0.4-mg/l maximum change criterion. Table 5.3-4 indicates that the overall average DOC concentrations for the 1976–1991 period was 3.37 mg/l for the baseline and 3.35 mg/l for Alternative 2A Stage 2. Therefore the incremental DOC impacts at Rock Slough resulting from SDIP are less than significant. No mitigation is required.

Impact WQ-24: Increases in Dissolved Organic Carbon at Contra Costa Water District Los Vaqueros Intake Resulting from Stage 2. Figure 5.3-38 shows the monthly DOC concentrations at the CCWD Los Vaqueros intake for Alternative 2A compared with the 2001 baseline DOC concentrations. Two monthly increases were greater than the 0.4-mg/l maximum change criterion. Table 5.3-4 indicates that the overall average DOC concentrations for the 1976–1991 period was 3.73 mg/l for the baseline and 3.77 mg/l for Alternative 2A Stage 2. Therefore, the DOC impacts at Los Vaqueros are less than significant. No mitigation is required.

Impact WQ-25: Increases in Dissolved Organic Carbon at SWP Banks Pumping Plant Resulting from Stage 2. Figure 5.3-39 shows the monthly DOC concentrations at SWP Banks for Alternative 2A Stage 2 compared with the 2001 baseline DOC concentrations. Two monthly increases were greater than the 0.4-mg/l maximum change criterion. Table 5.3-4 indicates that the overall average DOC concentrations for the 1976–1991 period was 3.80 mg/l for the baseline and was 3.77 mg/l for Alternative 2A Stage 2. Therefore, the DOC impacts at SWP Banks are less than significant. No mitigation is required.

Impact WQ-26: Increases in Dissolved Organic Carbon at CVP Tracy Pumping Plant Resulting from Stage 2. Figure 5.3-40 shows the monthly DOC concentrations at CVP Tracy for Alternative 2A Stage 2 compared with the 2001 baseline DOC concentrations. Three of the monthly increases were greater than the 0.4-mg/l maximum change criterion. Table 5.3-4 indicates that the overall average DOC concentrations for the 1976–1991 period was 3.71 mg/l for the baseline and was 3.68 mg/l for Alternative 2A Stage 2. Therefore, the DOC impacts at CVP Tracy are less than significant. No mitigation is required.

Although none of the simulated DOC concentrations for the other SDIP alternatives are shown graphically in this section, the simulations indicate that there are no significant DOC impacts at any of the water supply intakes for any of the SDIP operational scenarios. The changes in pumping and channel flows are not large enough to make a substantial difference in the agricultural drainage contributions, so the corresponding DOC concentrations are not significantly changed from the 2001 existing conditions baseline or from the 2020 future no action baseline.

Impact WQ-27: Changes in Stockton Deep Water Ship Channel Dissolved Oxygen Concentrations Resulting from Stage 2. Figure 5.3-41 shows that the estimated effect of Alternative 2A Stage 2 DSM2-simulated flows on the Stockton DWSC DO was to increase the DO by as much as 1 mg/l (equivalent to a flow increase of 500 cfs). There are some months when the estimated DO concentrations were reduced because the simulated flows at Stockton were reduced (by the 500 cfs assumed for the Old River diversion). This would be identified as a significant DO impact, except that this reduction in flow would not actually occur under Stage 2 operations of the head of Old River gate. Gate operations will reduce the Old River diversions that would have occurred under existing conditions. The possible effects of increased pumping on the head of Old River diversions will be controlled with the gate to provide increased flows at Stockton. Table 5.3-2 gives the June–October average estimated DO concentrations in the DWSC for 1976-1991. The average baseline DO in these months was 4.87 mg/l, and the estimated DO for Alternative 2A Stage 2 was 5.03 mg/l. This is a substantial improvement in the simulated flow and DO conditions at Stockton that is the result of the head of Old River tidal gate operations. No mitigation is required.

2020 Conditions

The water quality effects for Alternative 2A Stage 2 under 2020 conditions are generally the same as the impacts and mitigation measures described above for Alternative 2A under 2001 conditions. DSM2-simulated EC values for Alternative 2A Stage 2 under 2020 conditions are presented in Tables 5.3-3B.

Interim Operations

Interim Operations would allow SWP Banks pumping capacity of 8,500 cfs from December 15 through March 15, prior to construction of the tidal gates. Implementation of Interim Operations would result in no significant water quality impacts. The higher pumping during the winter period would not result in any water quality impacts. Between March 16 and December 14, Interim Operations would be the same as Alternative 1 (existing conditions) and would not result in any impacts on water quality.

Alternative 2B

Stage 1 (Physical/Structural Component)

The physical/structural component of Alternative 2B Stage 1 are identical to those of Alternative 2A Stage 1. Construction of the tidal gates will only temporarily influence water quality in the south Delta channels. Localized effects during construction and dredging of channels will be minimized with appropriate dredging procedures. The construction impacts may be comparable to those created by the installation and removal of the four temporary barriers each year. Operation of the tidal gates during Stage 1 of Alternative 2B will provide substantial water quality benefits at many south Delta channel locations. The simulated effects of Alternative 2B Stage 1 on EC will be identical to those already shown for Alternative 2A Stage 1. Therefore, Impacts WQ-1 through WQ-13 as described under Alternative 2A, would also occur under Alternative 2B.

Stage 2 (Operational Component)

The major operational assumptions for Alternative 2B Stage 2 are described in Chapter 2. Maximum SWP Pumping of 8,500 cfs is simulated by CALSIM in more months than for the No Action Alternative, because the 8,500 cfs limit applies in July–November. However, other Delta operating criteria may limit the SWP pumping to less than 8,500 cfs in many months.

Only the monthly operational patterns of Alternative 2B would be slightly different from those simulated for Alternative 2B. Table 5.3-5 gives the simulated EC changes for Alternative 2B and indicates that the simulated changes in EC at Emmaton and Jersey Point (WQ-14 and WQ-15) for Alternative 2B were nearly identical to those for Alternative 2A and were less than significant.

Table 5.3-5. DSM2-Simulated Electrical Conductivity Changes for Alternative 2B Stage 2 for the 1976–1991 Period

	EC Base Average	EC Alternative Average	EC Change	EC % Change	Number of Increases >10% Base	Average >10% Increase	Number of Increases >100 µS/cm	Average of Increases >100 µS/cm
A. 2001 Conditions								
Emmaton	1,074	1,098	24	2.2	15	270	21	257
Jersey Point	1,079	1,099	20	1.9	17	242	19	245
Rock Slough	532	540	9	1.6	14	90	5	133
Old River at SR 4	468	478	10	2.1	15	72	2	135
SWP Banks	447	457	10	2.3	15	59	1	137
CVP Tracy	530	479	-51	-9.6	9	81	2	103
Old River at Tracy Boulevard	595	496	-99	-16.6	11	112	5	169
Middle River at Mowry Bridge	601	436	-165	-27.5	6	48	0	–
Grant Line Canal at Tracy Boulevard	595	550	-45	-7.6	12	57	0	–
B. 2020 Conditions								
Emmaton	1,072	1,091	19	1.7	20	318	22	319
Jersey Point	1,081	1,103	22	2.0	19	395	25	333
Rock Slough	539	548	10	1.8	19	137	11	195
Old River at SR 4	469	480	11	2.4	18	115	9	178
SWP Banks	446	459	13	2.8	26	76	5	192
CVP Tracy	526	481	-44	-8.4	14	104	4	170
Old River at Tracy Boulevard	595	499	-96	-16.1	13	113	6	167
Middle River at Mowry Bridge	603	435	-167	-27.8	5	54	0	–
Grant Line Canal at Tracy Boulevard	601	552	-49	-8.2	11	60	0	–

EC = electrical conductivity (in µS/cm).
µS/cm = microSiemens per centimeter.

Impact WQ-16: Salinity Changes at Rock Slough Resulting from Stage 2. Figure 5.3-42 shows the monthly EC values for Alternative 2B in Rock Slough and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. Table 5.3-5A indicates that the average EC at Rock Slough for the 2001 baseline No Action Alternative was 532 µS/cm. The average simulated EC for Alternative 2B was 540 µS/cm. The average increase at Rock Slough was therefore only about 10 µS/cm (2.1% of the baseline average). No mitigation is required.

Impact WQ-17: Salinity Changes in Old River at State Route 4 Bridge Resulting from Stage 2. Figure 5.3-43 shows the monthly EC values for Alternative 2B at Old River at the SR 4 Bridge and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. Table 5.3-5A indicates that the average EC at Old River at the SR 4 Bridge for the 2001 baseline No Action Alternative for the 16-year period simulated with DSM2 was 468 µS/cm. The average simulated EC for Alternative 2B was 478 µS/cm. The average increase at SR 4 was therefore about 10 µS/cm (2.1% of the baseline average). No mitigation is required.

Impact WQ-18: Salinity Changes at Clifton Court Forebay (SWP Banks Pumping Plant) Resulting from Stage 2. Figure 5.3-44 shows the monthly EC values for Alternative 2B at CCF, which provides the water for export at SWP Banks, and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. Table 5.3-5A indicates that the average EC at CCF for the 2001 baseline No Action Alternative was 447 µS/cm. The average simulated EC for Alternative 2B was 457 µS/cm. The average increase at SWP Banks was therefore about 11 µS/cm (2.3% of the baseline average). No mitigation is required.

Impact WQ-19: Salinity Changes at CVP Tracy Pumping Plant Resulting from Stage 2. Figure 5.3-45 shows the monthly EC values for Alternative 2B at CVP Tracy and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. Table 5.3-5A indicates that the average EC at CVP Tracy for the 2001 baseline No Action Alternative was 530 µS/cm. The average simulated EC for Alternative 2B was 479 µS/cm. The average reduction at CVP Tracy was therefore about 51 µS/cm (9.6% of the baseline average). This is a substantial improvement in EC values that results from the tidal gate operations. No mitigation is required.

Impact WQ-20: Salinity Changes in Old River at Tracy Boulevard Bridge Resulting from Stage 2. Figure 5.3-46 shows the monthly EC values for Alternative 2B in Old River at the Tracy Boulevard Bridge and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. The applicable EC objective at the Old River at Tracy Boulevard Bridge is 700 µS/cm during the April–August irrigation season and 1,000 µS/cm in the remainder of the months. The monthly change criterion (10% of maximum) is therefore 70 µS/cm during the irrigation season and 100 µS/cm in the remaining months. The bottom graph indicates the changes in EC in Old River at the Tracy Boulevard Bridge, with the Alternative 2B EC values plotted against the No Action EC values. The solid dots indicate months when the EC objective is 700 µS/cm. A change that is slightly below the red line would indicate a significant monthly change in these months.

Table 5.3-4 indicates that the average EC at Old River at the Tracy Boulevard Bridge for the 2001 baseline No Action Alternative was 595 µS/cm. The average simulated EC for Alternative 2B was 496 µS/cm. The average reduction in Old River at the Tracy Boulevard Bridge was therefore about 99 µS/cm (16.6% of the baseline average). This is a very substantial improvement in EC that was achieved with tidal gate operations. No mitigation is required.

Impact WQ-21: Salinity Changes in Grant Line Canal at Tracy Boulevard Bridge Resulting from Stage 2. Figure 5.3-47 shows the monthly EC values for Alternative 2B in Grant Line Canal at the Tracy Boulevard Bridge and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. Table 5.3-5A indicates that the average EC in Grant Line Canal at the Tracy Boulevard Bridge for the 2001 baseline No Action Alternative was 595 µS/cm. The average simulated EC for Alternative 2B was 550 µS/cm. The average reduction in Grant Line Canal at the Tracy Boulevard Bridge was 45 µS/cm (7.6% of baseline). No mitigation is required.

Impact WQ-22: Salinity Change in Middle River at Mowry Bridge Resulting from Stage 2. Figure 5.3-48 shows the monthly EC values for Alternative 2B in Middle River at the Mowry Bridge and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2.

Table 5.3-5A indicates that the average EC at Middle River at the Mowry Bridge for the 2001 baseline No Action Alternative was 601 µS/cm. The average simulated EC for Alternative 2B was reduced to 436 µS/cm. The average reduction in Middle River at the Mowry Bridge was therefore 165 µS/cm (27.5% of the baseline average). This is a very substantial improvement in EC that was achieved with tidal gate operations. No mitigation is required.

Impacts WQ-23 to WQ-26: Increases in Dissolved Organic Carbon at Water Supply Intakes Resulting from Stage 2. The DSM2-simulated changes in DOC for Alternative 2B are nearly identical to the simulated changes for Alternative 2A. The simulated DOC values for Alternative 2B are given in Table 5.3-6. The simulated DOC changes for Alternative 2B are less than significant. No mitigation is required.

Impact WQ-27: Changes in Stockton Deep Water Ship Channel Dissolved Oxygen Concentrations Resulting from Stage 2. The monthly average San Joaquin River flows at Stockton simulated by DSM2 for Alternative 2B are nearly identical to those simulated for Alternative 2A because the simulated gate operations are the same for these alternatives. The estimated effects on DO of Alternative 2B are therefore nearly identical to those estimated for Alternative 2A.

Figure 5.3-49 shows that the estimated effect of Alternative 2B simulated flows on the Stockton DWSC DO was to increase the DO by as much as 1 mg/l (equivalent to a flow increase of 500 cfs). There are some months when the estimated DO concentrations were reduced because the simulated flows at Stockton were reduced (by the 500 cfs assumed Old River diversion). This would be identified as a significant DO impact, except that this reduction in flow would not actually occur under Stage 2 operations of the head of Old River gate.

Gate operations will reduce the Old River diversions that would have occurred under existing conditions. The possible effects of increased pumping on the head of Old River diversions will be controlled with the gate to provide increased flows at Stockton. The calculated DO impacts are summarized in Table 5.3-2 for Alternative 2B. The average DO for the June–October period for Alternative 2B was 5.03 mg/l, an average of 0.16 mg/l more than the 2001 baseline average DO value for these months. This is a benefit for DO concentrations in the DWSC that resulted from the head of Old River tidal gate operations. No mitigation is required.

2020 Conditions

The water quality benefits for Alternative 2B Stage 2 under 2020 conditions are assumed to be the same as the benefits described above for Alternative 2B Stage 2 under 2001 conditions. DSM2-simulated EC values for Alternative 2B Stage 2 under 2020 conditions are presented in Table 5.3-5B.

Table 5.3-6. DSM2-Simulated Dissolved Organic Carbon Values for Alternative 2B under 2001 Conditions for the 1976–1991 Period

	DOC Base Average	DOC Alternative Average	DOC Change	DOC % Change	Number of Changes >0.4 mg/l	Average Change >0.4 mg/l
2001						
Rock Slough	3.37	3.36	-0.01	-0.4	2	0.81
Old River at State Route 4	3.73	3.78	0.05	1.3	13	0.65
CVP Tracy Pumping Plant	3.71	3.68	-0.04	-1.0	4	0.57
SWP Banks Pumping Plant	3.80	3.78	-0.02	-0.4	2	0.55

DOC = dissolved organic carbon.
mg/l = milligrams per liter.

Alternative 2C

Stage 1 (Physical/Structural Component)

The physical/structural component of Alternative 2C are identical to those of Alternative 2A. Construction of the tidal gates will only temporarily influence water quality in the south Delta channels. Localized effects during construction and dredging of channels will be minimized with appropriate dredging procedures. The construction impacts may be comparable to those created by the installation and removal of the four temporary barriers each year. Operation of the tidal gates during Stage 1 of Alternative 2C will provide substantial water quality benefits at many south Delta channel locations. The simulated effects of Alternative 2C Stage 1 on EC will be identical to those already shown for Alternative 2A Stage 1. Therefore, Impacts WQ-1 through WQ-13 as described under Alternative 2A, would also occur under Alternative 2C.

2020 Conditions

The water quality impacts associated with dredging and construction and operation of tidal gates under the 2020 conditions for Stage 1 of Alternative 2C would be essentially the same as described above for Stage 1 of Alternative 2A under 2001 conditions.

Stage 2 (Operational Component)

The major operational assumptions for Alternative 2C Stage 2 are described in Chapter 2. Maximum SWP pumping of 8,500 cfs is simulated by CALSIM in more months than for the No Action Alternative, because the 8,500-cfs limit applies in July–March. However, other Delta operating criteria may limit the SWP pumping to less than 8,500 cfs in many months.

Only the monthly operational patterns of Alternative 2C would be slightly different from those simulated for Alternative 2A. Table 5.3-7 gives the simulated EC changes for Alternative 2C and indicates that the simulated changes in EC at Emmaton and Jersey Point (WQ-14 and WQ-15) for Alternative 2C were nearly identical to those for Alternative 2A and were less than significant.

Table 5.3-7. DSM2-Simulated Electrical Conductivity Changes for Alternative 2C Stage 2 for the 1976–1991 Period

	EC Base Average	EC Alternative Average	EC Change	EC % Change	Number of Increases >10% Base	Average >10% Increase	Number of Increases >100 µS/cm	Average of Increases >100 µS/cm
A. 2001 Conditions								
Emmaton	1,074	1,100	27	2.5	19	235	22	251
Jersey Point	1,079	1,109	30	2.8	24	225	26	231
Rock Slough	532	543	11	2.1	17	97	5	163
Old River at SR 4	468	480	12	2.6	18	81	3	162
SWP Banks	447	459	12	2.7	18	67	2	175
CVP Tracy	530	482	-49	-9.2	10	88	2	117
Old River at Tracy Blvd	595	498	-96	-16.2	13	113	6	168
Middle River at Mowry Bridge	601	436	-164	-27.4	6	47	0	
Grant Line Canal at Tracy Boulevard	595	550	-45	-7.5	11	55	0	
B. 2020 Conditions								
Emmaton	1,072	1,096	24	2.3	25	247	27	275
Jersey Point	1,081	1,117	35	3.3	29	325	32	320
Rock Slough	539	553	14	2.6	25	130	14	187
Old River at SR 4	469	484	15	3.2	9	298	11	172
SWP Banks	446	462	15	3.4	23	91	7	178
CVP Tracy	526	484	-41	-7.8	15	106	5	162
Old River at Tracy Blvd	595	502	-93	-15.6	13	116	6	176
Middle River at Mowry Bridge	603	436	-167	-27.6	5	54	0	
Grant Line Canal at Tracy Boulevard	601	552	-49	-8.2	11	61	0	

EC = electrical conductivity (in µS/cm).
µS/cm = microSiemens per centimeter.

Impact WQ-16: Salinity Changes at Rock Slough Resulting from Stage 2. Figure 5.3-50 shows the monthly EC values for Alternative 2C in Rock Slough and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. Table 5.3-7A indicates that the average EC at Rock Slough for the 2001 baseline No Action Alternative was 532 µS/cm. The average simulated EC for Alternative 2C was 543 µS/cm. The average increase at Rock Slough was therefore about 11 µS/cm (2.1% of the baseline average). This impact is less than significant. No mitigation is required.

Impact WQ-17: Salinity Changes in Old River at State Route 4 Bridge Resulting from Stage 2. Figure 5.3-51 shows the monthly EC values for Alternative 2C in Old River at the SR 4 Bridge and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. Table 5.3-7A indicates that the average EC at Old River at the SR 4 Bridge for the 2001 baseline No Action Alternative for the 16-year period simulated with DSM2 was 468 µS/cm. The average simulated EC for Alternative 2C was 480 µS/cm. The average increase at the SR 4 Bridge was therefore about 12 µS/cm (2.6% of the baseline average). This impact is less than significant. No mitigation is required.

Impact WQ-18: Salinity Changes at Clifton Court Forebay (SWP Banks Pumping Plant) Resulting from Stage 2. Figure 5.3-52 shows the monthly EC values for Alternative 2C at CCF and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. Table 5.3-7A indicates that the average EC at CCF for the 2001 baseline No Action Alternative was 447 µS/cm. The average simulated EC for Alternative 2C was 459 µS/cm. The average increase at SWP Banks was therefore about 12 µS/cm (2.7% of the baseline average). This impact is less than significant. No mitigation is required.

Impact WQ-19: Salinity Changes at CVP Tracy Pumping Plant Resulting from Stage 2. Figure 5.3-53 shows the monthly EC values for Alternative 2C at CVP Tracy and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. Table 5.3-7A indicates that the average EC at CVP Tracy for the 2001 baseline No Action Alternative was 530 µS/cm. The average simulated EC for Alternative 2C was 482 µS/cm. The average reduction at CVP Tracy was therefore about 49 µS/cm (9.2% of the baseline average). This is a substantial improvement in EC values that results from the tidal gate operations. No mitigation is required.

Impact WQ-20: Salinity Changes in Old River at Tracy Boulevard Bridge Resulting from Stage 2. Figure 5.3-54 shows the monthly EC values for Alternative 2C in Old River at the Tracy Boulevard Bridge and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. Table 5.3-7A indicates that the average EC at Old River at the Tracy Boulevard Bridge for the 2001 baseline No Action Alternative was 595 µS/cm. The average simulated EC for Alternative 2C was 498 µS/cm. The average reduction in Old River at the Tracy Boulevard Bridge was therefore about 96 µS/cm (16.2% of the baseline average). This is a very substantial improvement in EC that was achieved with tidal gate operations. No mitigation is required.

Impact WQ-21: Salinity Changes in Grant Line Canal at Tracy Boulevard Bridge Resulting from Stage 2. Figure 5.3-55 shows the monthly EC values for Alternative 2C in Grant Line Canal at the Tracy Boulevard Bridge and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. Table 5.3-7A indicates that the average EC at Grant Line Canal at the Tracy Boulevard Bridge for the 2001 baseline No Action Alternative was 595 µS/cm. The average simulated EC for

Alternative 2C was 550 µS/cm. This is a substantial improvement in EC that was achieved with tidal gate operations. No mitigation is required.

Impact WQ-22: Salinity Change in Middle River at Mowry Bridge Resulting from Stage 2. Figure 5.3-56 shows the monthly EC values for Alternative 2C at Middle River at the Mowry Bridge and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. Table 5.3-7A indicates that the average EC at Middle River at the Mowry Bridge for the 2001 baseline No Action Alternative was 601 µS/cm. The average simulated EC for Alternative 2C was reduced to 436 µS/cm. This is a very substantial improvement in EC that was achieved with tidal gate operations. No mitigation is required.

Impacts WQ-23 to WQ-26: Increases in Dissolved Organic Carbon at Water Supply Intakes Resulting from Stage 2. The DSM2-simulated changes in DOC for Alternative 2C are nearly identical to the simulated changes for Alternative 2A. The simulated DOC values for Alternative 2C are given in Table 5.3-8. The simulated DOC changes for Alternative 2C are less than significant. No mitigation is required.

Table 5.3-8. DSM2-Simulated Dissolved Organic Carbon Values for Alternative 2C under 2001 Conditions for the 1976–1991 Period

	DOC Base Average	DOC Alternative Average	DOC Change	DOC % Change	Number of Changes >0.4 mg/l	Average Change >0.4 mg/l
2001						
Rock Slough	3.37	3.34	-0.03	-0.9	1	0.74
Old River at State Route 4	3.73	3.78	0.05	1.3	13	0.64
CVP Tracy Pumping Plant	3.71	3.68	-0.04	-1.0	2	0.70
SWP Banks Pumping Plant	3.80	3.78	-0.02	-0.4	2	0.52

DOC = dissolved organic carbon.
mg/l = milligrams per liter.

Impact WQ-27: Changes in Stockton Deep Water Ship Channel Dissolved Oxygen Concentrations Resulting from Stage 2. The monthly average San Joaquin River flows at Stockton simulated by DSM2 for Alternative 2C are nearly identical to those simulated for Alternative 2A because the simulated gate operations are the same for these alternatives. The estimated effects on DO of Alternative 2C are therefore nearly identical to those estimated for Alternative 2A.

Figure 5.3-57 shows that the estimated effect of Alternative 2C DSM2-simulated Stockton flows on the Stockton DWSC DO was to increase the DO by as much as 1 mg/l (equivalent to a flow increase of 500 cfs). There are some months when the estimated DO concentrations were reduced because the simulated flows at Stockton were reduced (by the 500 cfs assumed Old River diversion). This would be identified as a significant DO impact, except that this reduction in flow would not actually occur under Stage 2 operations of the head of Old River gate. Gate operations will reduce the Old River diversions that would have occurred under existing conditions. The possible effects of increased pumping on the head of Old River diversions will be controlled with the gate to provide increased flows at Stockton. Table 5.3-2 indicates that the average calculated DO for Alternative 2C was about 0.16 more than the 2001 baseline value. This is a benefit for DO concentrations in the DWSC that resulted from the head of Old River tidal gate operations. No mitigation is required.

2020 Conditions

The water quality benefits for Alternative 2C under 2020 conditions are assumed to be the same as the benefits described above for Alternative 2C under 2001 conditions. DSM2-simulated EC values for Alternative 2C under 2020 conditions are presented in Table 5.3-7B.

Alternative 3B

Stage 1 (Physical/Structural Component)

Construction of the tidal gates will only temporarily influence water quality in the south Delta channels. Localized effects during construction and dredging of channels will be minimized with appropriate dredging procedures. Alternative 3B does not include the proposed gate at Grant Line Canal and calls for slightly less dredging activity, resulting in less potential for surface water contamination from dredging and disposal operations. The construction impacts may be comparable to those created by the installation and removal of the four temporary barriers each year. Operation of the tidal gates during Stage 1 of Alternative 3B will provide substantial water quality benefits at many south Delta channel locations. The simulated effects of Alternative 3B Stage 1 on EC will be similar to those already shown for Alternative 2A Stage 1. Therefore, Impacts WQ-1 through WQ-13 as described under Alternative 2A, would also occur under Alternative 3B.

2020 Conditions

The water quality impacts associated with dredging and construction and operation of tidal gates under the 2020 conditions for Alternative 3B would be essentially the same as described above for Alternative 2A under 2001 conditions.

Stage 2 (Operational Component)

The major operational assumptions for Alternative 3B Stage 2 are described in Chapter 2. They are the same as for Stage 2 of Alternative 2B. Table 5.3-9 gives the simulated EC changes for Alternative 3B Stage 2 and indicates that the simulated changes in EC at Emmaton and Jersey Point (WQ-14 and WQ-15) for

Alternative 3B were identical to those for Alternative 2B and were less than significant.

The simulated changes in EC at the CCWD Rock Slough and Los Vaqueros intakes (Impacts WQ-16 and WQ-17) were also identical to those simulated for Alternative 2B. Some EC changes associated with Alternative 3B Stage 2 were simulated in the south Delta channels.

Table 5.3-9. DSM2-Simulated Electrical Conductivity Changes for Alternative 3B Stage 2 for the 1976–1991 Period

	EC Base Average	EC Alternative Average	EC Change	EC % Change	Number of Increases >10% Base	Average >10% Increase	Number of Increases >100 µS/cm	Average of Increases >100 µS/cm
A. 2001 Conditions								
Emmaton	1,074	1,098	24	2.2	15	271	21	258
Jersey Point	1,079	1,099	19	1.8	17	242	19	244
Rock Slough	532	540	8	1.5	14	90	5	133
Old River at SR 4	468	477	9	1.9	14	75	2	136
SWP Banks	447	457	10	2.3	14	59	1	136
CVP Tracy	530	480	-50	-9.5	8	84	2	101
Old River at Tracy Blvd	595	496	-99	-16.7	12	102	5	158
Middle River at Mowry Bridge	601	430	-171	-28.4	5	44	0	–
Grant Line Canal at Tracy Boulevard	595	541	-54	-9.1	12	56	0	–
B. 2020 Conditions								
Emmaton	1072	1091	19	1.7	20	318	22	320
Jersey Point	1081	1102	21	1.9	19	394	24	342
Rock Slough	539	548	9	1.7	19	137	11	195
Old River at SR 4	469	479	10	2.2	18	115	9	179
SWP Banks	446	459	12	3	24	79	5	193
CVP Tracy	526	482	-44	-8.3	14	104	5	159
Old River at Tracy Blvd	595	498	-97	-16.3	13	107	6	158
Middle River at Mowry Bridge	603	430	-173	-29	5	50	0	–
Grant Line Canal at Tracy Boulevard	601	542	-59	-9.8	11	58.6	0	–

EC = electrical conductivity (in µS/cm).
µS/cm = microSiemens per centimeter.

Impact WQ-18: Salinity Changes at Clifton Court Forebay (SWP Banks Pumping Plant) Resulting from Stage 2. Figure 5.3-58 shows the monthly EC values for Alternative 3B Stage 2 at CCF, and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by

DSM2. Table 5.3-9A indicates that the average EC at CCF for the 2001 baseline No Action Alternative was 447 µS/cm. The average simulated EC for Alternative 3B was 457 µS/cm. The average increase at SWP Banks was therefore about 10 µS/cm (2.3% of the baseline average). Because this long-term increase is less than 5% of the baseline average, the simulated changes at SWP Banks are considered to be less than significant. No mitigation is required.

Impact WQ-19: Salinity Changes at CVP Tracy Pumping Plant Resulting from Stage 2. Figure 5.3-59 shows the monthly EC values for Alternative 3B Stage 2 at CVP Tracy and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. Table 5.3-9A indicates that the average EC at CVP Tracy for the 2001 baseline No Action Alternative was 530 µS/cm. The average simulated EC for Alternative 3B Stage 2 was reduced to 480 µS/cm. The average decrease at CVP Tracy was therefore about 50 µS/cm (9.5% below the baseline average). Because this long-term average EC is reduced compared to the baseline, this is a significant benefit for water quality that was achieved with tidal gate operations. No mitigation is required.

Impact WQ-20: Salinity Changes in Old River at Tracy Boulevard Bridge Resulting from Stage 2. Figure 5.3-60 shows the monthly EC values for Alternative 3B Stage 2 in Old River at the Tracy Boulevard Bridge and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. The solid dots indicate months when the EC objective is 700 µS/cm. A change that is slightly below the red line would indicate a significant monthly change in these months.

Table 5.3-9A indicates that the average EC at Old River at the Tracy Boulevard Bridge for the 2001 baseline No Action Alternative was 595 µS/cm. The average simulated EC for Alternative 3B was reduced to 496 µS/cm. The average decrease in Old River at the Tracy Boulevard Bridge was therefore about 99 µS/cm (16.7% below the baseline average). Because this long-term average EC is reduced substantially compared to the baseline, there is a significant water quality benefit that was achieved with tidal gate operations. No mitigation is required.

Impact WQ-21: Salinity Changes in Grant Line Canal at Tracy Boulevard Bridge Resulting from Stage 2. Figure 5.3-61 shows the monthly EC values for Alternative 3B Stage 2 in Grant Line Canal at the Tracy Boulevard Bridge and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. Table 5.3-9A indicates that the average EC in Grant Line Canal at the Tracy Boulevard Bridge for the 2001 baseline No Action Alternative was 595 µS/cm. The average simulated EC for Alternative 3B Stage 2 was 541 µS/cm. The average reduction in Grant Line Canal at Tracy Boulevard Bridge was therefore about 54 µS/cm (9.1% of the baseline average). Because this long-term reduction is more than 5% of the baseline average, the simulated changes at Grant Line Canal at Tracy Boulevard Bridge are considered to be a significant water quality benefit that was achieved with tidal gate operations. No mitigation is required.

Impact WQ-22: Salinity Changes in Middle River at Mowry Bridge Resulting from Stage 2. Figure 5.3-62 shows the monthly EC values for Alternative 3B Stage 2 in Middle River at the Mowry Bridge and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. Table 5.3-9A indicates that the average EC at Middle River at the Mowry Bridge for the 2001 baseline No Action Alternative was 601 µS/cm. The average simulated EC for Alternative 3B was reduced to 430 µS/cm. The average decrease at Middle River at the Mowry Bridge was therefore 171 µS/cm (28.4% below the baseline average). This is a substantial water quality benefit that was achieved with tidal gate operations. No mitigation is required.

Impacts WQ-23 to WQ-26: Increases in Dissolved Organic Carbon at Water Supply Intakes Resulting from Stage 2. The DOC concentrations were not simulated with DSM2 for Alternative 3B, because DOC is not expected to substantially change with south Delta tidal gate operations. The DOC impacts would be similar to those simulated for Alternative 2B. The expected DOC changes for Alternative 3B are less than significant. No mitigation is required.

Impact WQ-27: Changes in Stockton Deep Water Ship Channel Dissolved Oxygen Concentrations Resulting from Stage 2. The monthly average San Joaquin River flows at Stockton simulated by DSM2 for Alternative 3B are similar to those simulated for the other SDIP alternatives, because the simulated head of Old River fish control gate operations are the same for all of these alternatives.

Figure 5.3-63 shows that the estimated effect of Alternative 3B simulated Stockton flows on the Stockton DWSC DO was to increase the DO by as much as 1 mg/l (equivalent to a flow increase of 500 cfs). There are some months when the estimated DO concentrations were reduced because the simulated flows at Stockton were reduced (by the 500 cfs assumed Old River diversion). This would be identified as a significant DO impact, except that this reduction in flow would not actually occur under Stage 2 operations of the head of Old River gate. Gate operations will reduce the Old River diversions that would have occurred under existing conditions. The possible effects of increased pumping on the head of Old River diversions will be controlled with the gate to provide increased flows at Stockton. Table 5.3-2 gives the calculated changes in DO for Alternative 3B Stage 2. The average DO was increased by 0.13 mg/l with Alternative 3B. No mitigation is required.

2020 Conditions

The water quality benefits for Alternative 3B under 2020 conditions are assumed to be the same as the benefits described above for Alternative 3B under 2001 conditions. DSM2-simulated EC values for Alternative 3B under 2020 conditions are presented in Table 5.3-9B.

Alternative 4B

Stage 1 (Physical/Structural Component)

Construction of the head of Old River gate will only temporarily influence water quality in the south Delta channels. Localized effects during construction and dredging of channels will be minimized with appropriate dredging procedures. Alternative 4B includes only the head of Old River gate, resulting in less potential for surface water contamination from dredging and disposal operations. Operation of the head of Old River tidal gate during Stage 1 of Alternative 4B will provide some water quality benefits in south Delta channel locations. The simulated effects of Alternative 4B Stage 1 on EC will be similar to those shown for Alternative 4B Stage 2 shown below. Therefore, Impacts WQ-1 through WQ-13 as described under Alternative 2A, would also occur under Alternative 4B.

2020 Conditions

The water quality impacts associated with dredging and construction and operation of the head of Old River gate under the 2020 conditions for Alternative 4B would be the same as described above for Alternative 4B under 2001 conditions.

Stage 2 (Operational Component)

The major operational assumptions for Alternative 4B Stage 2 are described in Chapter 2. They are the same as for Stage 2 of Alternative 2B. Table 5.3-10 gives the simulated EC changes for Alternative 4B Stage 2 and indicates that the simulated changes in EC at Emmaton and Jersey Point (WQ-14 and WQ-15) for Alternative 3B were identical to those for Alternative 2B and were less than significant. The simulated changes in EC at the CCWD Rock Slough and Los Vaqueros intakes (Impacts WQ-16 and WQ-17) were also identical to those simulated for Alternative 2B. Some EC changes associated with Alternative 4B Stage 2 were simulated in the south Delta channels.

Table 5.3-10. DSM2-Simulated Electrical Conductivity Values for Alternative 4B Stage 2 for the 1976–1991 Period

	EC Base Average	EC Alternative Average	EC Change	EC % Change	Number of Increases >10% Base	Average >10% Increase	Number of Increases >100 µS/cm	Average of Increases >100 µS/cm
A. 2001 Conditions								
Emmaton	1,074	1,097	24	2.2	15	270	21	257
Jersey Point	1,079	1,097	18	1.6	16	242	18	250
Rock Slough	532	539	7	1.3	14	89	4	139
Old River at SR 4	468	475	7	1.5	14	74	2	134
SWP Banks	447	454	7	1.7	13	61	1	133
CVP Tracy	530	508	-22	-4.2	13	77	3	121
Old River at Tracy Blvd	595	621	27	4.5	33	160	24	193
Middle River at Mowry Bridge	601	544	-56	-9.4	15	102	9	123
Grant Line Canal at Tracy Boulevard	595	581	-14	-2.4	3	167	3	167
B. 2020 Conditions								
Emmaton	1,072	1,090	18	1.7	20	317	22	319
Jersey Point	1,081	1,101	19	1.8	18	407	23	350
Rock Slough	539	547	8	1.5	19	136	11	193
Old River at SR 4	469	477	9	1.8	18	114	9	177
SWP Banks	446	456	9	2.1	22	81	5	190
CVP Tracy	526	510	-16	-3.0	21	91	5	170
Old River at Tracy Blvd	595	624	29	4.9	31	190	23	227
Middle River at Mowry Bridge	603	546	-56	-9.4	16	97	5	132
Grant Line Canal at Tracy Boulevard	601	583	-18	-2.9	0		0	

EC = electrical conductivity.
µS/cm = microSiemens per centimeter.

Impact WQ-18: Salinity Changes at Clifton Court Forebay (SWP Banks Pumping Plant) Resulting from Stage 2. Figure 5.3-64 shows the monthly EC values for Alternative 4B Stage 2 at CCF, which provides the water for export at SWP Banks, and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. Table 5.3-10A indicates that the average EC at CCF for the 2001 baseline No Action Alternative was 447 µS/cm. The average simulated EC for Alternative 4B Stage 2 was 454 µS/cm. The average increase at SWP Banks was therefore about 7 µS/cm (1.7% of the baseline average). Because this long-term increase is less than 5% of the baseline average, the simulated changes at SWP Banks are considered to be less than significant. No mitigation is required.

Impact WQ-19: Salinity Changes at CVP Tracy Pumping Plant Resulting from Stage 2. Figure 5.3-65 shows the monthly EC values for Alternative 4B Stage 2 at CVP Tracy and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. Table 5.3-10A indicates that the average EC at CVP Tracy for the 2001 baseline No Action Alternative was 530 µS/cm. The average simulated EC for Alternative 4B Stage 2 was reduced to 508 µS/cm. The average decrease at CVP Tracy was therefore about 22 µS/cm (4.2% below the baseline average). Because this long-term average EC is reduced compared to the baseline, there is a small water quality benefit. No mitigation is required.

Impact WQ-20: Salinity Changes in Old River at Tracy Boulevard Bridge Resulting from Stage 2. Figure 5.3-66 shows the monthly EC values for Alternative 4B Stage 2 at Old River at the Tracy Boulevard Bridge and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. The solid dots indicate months when the EC objective is 700 µS/cm. A change that is slightly below the red line would indicate a significant monthly change in these months.

Table 5.3-10A indicates that the average EC at Old River at the Tracy Boulevard Bridge for the 2001 baseline No Action Alternative was 595 µS/cm. The average simulated EC for Alternative 4B was 621 µS/cm. The average increase at Old River at the Tracy Boulevard Bridge was therefore about 27 µS/cm (4.5% of the baseline average). Because this long-term increase about 5% of the baseline average, the overall change is considered to be a significant impact on baseline EC. However, several of the largest EC changes were during months when the assumed Vernalis EC (simulated by CALSIM) was greater than the EC objectives. It is unlikely that these high Vernalis EC values are correct. Furthermore, the simulated operations of the head of Old River gate could potentially be changed to allow less San Joaquin River flow into the south Delta channels. Adaptive management of the gate operations is expected to reduce this simulated impact to less than significant. No further mitigation is expected to be required.

Impact WQ-21: Salinity Change in Grant Line Canal at Tracy Boulevard Bridge Resulting from Stage 2. Figure 5.3-67 shows the monthly EC values for Alternative 4B Stage 2 at Grant Line Canal at the Tracy Boulevard Bridge and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. Table 5.3-10A indicates that the average EC in Grant Line Canal at the Tracy Boulevard Bridge for the 2001 baseline No Action Alternative was 595 µS/cm. The average simulated EC for Alternative 4B Stage 2 was reduced to 581 µS/cm. The average decrease in Grant Line Canal at the Tracy Boulevard Bridge was therefore about 14 µS/cm (2.4% below the baseline average). Because this long-term average EC is reduced compared to the baseline, there is a small water quality benefit. No mitigation is required.

Impact WQ-22: Salinity Change in Middle River at Mowry Bridge Resulting from Stage 2. Figure 5.3-68 shows the monthly EC values for

Alternative 4B Stage 2 in Middle River at the Mowry Bridge and the changes from the monthly EC values for the No Action Alternative for 1976–1991 as simulated by DSM2. Table 5.3-10A indicates that the average EC in Middle River at the Mowry Bridge for the 2001 baseline No Action Alternative was 601 µS/cm. The average simulated EC for Alternative 4B Stage 2 was reduced to 544 µS/cm. The average decrease at Middle River at the Mowry Bridge was therefore 56 µS/cm (9.4% below the baseline average). This is a significant water quality benefit resulting from the head of Old River tidal gate operation. No mitigation is required.

Impacts WQ-23 to WQ-26: Increases in Dissolved Organic Carbon at Water Supply Intakes Resulting from Stage 2. The DOC concentrations were not simulated with DSM2 for Alternative 4B, because DOC is not expected to change with south Delta tidal gate operations. The DOC impacts would be similar to those simulated for Alternative 2B. The expected DOC changes for Alternative 4B are less than significant. No mitigation is required.

Impact WQ-27: Changes in Stockton Deep Water Ship Channel Dissolved Oxygen Concentrations Resulting from Stage 2. The monthly average San Joaquin River flows at Stockton simulated by DSM2 for Alternative 4B are nearly identical to those simulated for Alternative 2B because the simulated head of Old River fish control gate operations are the same for these alternatives. The estimated effects on DO of Alternative 4B are therefore nearly identical to those estimated for Alternative 2B.

Figure 5.3-69 shows that the estimated effect of Alternative 4B simulated Stockton flows on the Stockton DWSC DO was to increase the DO by as much as 1 mg/l (equivalent to a flow increase of 500 cfs). There are some months when the estimated DO concentrations were reduced because the simulated flows at Stockton were reduced (by the 500 cfs assumed Old River diversion). This would be identified as a significant DO impact, except that this reduction in flow would not actually occur under Stage 2 operations of the head of Old River gate. Gate operations will reduce the Old River diversions that would have occurred under existing conditions. The possible effects of increased pumping on the head of Old River diversions will be controlled with the gate to provide increased flows at Stockton. Table 5.3-2 indicates that the average DO was increased by 0.13 mg/l with Alternative 4B. No mitigation is required.

2020 Conditions

The water quality benefits for Alternative 4B Stage 2 under 2020 conditions are assumed to be the same as the benefits described above for Alternative 4B Stage 2 under 2001 conditions. DSM2-simulated EC values for Alternative 4B Stage 2 under 2020 conditions are presented in Table 5.3-10B.

Water Quality Effects from Water Transfers

Water quality impacts for the SDIP alternatives have been evaluated with DSM2, based on CALSIM operational scenarios that did not include the potential future water transfers from existing upstream water districts, CVP contractors, or SWP contractors to south-of-Delta districts or water contractors. Section 5.1, Water Supply and Management, evaluated the potential for future water transfers through the delta in the months of July, August, and September. The potential for indirect water quality impacts from this additional SWP Banks export pumping has not been directly simulated with DSM2. Chapter 10 describes the cumulative effects of these additional water transfers combined with current and potential future actions or projects.

However, it is assumed that all future water transfers would be implemented (i.e., allowed) such that Delta water quality (i.e., salinity) would be protected (i.e., no increased salinity). This is normally described as a “carriage water” requirement, which is a small additional inflow that is used to increment Delta outflow during a water transfer (i.e., extra SWP Banks pumping) so that the resulting salinity at Jersey Point will remain the same as without the water transfer. DWR has traditionally imposed a carriage water requirement of about 20% on short-term water transfers through the Delta. It is therefore assumed in the water transfer analysis that the increased Delta salinity resulting from the increased pumping during a water transfer will be directly mitigated by a carriage water requirement for a slightly increased Delta outflow. Because the Delta cross-channel gates will be open during the months of July–September when the water transfers are anticipated, the actual indirect effects of the increased pumping on salinity at Jersey Point will be minimized.

Increased SWP Banks pumping during the summer months of July–September may have a slightly beneficial effect on CVP Tracy and SWP Banks water quality because the Sacramento River water quality is very good relative to the water quality of the San Joaquin River and agricultural drainage. The additional water transfers will tend to reduce the influence from these poorer quality sources of water at the CVP Tracy and SWP Banks pumping plants.

Therefore, the likely indirect effects of potential future water transfers on salinity in south Delta locations (including the CCWD intakes at Rock Slough and Old River) is assumed to be less than significant for any of the SDIP alternatives.

5.4 Geology, Seismicity, Soils, and Mineral Resources

Introduction

This section describes the existing environmental conditions and the consequences of the SDIP alternatives on geological resources such as soils and mineral resources. Specifically, it evaluates and discusses the consequences associated with construction and operation of the project. Significance of impacts is determined by using criteria set forth in the State CEQA Guidelines.

The primary concerns related to geological resources are structural damage and injury as a result of liquefaction; accelerated runoff, erosion, and sedimentation from grading, excavation, and construction activities; and structural damage and injury from development on expansive soils.

Summary of Significant Impacts

There are no significant impacts on geology, seismicity, soils, and mineral resources as a result of constructing or operating any project alternative. All impacts are discussed in detail in the Environmental Consequences section.

Affected Environment

Sources of Information

The description of existing groundwater conditions in the SDIP project area is based primarily on:

- Maps and reports by USGS
- Map and reports by the California Geological Survey (CGS),
- Maps and report by NRCS,
- San Joaquin and Contra Costa County general plans, and
- Draft EIR/EIS for the ISDP (California Department of Water Resources and Bureau of Reclamation 1996a)

Geology

This section addresses the geology, historical geology, and geomorphology of the south Delta region. Quaternary sediments and geologic hazards pertaining to the SDIP project area are emphasized.

Geology of the Project Area

The thick alluvial deposits of the SDIP project area consist of Holocene flood basin deposits, known as the Dos Palos Alluvium. Underlying these alluvial sediments are Pleistocene, Pliocene/Miocene, Jurassic, and Mesozoic/Paleozoic formations. From youn to older, these formations are older alluvium, fanglomerate deposits, Copper Hill Volcanics, Merced Falls Slate and Salt Springs Slate, Gopher Ridge Volcanics, and ultramafic rocks (Wagner et al. 1990).

Geologic formations are commonly separated by buried soil horizons, indicating that the formations were deposited in phases, separated by periods of subaerial weathering. These paleosols represent a complex intermingling of coarse sand and gravel bedload deposits, sand- and silt-sized overbank deposits, and silt- and clay-sized backswamp deposits. The recent alluvial sediments that overlie these formations are generally dark-colored, often highly organic, and of mixed lithologic composition and origin. These recent deposits have formed mostly *in situ* on top of the aforementioned deposits.

Geomorphological Alterations

Prior to the mid-1800s, the south Delta islands consisted of flood basins filled with tules and other marshland vegetation. The islands were separated by channels that were contained by natural levees of low relief that were easily overtopped by flooding episodes. Flooding was essential to the formation of peat soils as the tules died when covered by water and new growth appeared as the islands drained (Shlemon and Begg 1975). The presence of erosion-resistant clays within the banktoe of the natural levees contributed to the stability and lack of migration of the channels. The flood basins along the Sacramento and San Joaquin Rivers provided storage and conveyance during flooding episodes, gradually releasing flows downstream, so that the channels in the Delta region were only moderately taxed by floods (Gilbert 1917).

The present geomorphic state of the Delta is a function of the intensity of water management in each of the tributary rivers, local farming practices, intra- and inter-Delta water transfers, and an extensive human-made levee system. Upstream water diversions for municipalities and agriculture reduce the amount of flow entering the Delta and the amount of sediment transported to the Delta. In addition, conveyance of water within and out of the Delta alters flow directions and affects sedimentation and erosion rates and patterns. The levee system within the Delta restricts flow to a network of human-made and natural channels and levees that reduce flood events and inhibit the formation of new soils on the Delta islands.

There are approximately 1,100 miles of levees protecting the 700,000 acres of “reclaimed” marshlands and uplands in the Delta. An estimated 200,000 acres, including a majority of the islands, are below sea level at elevations as low as -25 feet (California State Lands Commission 1991).

Land Subsidence

Historically, land subsidence has been a significant problem in the southern half of the San Joaquin Valley and is a major concern in the south Delta. It has the effect of increasing the channel water pressure on levees. As a result of this increased pressure, the probability of levee failure and flooding is increased (California Department of Water Resources 1993). Consequently, the levees are in need of continual maintenance.

Subsidence occurs in three ways in the SDIP area: as a result of groundwater overdraft, compaction, and oxidation of peat soils, and hydrocompaction. Land subsidence as a result of groundwater overdraft is discussed in the Groundwater section of this chapter. Land subsidence as a result of compaction and oxidation of peat soils and/or hydrocompaction is discussed below.

Compaction of Peat Soils

Land subsidence can occur as a result of farming or reducing the frequency of flooding. Most of the south Delta islands are covered in thick layers of peat, a highly organic soil. Tillage of the peat soil, combined with reducing the frequency of flooding and construction of drainage ditches, exposes the peat soils to oxygen. This creates a chemical reaction that causes the soil to oxidize and consolidate, lowering the land level. Subsidence of this type is a major concern in the SDIP area (Figure 5.4-1).

Hydrocompaction

Hydrocompaction refers to the loss of water between peat particles as a result of compaction from farming practices. The loss of water helps to lower the surface.

Subsidence of this type is not well documented in the SDIP area; however, because this process is closely related to compaction of peat soils and associated chemical reactions, it is assumed that it is a contributing factor.

Seismicity

Seismic hazards refer to earthquake fault ground rupture, ground shaking, liquefaction and related hazards, and earthquake-induced slope failure. Ground shaking and liquefaction and related hazards (e.g., lateral spreading and differential settlement) are the most significant seismic hazards of the SDIP project area.

The purpose of the Alquist-Priolo Earthquake Fault Zoning Act (Alquist-Priolo Act) is to regulate development near active faults to mitigate the hazard of surface rupture. Faults within an Alquist-Priolo Earthquake Fault Zone are typically active faults. As defined under the Alquist-Priolo Act, an active fault is one that has had surface displacement within Holocene time (about the last 11,000 years). A potentially active fault is one that has had surface displacement during Quaternary time (last 1.6 million years).

The SDIP project area is subject to seismic hazards because of its proximity to the San Andreas fault system. Faults within the San Andreas fault system are known to be historically active and are capable of generating earthquakes with sufficient magnitude to cause strong ground motion in the project area. Several active, potentially active, and pre-Quaternary faults are located in an approximate 20-mile radius of the SDIP project area. The Hayward, Calaveras, Concord, Greenville, and Marsh Creek and Clayton Faults (both extensions of the Greenville Fault) are all considered active (Jennings 1994). All of these faults are within Alquist-Priolo Earthquake Fault Zones (Hart and Bryant 1997). Of these, the Greenville Fault Zone is closest to the SDIP project area, located about 11 miles to the west. Several other potentially active and pre-Quaternary faults are present in an approximate 20-mile radius. These include, but are not limited to, the San Joaquin, Black Butte, Vernalis, Midway, Stockton, Midland, Antioch, and Montezuma Hills Faults (Jennings 1994).

The proposed fish control gate, three flow control gates, and dredging activities would be located within the western portion of San Joaquin County. These sites are all located in Seismic Zone 3, as defined by the Uniform Building Code (UBC). The Zone 3 designation indicates earthquakes in the region have the potential to make standing difficult and to cause stucco and some masonry walls to fall. Structures must be designed to meet the regulations and standards associated with Zone 3 hazards.

Ground Shaking Hazard

The SDIP project area is located in a region of California characterized by high groundshaking hazard. Based on a probabilistic seismic hazard map that depicts the peak horizontal ground acceleration values exceeded at a 10% probability in 50 years (Petersen et al. 1996), the probabilistic peak horizontal ground acceleration values for the SDIP project area range from 0.3 to 0.4 g (where *g* is the force of gravity). This indicates that the groundshaking hazard in the SDIP project area is low to moderate.

Liquefaction and Related Hazards

Liquefaction is the most likely form of ground failure to occur in San Joaquin County. Poorly consolidated, water-saturated fine sands and silts located within 50 feet of the surface typically are considered to be the most susceptible to liquefaction. Soils and sediments that are not water-saturated and that consist of coarser or finer materials are generally less susceptible to liquefaction (California Division of Mines and Geology 1997). The susceptibility of soils and sediments to liquefaction in the CCF vicinity is very high (Association of Bay Area Governments 2001). Based on the silt/sand composition of the soils and sediments and proximity to groundwater, liquefaction hazard is expected to be relatively high for the remaining portions of the SDIP project area.

Two potential ground failure types associated with liquefaction in the south Delta are lateral spreading and differential settlement (Association of Bay Area Governments 2001). Lateral spreading involves a layer of ground at the surface being carried on an underlying layer of liquefied material over a nearly level surface toward a river channel or other open face. Lateral spreading is common in the south Delta area and poses a significant hazard (Association of Bay Area Governments 2001).

Another common hazard in the south Delta area is differential settlement, as soil compacts and consolidates to varying degrees after ground shaking ceases. Differential settlement occurs when the layers that liquefy are not of uniform thickness, a common problem when the liquefaction occurs in artificial fills. Settlement can range from 1% to 5%, depending on the cohesiveness of the sediments (Tokimatsu and Seed 1984). In the SDIP project area, where a significant portion of sediments are poorly consolidated, water-saturated, fine sands and silts, differential settlement is expected to be a significant hazard.

Soils

The soils in the south Delta have been mapped by the U.S. Department of Agriculture, Soil Conservation Service (now the NRCS) and are described in the soil surveys of Contra Costa and San Joaquin Counties (Welch 1977; McElhiney 1992). According to these surveys, soils in the south Delta are composed predominantly of loams, clays, clay loams, silty clay loams, and mucks. In general, all of these soils are very deep and very poorly to poorly drained, depending on their respective textural characteristics and depth to groundwater. The Peltier-Egbert, Merritt-Grangeville-Columbia, Rindge-Kingile, Sacramento-Omni, and Willows-Pescadero soil associations occur on the deltas, floodplains, and levees and make up the majority of soils in the SDIP project area (Table 5.4-1).

Table 5.4-1. Soil Characteristics of the SDIP Project Area

Soil Association	Soil Description
Merritt-Grangeville-Columbia	Poorly drained and somewhat poorly drained, moderately coarse-textured and medium-textured soils that are very deep and have been partially drained or drained; on floodplains
Peltier-Egbert	Poorly drained, highly organic moderately fine-textured soils that are deep and have been partially drained; on deltas and floodplains
Rindge-Kingile	Nearly level, very poorly drained, organic soils and very poorly drained, highly organic, moderately fine-textured, mineral soils, all of which are very deep and have been partially drained; on deltas and floodplains
Sacramento-Omni	Nearly level, poorly drained and very poorly drained clays and loams on deltas and floodplains
Willows-Pescadero	Poorly drained, moderately fine-textured and fine-textured, saline-sodic soils that are very deep and have been partially drained; in basins

Sources: McElhiney 1992 and Welch 1977.

Table 5.4-2 summarizes soil characteristics for the four sites where the proposed fish control gate and three flow control gates would be constructed. Soils in the SDIP project area generally have a slow runoff rate and a slight hazard of water erosion. Moderate to high shrink-swell potentials (i.e., expansive soils), caving, and land subsidence are the most limiting factors in the SDIP project area.

Expansive soils, such as clay, swell when they absorb water and shrink as they dry. The basic cause of expansion is the attraction and absorption of water in the expandable crystal structures of clays. The south Delta is an area with one of the greatest shrink-swell soil problems in San Joaquin County.

The Columbia fine sandy loam and the Grangeville fine sandy loam are subject to caving when excavated.

It is important to recognize that the soil properties described above characterize the soils in their natural, unaltered condition. The presence of levees and conversion of wetlands into agricultural land have altered soil characteristics. Soils have been effectively drained by the presence of levee and ditch construction. Additionally, the construction of the proposed fish control gate, three flow control gates, and dredging activities most likely would occur within channels, where the soil survey mapping does not accurately describe the soil characteristics.

Table 5.4-2. Soil Characteristics of the SDIP Project Component Areas

Soil Map Unit	Shrink-Swell Potential	Water Erosion Hazard	Runoff Rate
Old River at DMC Flow Control Structure			
Fluvaquents, 0–2% slopes, frequently flooded	High	Slight	Very slow
Grangeville fine sandy loam, partially drained, 0–2% slopes	Low	Slight	Slow
Pescadero clay loam, partially drained, 0–2% slopes	Moderate to high	Slight	Very slow
Willows clay, partially drained, 0–2% slopes	High	Slight	Slow
Head of Old River Fish Control Structure			
Columbia fine sandy loam, clayey substratum, partially drained, 0–2% slopes	Low to high	Slight	Slow
Merritt silty clay loam, partially drained, 0–2% slopes	Low to moderate	Slight	Slow
Grant Line Canal Flow Control Structure			
Grangeville fine sandy loam, partially drained, 0–2% slopes	Low	Slight	Slow
Peltier mucky clay loam, partially drained, 0–2% slopes	Moderate to high	Slight	Very slow
Ryde clay loam, partially drained, 0–2% slopes	Moderate	Slight	Very slow
Middle River Flow Control Structure			
Kingile muck, partially drained, 0–2% slopes	Low to moderate	Slight	Very slow
Merritt silty clay loam, partially drained, 0–2% slopes	Low to moderate	Slight	Slow
Peltier mucky clay loam, partially drained, 0–2% slopes	Moderate to high	Slight	Very slow
Rindge muck, partially drained, 0–2% slopes	Low	Slight	Very slow
Tokay fine sandy loam, 0–2% slopes	Low	Slight	Slow

Sources: McElhiney 1992 and Welch 1977.

Mineral and Natural Gas Resources

The primary extractive resources in San Joaquin County are sand, gravel, and natural gas. Peat soil, placer gold, and silver are extracted to a much lesser extent. The San Joaquin County General Plan identifies four areas in the county, referred to as sectors, containing regionally significant deposits of high-grade aggregate (sand and gravel).

One extraction site is located in the SDIP project vicinity, at the confluence of the San Joaquin and Old Rivers, near the proposed head of Old River fish control gate. This site has not been operated since 1991. Peat soil has been mined at this site since 1971. The Delta Humus Company removes the peat soil from a flooded portion of Venice Island and sells it to local growers and others who package the soil for retail sale. The Delta Humus Company is one of two companies in California that extract peat. No significant mineral resources near the SDIP project area in Contra Costa County are extracted (Contra Costa County 1996).

San Joaquin and Contra Costa Counties have long been active sites for natural gas extraction, with the Delta serving as an important natural gas source and underground gas storage area. Most natural gas extraction activities in San Joaquin and Contra Costa Counties take place in the vicinity of the south Delta. Lathrop, McDonald Island, and Union Island gas fields account for a majority of the natural gas extracted from San Joaquin County.

Environmental Consequences

Assessment Methods

Evaluation of the impacts in this section is based on the results of technical reports prepared for the project, GIS and data from the Department of Conservation Farmland Mapping and Monitoring Program, and on professional judgment. This impact analysis assumes that the project applicant will conform to the latest Caltrans and UBC standards, county general plan seismic safety standards, county grading ordinances, and National Pollutant Discharge Elimination System (NPDES) requirements.

The impact analysis is based partly on the SDIP EIR/EIS Engineering Information for Impacts Analysis, an unpublished Jones & Stokes document with information derived from existing construction-related information from the *Draft EIR/EIS Interim South Delta Program* Volumes I and II, the SDIP planning sessions between DWR and Jones & Stokes staff, and information provided by DWR Division of Engineering staff.

Regulatory Setting

The following local policies and ordinances are in place to protect people and property from geologic hazards.

Seismic Elements of the San Joaquin County and Contra Costa County General Plans

The seismic elements of the San Joaquin County and Contra Costa County general plans contain goals, objectives, and policies aimed at reducing the seismic risk to people and property. Any substantial conflict between the SDIP and these goals, objectives, and policies would constitute a significant impact.

National Pollutant Discharge Elimination System Program

As of February 2003, EPA requires that the project proponent or contractor apply for a storm water permit and develop a SWPPP for ground-disturbing activities that would affect 1 acre or more under the NPDES program. For the purposes of the NPDES program, construction activities are defined as clearing, excavating, grading, or other land-disturbing activities. The State of California has been delegated by EPA to administer this permit, which authorizes stormwater discharges to waters of the United States under its General Permit for Storm Water Discharges Associated with Construction Activities.

The SWPPP describes proposed construction activities, receiving waters, stormwater discharge locations, and BMPs that will be used to reduce project construction effects on receiving water quality. The components of the SWPPP most relevant to geologic resources are erosion and sediment control measures, described in the Environmental Commitments section of Chapter 2.

Significance Criteria

The standards of significance described in NEPA, CEQA, and seismic elements of the San Joaquin County and Contra Costa County general plans were used in this analysis, as described below.

The NEPA CEQ regulations require a discussion of direct and indirect effects of the proposed alternatives (40 CFR 1508.8). Any possible conflicts between the proposed action and the objectives of any land use plans, policies, and controls in the area affected also must be discussed. In determining significance, NEPA requires that context and intensity of the effects be considered. Cumulative impacts also must be analyzed according to NEPA.

Appendix G of the State CEQA Guidelines provides guidance for evaluation of project effects on geologic and mineral resources. Based on these guidelines, the project is considered to have a significant impact on the geology, soils, or mineral resources if it would:

- expose people or structures to rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault;
- expose people or structures to strong seismic ground shaking;
- expose people or structures to seismic-related ground failure, including liquefaction;
- expose people or structures to landslides;
- result in substantial soil erosion or the loss of topsoil;

- be located on a geologic unit or soil that is unstable or that would become unstable as a result of the project and potentially result in an on-site or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse;
- be located on expansive soil, as defined in Table 18-1-B of the UBC (1995), creating substantial risks to life or property.

CALFED Programmatic Mitigation Measures

The August 2000 CALFED Programmatic ROD includes mitigation measures for agencies to consider and use where appropriate in the development and implementation of project-specific actions. The mitigation measures address the short-term, long-term and cumulative effects of the CALFED Program.

These programmatic mitigation measures are numbered as they appear in the ROD, and only those measures relevant to the SDIP resource area are listed below; therefore, numbering may appear out of sequence. To see a full listing of CALFED programmatic mitigation measures, please refer to Appendix E, “Mitigation Measures Adopted in the CALFED Record of Decision.”

Geology and Soils Mitigation Measures

1. Protect flooded Delta island inboard levee slopes against wind and wave erosion with vegetation, soil matting, or rock.
2. Protect exposed soils with mulches, geotextiles, and vegetative ground covers to the extent possible during and after project construction activities in order to minimize soil loss.
3. Implement erosion control measures and bank stabilization projects.
4. Reuse dredged materials to reduce or replace soil loss.
5. Prepare and implement best construction management plans.
6. Prepare and implement construction mitigation plans.
7. Modify storage facility operations to maintain the frequency, magnitude, and duration of flows necessary to maintain and restore downstream riparian habitat.

Groundwater Mitigation Measure

24. Design new levees and improve existing levees to withstand hydraulic stresses and seepage from flooding Delta islands.

Alternative 1 (No Action)

Under the No Action Alternative, the project components described below, including fish control and flow control gates, would not be built or operated; and diversion and pumping would not increase. There would be no impact on geologic resources, and existing conditions as described above would remain. Annual installation of temporary barriers would not result in significant impacts on or hazards related to geology and soils.

2020 Conditions

Under the future no action conditions (2020 conditions) SDIP would not be implemented. It is expected that the temporary barriers program would continue and that no significant impacts on or hazards related to geology and soils would result. Conditions would be similar to those described under existing conditions.

Alternatives 2A, 2B, and 2C

Stage 1 (Physical/Structural Component)

Fish Control Gate and Flow Control Gates

Impact GEO-1: Potential Structural Damage and Injury from Ground Shaking. A large earthquake could cause low to moderate ground shaking in the project area. Anticipated ground acceleration at the site (0.3–0.4 g) is great enough to cause structural damage to the fish control gate, three flow control gates, and associated structures. Although the potential for moderate ground shaking exists in the vicinity of proposed gates, this impact is considered less than significant because DWR has incorporated requirements for standard UBC and general plan construction standards into the project design to minimize the potential groundshaking hazards on gate facilities. No mitigation is required. Please refer to Environmental Commitments in Chapter 2, “Project Description.”

Impact GEO-2: Potential Structural Damage and Injury from Development on Materials Subject to Liquefaction. A large earthquake could cause moderate groundshaking in the project area, potentially resulting in liquefaction and associated ground failure such as lateral spreading and differential settlement. Anticipated ground acceleration at the site (0.3–0.4 g) is anticipated to be great enough to cause liquefaction of the dense granular materials beneath the project area. It is assumed that a geotechnical report will be prepared by a qualified engineer prior to any construction activities. This report will include documentation of any soils that may be subject to liquefaction hazard. The SDIP environmental commitment to incorporate requirements for standard UBC and general plan construction standards into the project design to minimize the potential groundshaking hazards on gate facilities would reduce this impact to be less than significant.

Impact GEO-3: Potential Downstream Erosion from Sudden Increase in Channel Discharge. If the fish control gate and/or three flow control gates were damaged as a result of ground shaking or liquefaction, the potential exists that the sudden release of water held behind the control gate could erode channel banks or scour the channel bottom in the vicinity of gates. Results of DSM2 indicate that under Alternatives 2A–2C, channel level would remain within approximately 1 foot of the present level in most areas. The volume of water released as a result of fish control or flow control gate failure would be relatively small and the energy from this water volume would dissipate quickly, reducing the potential for channel bank or bottom scouring. Additionally, riprap would be used as slope protection on existing levees near the fish and flow control gates, minimizing the potential for bank erosion. This impact is less than significant. No mitigation is required.

Impact GEO-4: Potential Accelerated Runoff, Erosion, and Sedimentation from Grading, Excavation, and Levee Construction Activities. Grading, excavation, removal of vegetation cover, and loading activities associated with constructing gates under these alternatives could temporarily increase erosion and sedimentation in the construction area. Although construction activities at these locations could also result in soil compaction and wind erosion effects that could adversely affect soils and reduce the revegetation potential at the construction sites and staging areas, these impacts are considered to be less than significant because DWR will implement a SWPPP. No mitigation is required. Please refer to Environmental Commitments in Chapter 2, “Project Description.”

Impact GEO-5: Decrease in Levee Stability from Proposed Construction Activities. Levees in the project area are prone to structural failures associated with liquefaction, slumping, and differential settlement. Contributing factors include poor construction materials, erosion by current and wave action, seepage through or under the levee, rodent burrows, and improper levee repairs (California Department of Water Resources 1982a). The SDIP already includes measures in the project description to ensure the protection of the adjacent levees near the fish control gate and the three flow control gates, including riprap for slope protection on existing levees and design specifications for the proposed new levee section at the Old River at DMC flow control gate. These measures are based on CALFED Geology and Soils Mitigation Measures 3, 4, 5, and 18 and CALFED Groundwater Mitigation Measure 24. These measures are also described in the ISDP, Byron Tract–Old River Levee Waterside Stability Analysis (California Department of Water Resources and Bureau of Reclamation 1996b) and include limiting removal of material to the center two-thirds of the width of the existing channel; maintaining a minimum side slope of 3:1 along the new cross sections; and designing a series of benches for the new cross section. This impact is less than significant. No mitigation is required.

Impact GEO-6: Potential Structural Damage and Injury from Development on Expansive Soils. Most soils with moderate to high shrink-swell potential in sites to be graded or excavated for the construction of the fish control gate and the flow control gates may have been disturbed by prior levee construction. These soils include Columbia fine sandy loam, clayey substratum and Merritt silty clay loam at the site of the head of Old River fish control gate; Kingile muck, Merritt silty clay loam, and Peltier mucky clay loam at the Middle River flow control gate; Peltier mucky clay loam and Ryde clay loam at the Grant Line Canal flow control gate; and Fluvaquents, Pescadero clay loam, and Willows clay at the Old River at DMC flow control gate. If proposed grading or excavation sites are located in areas that contain these expansive soils, potential structural damage and injury from development on expansive soils could occur. However, the potential for these expansive soils to result in a significant impact on structures would be avoided by following UBC when designing and constructing the gates. This impact is less than significant and no mitigation is required.

Impact GEO-7: Potential for Caving as a Result of Excavations. Shallow excavations associated with the construction of the head of Old River fish control gate, the Grant Line Canal flow control gate, and the Old River at DMC flow control gate may be subject to caving because of the presence of either Columbia fine sandy loam or Grangeville fine sandy loam. Both of these soils are subject to caving when excavated, potentially creating a safety risk; however, construction-related excavations shall be shored or otherwise stabilized in accordance with engineering and regulatory safety standards. This impact is less than significant. No mitigation is required.

Dredging

Impact GEO-8: Potential Decrease in Levee Stability from Dredging Activities. Under Alternatives 2A–2C dredging activities in West Canal, Middle River and Old River sloughs could potentially result in effects on levee stability in areas where dredging could encroach on the toe of adjacent levees. If sediment were to be removed at the base of the levee banks or if dredging activities resulted in scouring at the base of the levee banks, portions of levees could fail. However, the SDIP has incorporated a number of design features to protect adjacent levees near the fish control gate and flow control gates. These features include placement of riprap for slope protection on existing levees and design specifications for the gates. These measures are based on CALFED Geology and Soils Mitigation Measures 3, 4, 5, 8, 14, and 16 and CALFED Groundwater Mitigation Measure 24. Levee stability measures also include limiting removal of material to the center two-thirds of the width of the existing channel and maintaining a minimum side slope of 3:1 along the new cross sections (California Department of Water Resources 1996a). This impact is less than significant. No mitigation is required.

Impact GEO-9: Potential Land Subsidence from Placement of Dredged Material onto Peat Soils. Dredging proposed under Alternatives 2A–2C would require placing sediment adjacent to dredged areas on nearby islands. Dredge spoils placed in areas with peat soils could result in consolidation of the underlying materials and potentially land subsidence. Fill placed on a peat foundation is known to cause consolidation, and primary consolidation occurs in a short period (a few weeks to a few months) and can equal the height of the fill placed. Secondary consolidation continues indefinitely; the rate of consolidation decreases with time. This consolidation is a function of the height of fill, the thickness of the peat, and elapsed time (U.S. Army Corps of Engineers 1982). Because peat soils are known to underlie islands near potential dredge spoil areas, some subsidence from Alternatives 2A–2C dredging activities is possible.

Reducing the elevation of the land surface in dredge spoil areas could result in a number of effects, including effects on crop production associated with a high water table and increasing the potential for seepage problems near the spoil area.

However, if dredge spoils are not disposed of on peat soils, it is likely that the addition of soils would increase the elevation of the land surface. This may benefit crop production in these areas.

SDIP design and construction measures take into consideration the potential for dredge spoils to affect adjacent properties. Subsurface conditions in spoil areas would be investigated prior to any disposal activities (i.e., a Suitability Analysis would be performed) as described under Environmental Commitments in Chapter 2. This impact is less than significant. No mitigation is required.

2020 Conditions

It is expected that soil conditions, as well as earthquake, groundshaking, and liquefaction hazards under 2020 conditions, would be similar to those described in existing conditions. Therefore, the impacts described above related to the implementation of Alternatives 2A–2C would be similar for 2020 conditions.

Stage 2 (Operational Component)

No significant impacts on soil or geologic resources would result from operating the SDIP under Alternative 2A–2C because the proposed increased diversions and pumping would not alter the geologic or soil hazards in the south Delta and operating Alternatives 2A–2C would not result in a loss of soil resources. This impact is less than significant. No mitigation is required.

2020 Conditions

Under 2020 conditions, implementation of Alternatives 2A–2C would not result in impacts on soil or geological resources for reasons similar to those described above.

Interim Operations

No significant impacts on soil or geologic resources would result from proposed interim operations because the proposed increased diversions and pumping would not alter the geologic or soil hazards in the south Delta and would not result in a loss of soil resources. This impact is less than significant. No mitigation is required.

Alternative 3B

Stage 1 (Physical/Structural Component)

Fish Control Gate and Flow Control Gates

Under Alternative 3B, impacts would be similar to Impacts GEO-1 through GEO-7 under Alternatives 2A–2C, except that the Grant Line Canal gate would not be constructed and impacts associated with this site would not occur.

Impact GEO-1: Potential Structural Damage and Injury from Ground Shaking. The impact on structural damage and injury from ground shaking would be slightly less under Alternative 3B than under Alternatives 2A–2C. Only three gates are proposed under Alternative 3B instead of the four gates proposed under Alternatives 2A–2C. Therefore, there would be fewer structures constructed that could be potentially damaged. This impact is less than significant. No mitigation is required.

Impact GEO-2: Potential Structural Damage and Injury from Development on Materials Subject to Liquefaction. The impact on structural damage and injury from development on materials subject to liquefaction would be slightly less under Alternative 3B than under Alternatives 2A–2C. Because Alternative 3B proposes only three gates, there is one less structure that could be constructed on materials subject to liquefaction. The SDIP environmental commitment to incorporate requirements for standard UBC and general plan construction standards into the project design to minimize the potential groundshaking hazards on gate facilities would reduce this impact to a less-than-significant level.

Impact GEO-3: Potential Downstream Erosion from Sudden Increase in Channel Discharge. The potential for downstream erosion from sudden increase in channel discharge would be slightly less under Alternative 3B than under Alternatives 2A–2C. The potential for the gates to become damaged and water behind them to cause erosion would be less under Alternative 3B because only three gates are proposed under this alternative. This impact is less than significant. No mitigation is required.

Impact GEO-4: Potential Accelerated Runoff, Erosion, and Sedimentation from Grading, Excavation, and Levee Construction Activities. Impacts on erosion from construction activities would be slightly less under Alternative 3B than under Alternatives 2A–2C. Because only three gates are proposed under Alternative 3B, there would be less construction activity and subsequently less erosion caused by construction activities. This impact is considered to be less than significant.

Impact GEO-5: Decrease in Levee Stability from Proposed Construction Activities. The impact on levee stability from proposed construction activities would be slightly less under Alternative 3B than under Alternatives 2A–2C. There would be less construction activity under Alternative 3B, and therefore, there would be less potential for levee stability to be decreased from construction activities. This impact is less than significant. No mitigation is required.

Impact GEO-6: Potential Structural Damage and Injury from Development on Expansive Soils. There would be less construction on potentially expansive soils under Alternative 3B, and therefore, the potential for structural damage and injury from development on expansive soils would be slightly less under Alternative 3B than under Alternatives 2A–2C. This impact is considered less than significant. No mitigation is required.

Impact GEO-7: Potential for Caving as a Result of Excavations. Because Alternative 3B includes one less gate, there would be slightly less potential for caving as a result of excavations. This impact is less than significant. No mitigation is required.

Dredging

Under Alternative 3B, impacts would be similar to Impacts GEO-8 and GEO-9 under Alternatives 2A–2C.

Impact GEO-8: Potential Decrease in Levee Stability from Dredging Activities. The impact on levee stability from dredging activities would be slightly less under Alternative 3B. Although the channel dredging that is proposed under Alternatives 2A–2C would be the same under Alternative 3B, there would be gate dredging at one less site under Alternative 3B. This impact is less than significant. No mitigation is required.

Impact GEO-9: Potential Land Subsidence from Placement of Dredged Material onto Peat Soils. The impact to land subsidence from placement of dredged materials onto peat soils would be slightly less under Alternative 3B than under Alternatives 2A–2C. Because there would be one less site being dredged under Alternative 3B, there would be less dredge spoils that may cause land subsidence. This impact is less than significant. No mitigation is required.

2020 Conditions

It is expected that soil conditions, as well as earthquake, groundshaking, and liquefaction hazards, would be similar to those described in existing conditions under 2020 conditions. Therefore, the impacts described above related to the implementation of Alternative 3B would be similar for 2020 conditions.

Stage 2 (Operational Component)

No significant impacts on soil or geologic resources would result from operating the SDIP under Alternative 3B because the proposed increased diversions and pumping would not alter the geologic or soil hazards in the south Delta, and operating Alternative 3B would not result in a loss of soil resources.

2020 Conditions

Under 2020 conditions, as above, no significant impacts on soil or geological resources would result from operating the SDIP under Alternative 3B. There is no impact. No mitigation is required.

Alternative 4B

Stage 1 (Physical/Structural Component)

Fish Control Gate and Flow Control Gates

Under Alternative 4B, impacts would be similar to Impacts GEO-1 through GEO-7 under Alternatives 2A–2C.

Impact GEO-1: Potential Structural Damage and Injury from Ground Shaking. The potential for structural damage and injury from ground shaking under Alternative 4B would be less than under Alternatives 2A–2C. Only one gate is proposed under Alternative 4B instead of the four gates proposed under Alternatives 2A–2C. Therefore, there would be fewer structures constructed that could potentially be damaged. This impact is less than significant. No mitigation is required.

Impact GEO-2: Potential Structural Damage and Injury from Development on Materials Subject to Liquefaction. The potential for structural damage and injury from development on materials subject to liquefaction would be slightly less under Alternative 4B than under Alternatives 2A–2C. Because Alternative 4B proposes only one gate, there are three fewer structures that could potentially be constructed on materials subject to liquefaction. This impact is less than significant. No mitigation is required.

Impact GEO-3: Potential Downstream Erosion from Sudden Increase in Channel Discharge. The potential for downstream erosion from sudden increase in channel discharge would be less under Alternative 4B than under Alternatives 2A–2C. The potential for the gates to become damaged and water behind them to cause erosion would be less under Alternative 4B because only one gate is proposed under this alternative. This impact is less than significant. No mitigation is required.

Impact GEO-4: Potential Accelerated Runoff, Erosion, and Sedimentation from Grading, Excavation, and Levee Construction Activities. Impacts on erosion from construction activities would be slightly less under Alternative 4B than under Alternatives 2A–2C. Because only one gate is proposed under Alternative 4B instead of the four proposed under Alternatives 2A–2C, there would be less construction activity and subsequently less erosion caused by construction activities. This impact is considered to be less than significant. No mitigation is required.

Impact GEO-5: Decrease in Levee Stability from Proposed Construction Activities. The impact on levee stability from proposed construction activities would be less under Alternative 4B than under Alternatives 2A–2C. There would be less construction activity under Alternative 4B, and therefore, there would be less potential for levee stability to be decreased from construction activities. This impact is less than significant. No mitigation is required.

Impact GEO-6: Potential Structural Damage and Injury from Development on Expansive Soils. The impact on structural damage and injury from development on expansive soils would be less under Alternative 4B than under Alternatives 2A–2C because there would be less construction. This impact is less than significant. No mitigation is required.

Impact GEO-7: Potential for Caving as a Result of Excavations. Because Alternative 4B includes only the head of Old River fish control gate, there would be less potential for caving as a result of excavations. This impact is less than significant. No mitigation is required.

Dredging

Under Alternative 4B, impacts would be similar to Impacts GEO-8 and GEO-9 under Alternatives 2A–2C.

Impact GEO-8: Potential Decrease in Levee Stability from Dredging Activities. The impact on levee stability from dredging activities would be less under Alternative 4B. Although the channel dredging that is proposed under Alternatives 2A–2C would be the same under Alternative 4B, there would only be gate dredging at one site instead of four. This impact is less than significant. No mitigation is required.

Impact GEO-9: Potential Land Subsidence from Placement of Dredged Material onto Peat Soils. The impact to land subsidence from placement of dredged materials onto peat soils would be less under Alternative 4B than under Alternatives 2A–2C. Because there would be only one site dredged under Alternative 4B, there would be less dredge spoils that may cause land subsidence. This impact is less than significant. No mitigation is required.

2020 Conditions

It is expected that soil conditions, as well as earthquake, groundshaking, and liquefaction hazards, would be similar to those described in existing conditions under 2020 conditions. Therefore, the impacts described above related to the implementation of Alternative 3B would be similar for 2020 conditions.

Stage 2 (Operational Component)

No significant impacts on soil or geologic resources would result from operating the SDIP under Alternative 4B because the proposed increased diversions and pumping would not alter the geologic or soil hazards in the south Delta and operating Alternative 4B would not result in a loss of soil resources. This impact is less than significant. No mitigation is required.

2020 Conditions

Under 2020 conditions, as above, no significant impacts on soil or geological resources would result from operating the SDIP under Alternative 4B. There is no impact. No mitigation is required.

Cumulative Evaluation of Impacts

Cumulative impacts on geological resources are analyzed in Chapter 10, "Cumulative Impacts." This chapter summarizes the other foreseeable future projects that may contribute to these impacts.

5.5 Flood Control and Levee Stability

Introduction

This chapter describes the existing environmental conditions and the environmental consequences of constructing and operating each of the SDIP alternatives on flood control and levee stability. Significance of impacts is determined by using significance criteria set forth in the State CEQA Guidelines.

Summary of Significant Impacts

There are no significant impacts on flood control and levee stability as a result of implementation of any of the alternatives. All impacts are discussed in detail in the Environmental Consequences section.

Affected Environment

Sources of Information

The following key sources of information were used in the preparation of this section:

- Draft EIR/EIS for the ISDP, July 1996;
- *Sacramento–San Joaquin Delta Atlas*, California Department of Water Resources, July 1995;
- Levee System Integrity Program Plan, CALFED Final Programmatic EIS/EIR Technical Appendix, July 2000;
- Sacramento–San Joaquin Delta, California Special Study, Office Report, Basis of Design and Cost Estimates, Department of the Army, U.S. Army Corps of Engineers, November 1992;
- *Engineering and Design*, Engineer Manual No. 1110-2-1601, Hydraulic Design of Flood Control Channels, Department of the Army, U.S. Army Corps of Engineers, 30 June 1994;
- *Engineering and Design*, Engineer Manual No. 1110-2-1913, Design and Construction of Levees, Department of the Army, U.S. Army Corps of Engineers, 30 April 2000;
- CALFED Levee Rehabilitation Study, Murray, Burns & Kienlen (MBK), September 4, 1998; and
- *CALFED Final Programmatic Environmental Impact Statement/ Environmental Impact Report*, July 2000.

Existing Flood Control in the Delta Region

Background

Until the 1850s, the Delta Region was mostly a tidal marsh, part of an interconnected estuary system that included the Suisun Marsh and San Francisco Bay (CALFED Bay-Delta Program 2000b). During the flood season, the Delta became a great inland lake, and when the floodwaters receded, the network of sloughs and channels reappeared throughout the marsh. Early settlers avoided the Delta for two reasons. First, the attempts at levee construction were hampered by high costs and lack of mechanical equipment. Second, laws were inadequate to give landowners clear title to wetlands and seasonally flooded lands. The discovery of gold at Sutter’s Mill in the foothills of the Sierra Nevada resulted in a large inflow of people. The growing population increased the demand for food. Congress passed the “Arkansas Act” in 1850, which warranted title of wetlands and flooded lands to private ownership. The higher demand for food and clear ownership laws accelerated land reclamation in the Delta.

Development of the Delta began in late 1850 when the Federal Swamp Land Act conveyed ownership of all swamp and overflow land, including Delta marshes, from the federal government to the State of California. Proceeds from the state’s sale of swampland were to go toward reclaiming them, primarily for conversion to agricultural land.

In 1861, the State Legislature created the Board of Swamp and Overflowed Land Commissioners to manage reclamation projects. In 1866, the board’s authority was transferred to county boards of supervisors. The first reclamation projects began in 1869, when developers constructed 4-foot-high by 12-food-wide levees on Sherman and Twitchell Islands using the peat soils of the Delta. Since then, levee construction has improved and expanded to 1,100 miles throughout the Delta to protect agricultural and urban lands against flooding.

Shortly after the completion of the levees in 1913, the construction of a complicated series of human-made waterways and water development facilities began in the Delta. The purpose of constructed waterways was to provide navigation, improve water circulation, or obtain material for levee construction. Water development facilities were constructed to ship water from the Delta to other parts of the state for agricultural, M&I, and other uses.

The extensive levee system, constructed waterways (the CCC and Stockton DWSC), water development facilities, groundwater development, and railroads enabled irrigated agriculture and urban communities to extend deeper into the Delta. Between 1920 and 1950, irrigated agriculture development increased rapidly from 2.7 to more than 4.7 million acres for the entire Central Valley. During the same period, urban land use also expanded. Private water development projects by cities and utility districts assisted in the expansion of urban development throughout California.

Approximately 71,000 acres of the Delta are developed for M&I uses, with most of the development located on the periphery of the Delta in Sacramento, San Joaquin, and Contra Costa Counties. The majority of urban development is located in the legal Delta, with less than 1,800 acres of developed land in the Suisun Marsh and Bay Area. Urban development includes residential, commercial, industrial, and other urban uses.

Much of the urban development in the south Delta is located in incorporated cities (Antioch, Brentwood, Isleton, Pittsburg, Rio Vista, and Tracy are located entirely within the Delta; and Sacramento, Stockton, and West Sacramento are located partially within the legal Delta) and the 14 unincorporated communities within the legal Delta (Discovery Bay, Oakley, Bethel, Courtland, Freeport, Hood, Ryde, Walnut Grove, Byron, Terminous, Thornton, Hastings Tract, and Clarksburg).

Facilities

The flood control facilities that currently protect the Delta region include levees, DCC control gates, and the Yolo Bypass.

Flooding of reclaimed Delta lands was a frequent result of levee erosion and overtopping during high-flow events. Since construction of the CVP and SWP, the frequency of levee failure attributable to overtopping from floodflows has decreased. Delta levees still fail, but the most frequent cause is either seepage, resulting in piping and stability failures, or overtopping because of high tides and high winds.

With the advent of the large state and federal water projects that allow more control over floodflows, flooding generally has been restricted to inundation of individual islands or tracts resulting from levee failure or overtopping. Since 1950, the construction of upstream dams has allowed dam and reservoir managers to detain flows. This management ability and control of floodwaters have further reduced the threat of flooding. Between 1950 and 1986, 60% of levee failures have been attributable to mass instability, commonly caused by a combination of seepage and historical subsidence, and 40% have been a result of overtopping.

The Delta levee system initially served to control island flooding during periods of high flow. Because of island reclamation and subsidence attributable to peat oxidation, however, it is now necessary for the levee system to prevent inundation during normal runoff and tidal cycles. About 1,100 miles of levees in the Delta provide flood protection to the 76 islands and tracts located there.

The major factors influencing Delta water level include high flows, high tide, and wind. Historically, the highest water levels usually have occurred from December through February, when high runoff combines with high tides, low barometric pressure, and wind-generated waves. Flood level elevation of rivers and channels surrounding the Delta islands generally ranges from 6.5 to 7.5 feet msl in the west and central Delta, where the most tidal influence is present. However, the 100-year flood level ranges from 14.0 to 17.0 feet msl in the south Delta (near Stewart Tract on the Old and Middle River channels), where the streamflows become dominant during large floods. These flood level ranges (from 6.5 to 17.0 feet msl) emphasize the importance of maintaining levees to varying heights and strengths throughout the Delta to protect against flooding where channel geometry and flow conditions can cause rapid level increases during storms.

The DCC control gates are closed during high flows and floods on the Sacramento River. During floods, when water levels on the Sacramento River exceed those on Mokelumne River channels, the gates prevent water from spilling out of the Sacramento River into the Mokelumne River and flooding leveed and non-leveed lands. If storms hit central California while the river water levels are lower on the Sacramento River, the DCC gates can be opened to spill high flows out of the Mokelumne River system and reduce water levels on the north and south forks of the Mokelumne River. This transfers floodwater from the non-project levees of the Mokelumne River to the Sacramento River, which is protected with project levees. The Sacramento River Flood Control Project (SRFCP) keeps the Sacramento River from flooding the Delta.

Unlike the system of reservoirs and weirs that control the magnitude of flooding on the rivers upstream of the Delta, the flood control system in the Delta (aside from the DCC control gates) operates passively. However, the levee system does require maintenance, monitoring, and improvement, particularly during floods, to maximize the level of protection it provides.

The SDIP project components are being integrated into the existing comprehensive conveyance and flood control system of the Delta. The conveyance system not only provides water for drinking, agriculture, and industrial uses, but also is designed to provide a level of prevention against flooding. The system includes more than 1,000 miles of levees and numerous hydraulic control structures. The levees and structures are maintained by various federal and state agencies and local reclamation districts. Although the proposed SDIP is not a flood control system, the in-channel gates will have a minor impact on how the existing conveyance and flood control system is operated and maintained.

The SDIP flow control and fish control gates will be integrated into the existing environment and habitat of the human-made Delta flood conveyance system. The riverine-like habitat of the system human-made channels includes vegetated and nonvegetated areas.

In addition to the proposed gates, dredging of various upstream and some downstream reaches is proposed. These locations correspond to agricultural diversion intakes and areas of decreased channel capacity.

Existing Levee Stability in the Delta Region

The stability of a levee depends on the strength of its foundation materials and its internal strength (CALFED Bay-Delta Program 2000c). If used in the proper proportions and engineered correctly, sands, silts, and clays can be used to build stable levees. High percentages of sands or peat within or beneath a levee, however, can weaken its stability. East Delta levees generally are supported by foundation materials composed of clay, silt, and sand; but some central and west Delta levees rest primarily on peat with some alluvial clay, bay mud, sand, and silt layers. Inorganic materials (sands, silts, and clays) provide adequate foundations, but uncompressed peat is highly deformable and unstable.

Of the Delta lowlands, approximately 380,000 acres consist primarily of peat soil. When exposed to air, the peat oxidizes and decomposes, resulting in land subsidence. Cultivation accelerates the oxidation of peat soils. Land subsidence adjacent to the levees is a problem in the Delta because it could jeopardize the stability of the levees, which in turn could cause flooding.

Levees can fail by three often interrelated mechanisms: overtopping, seepage and piping, and instability. Several other factors can damage levees and eventually lead to levee failure. These include erosion, seismic movements, burrowing from small mammals, wind and wave action, and dead or decaying roots from levee vegetation (living vegetation also can provide some protection against levee erosion by reducing wave and wind action). From 1950 to 1986, fifteen stability-failure floods and eight overtopping floods occurred in the region.

The Delta is subject to seismic activity from several faults. The San Andreas Fault system has the greatest potential to affect Delta seismicity. The Hayward Fault is closer to the Delta and has the second highest potential to affect Delta seismicity, with perhaps a slightly decreased level of shaking than could result from the San Andreas Fault. Other faults, including the Healdsburg–Rogers Creek Fault, Maacama Fault, Coast Range Sierra Nevada Boundary Zone, and Green Valley–Cordelia and Concord Faults, could affect Delta seismicity to a much lesser level of shaking and duration.

Since reclamation, each of the 70 major islands or tracts has flooded at least once. About 100 failures have occurred since the early 1900s. Except for Big Break, Little Franks, and Little Holland Tracts and Little Mandeville, Lower Sherman, and Mildred Islands, flooded islands historically have been restored even when the cost of repairs exceeded the appraised value of the land.

The existing levees at the four proposed permanent gate sites are constructed of dredged and imported fill material; protected to various degrees from water scour and erosion by riverside and landside rock revetments; and are either federal “project” or “non-project” levees. Project levees are located at the head of Old River site; all other gate location levees are non-project levees.

The levees in the Delta were evaluated as part of the CALFED Bay-Delta Program Final Programmatic EIS/EIR (July 2000(b)). The Levee System Integrity Program Plan identified the existing levee condition, including that of levees in the general vicinity of the proposed gate locations. One of the objectives of the plan was to identify those levees in the Delta that do not meet the minimum standard of Public Law (PL) 84-99. PL 84-99 defines the minimum standard for levee construction to provide flood protection against a 100-year flood event. The CALFED Levee Rehabilitation Study (Murray, Burns & Kienlen 1998) states that 68% of the non-project levees do not meet the PL 84-99 standard and "unless there was specific knowledge of site conditions, project levees were assumed to meet the PL-99 standard." This result was based on the extrapolation of results for non-project levees in the Delta for which site-specific knowledge for 32 of 51 Delta islands showed the existence of noncompliant levees.

The existing levee stability in the areas proposed for dredging, corresponding to agricultural diversion intakes and areas of decreased channel capacity, is typical of the nearby channels.

Environmental Consequences

Assessment Methods

The methods and assessment approach used to evaluate impacts on flood control and levee stability included the application of quantitative modeling results and qualitative assessments. The assessment methods include:

- quantitative modeling performed using the State of California Delta Simulation Model (DSM2); this model has been used to forecast water levels and channel velocities for the various gate and operational scenarios;
- qualitative and semiquantitative levee assessment as described in the Final Programmatic EIS/EIR Technical Appendix (CALFED Bay-Delta Program 2000c); and
- assessment of the degree of scour and sedimentation related to flood control and levee stability as described in Section 5.6.

Regulatory Setting

The following federal, state, and local regulations, laws, and policies are pertinent to flood control and levee stability in the Delta.

Delta Protection Act of 1992

The Delta Protection Act of 1992 declares that the basic goals of the state for the Delta are, among other findings, to improve flood protection by structural and nonstructural means to ensure an increased level of public health and safety.

Safe, Clean, Reliable Water Supply Act

The Safe, Clean, Reliable Water Supply Act declares that the basic goals of the state for the Delta are, among other findings, to protect the integrity of the state's water supply system from catastrophic failure attributable to earthquakes and flooding.

Public Law 84-99 Delta Specific Standard

This federal law specifies, among other findings, minimum standards to which the rehabilitation and construction of levees in the Delta should be constructed.

Section 401 of the Clean Water Act and State Regulations in Title 23 California Code of Regulations

This regulation establishes requirements for all dredging activities for navigable waters of the State of California.

Significance Criteria

The criteria used for determining the significance of an impact on control and levee stability are based on the State CEQA Guidelines and professional standards and practices. Impacts on flood control and levee stability may be considered significant if implementation of an alternative would:

- substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner that would result in flooding on or off site;
- place within a 100-year flood hazard area structures that would impede or redirect floodflows; or
- expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam.

CALFED Programmatic Mitigation Measures

The August 2000 CALFED Programmatic ROD includes mitigation measures for agencies to consider and use where appropriate in the development and implementation of project-specific actions. The mitigation measures address the short-term, long-term and cumulative effects of the CALFED Program. As indicated in the Summary of Significant Impacts section, no significant impacts on flood control and levee stability were identified. However, the CALFED programmatic mitigation applicable to flood control was considered during project development. These programmatic mitigation measures are numbered as they appear in the ROD. A full listing of CALFED Programmatic Mitigation Measures is included in Appendix E, "Mitigation Measures Adopted in the CALFED Record of Decision."

Flood Control and Levee Stability Mitigation

- Improve levees to withstand expected hydraulic stresses and seepage.
- Use riprap or another suitable means of slope protection to dissipate wave force.
- Design structures to minimize the loss of channel conveyance at gate structures located in channels.
- Implement flood management measures including dredging, levee maintenance, and snag removal.

Alternative 1 (No Action)

The No Action Alternative would not result in any construction-related or operations-related flood or levee stability impacts associated with SDIP facilities.

Under the No Action Alternative, temporary fish control and flow control barriers on Old River, Middle River, and Grant Line Canal would continue to have the same effect on flood control and levee stability as under existing conditions. This effect is the same as under existing conditions; therefore, no impact on flood control or levee stability would occur.

2020 Conditions

Under Future No Action conditions (2020 conditions) the SDIP would not be implemented. It is expected that the temporary barriers program would continue. It is also expected that flood control and levee stability would be maintained or improved under 2020 conditions. Therefore, no impact on flood control or levee stability would occur.

Alternatives 2A, 2B, and 2C

Stage 1 (Physical/Structural Component)

Fish Control Gate and Flow Control Gates

Impact FC-1: Temporary Decrease in Flood Protection or Levee Stability during Construction of Gates. Construction of the fish control and flow control gates on Old River, Middle River, and Grant Line Canal would decrease the level of flood control and levee stability during certain construction phases. Each gate would require approximately 15–36 months to construct, and gates would be constructed concurrently. The temporary decrease in flood control and levee stability would result from in-channel work that would affect channel flow capacity or decrease levee height or strength. This in-channel work would result in a less-than-significant impact on flood control because:

- the decrease in flood control and levee stability would be temporary;
- in-channel work would be performed primarily during lower flow periods when the potential for flood events is very low;
- provisions would be included for passing a 100-year storm flow during construction, including cofferdam design to allow overtopping, removal of in-channel construction equipment and materials, and temporary placement of riprap or other erosion control materials, depending on the method of gate construction.

No mitigation is required.

Impact FC-2: Raise Flood Level Elevations and Increase the Frequency of Flooding. The flow control gates are being proposed as an effective means of providing added control of various river levels in the Delta. The fish control gate may also be operated to help control water levels. During wet season periods, the gates are to be open and designed to effectively pass floodflows with a 100-year recurrence frequency.

Several key design features are planned to address the local effects the gates could have on flood control and levee stability. These features include, as described in Appendix F: resistance to scour, erosion; debris management; resistance to high-flow related hydrodynamic forces; and high-flow management.

- Gate erosion protection will include rock riprap along the channel and levees upstream and downstream of the gate and installing sheetpile walls near the boat lock approaches. The invert of the gate will have a concrete apron and sheetpile cutoffs under the apron. The design floodflow velocity through the gate will not exceed 3 feet/sec for Middle River and 6.5 feet/sec for Grant Line Canal when the gates are open. The erosion protection system will armor the channel to withstand any localized scouring effects from flood and normal operating conditions.
- The three agriculture gates will be operated approximately daily during the irrigation season. Debris will be allowed to pass through the gates upon

operation. The gates will also be designed to minimize the number of dead zones to prevent a buildup of debris close to the structure.

- The gates and levee modifications will be designed to meet or exceed the Corps design criteria. The criteria include load combinations using fluid loads at the maximum water surface differential across the gate and impact loads attributable to floating debris or runaway boats.
- The gates will be designed to pass a 100-year flood. The flow capacity through the gates will be at least equal to the existing channel capacity. Backwater effect immediate to each gate structure would be minimal. During periods of high flows, the bottom-hinged gates and the boat lock will be opened.

This impact on flood control as a result of raising flood level is considered less than significant. No mitigation is required.

Impact FC-3: Increase the Degree or Quantity of Seepage, Levee Settlement, Wind Erosion, or Subsidence. The flow control gates are being proposed as an effective means of providing added control of various river levels in the Delta. The goal of this added control is to provide higher water surface elevations during peak irrigation periods to ensure improved diversion capability. Based on estimates of water level in the same DSM2 quantitative modeling used for velocity analysis, forecast levels for all alternatives are expected to increase from 0.33 to 0.41 foot during a typical dry critical year and 0.1 to 0.94 foot during a typical wet year, relative to the No Action Alternative. Based on evaluation of the forecast levels for all alternatives (See Appendix F), the average level will increase approximately 7%. Through application of the stability failure analysis method, as presented in the Final Programmatic EIS/EIR Technical Appendix (CALFED Bay-Delta Program 2000c), this increase has a negligible impact on flood control and levee stability.

The higher water surface elevation will result in minor increases in hydrostatic pressures on levees. The minor increase in hydrostatic pressures is expected to have a negligible effect on the degree or quantity of seepage, levee settlement, and subsidence. The periodic increase in water surface elevations is expected to have a negligible change in wave fetch and associated levee erosion.

The discussion and evaluation of potential scour and sedimentation impacts are presented in Section 5.6.

This small change in levee seepage, settlement, and subsidence would result in a less than significant impact on flood control and levee stability. No mitigation is required.

Impact FC-4: Decrease Inspection, Maintenance, and Repair Capabilities, Levee Slope Protection, Emergency Response Capabilities, Channel Capacity, and Seismic Resistance. The gates and levee modifications will be designed to meet or exceed Corps design criteria. The gate designs will facilitate inspection, maintenance, and repair and will meet the latest seismic design criteria. Emergency response capabilities will not be affected for over-levee access; access via water through all gates, with the exception of the Middle River, will be provided by boat lock facilities. Emergency response access into Middle River from the confluence with Old River will be unaffected by the planned gates.

Channel capacity will be affected to a minor degree because the purpose of the gates is to periodically increase water surface elevations. During nonirrigation periods when this purpose is not relevant, the gates will pass a 100-year flood. The flow capacity in general through the gates will be at least equal to the existing channel capacity. During periods of high flows, the bottom-hinged gates, and the boat lock in Grant Line Canal will be opened. It is anticipated, especially for a 100-year flood, that there will be overtopping of the sheetpile wall section. This impact is less than significant. No mitigation is required.

Impact FC-5: Substantially Decrease or Degrade the Degree of Public Health and Safety. Under Alternatives 2A–2C, public health and safety are potentially affected as a result of an unacceptable decrease in flood control or levee stability, or because of the transport/accumulation of sediments containing hazardous contaminants.

No decrease in flood control or levee stability is expected during construction or operation of the gates. All gates and levee modifications will be designed and installed to meet or exceed Corps criteria. Planned modifications to existing levees and new hydraulic structures will maintain existing channel capacity. Projected impacts of the proposed gates on levee stability as a result of increased water surface elevations (the objective of the gate installation and operation) during typical irrigation periods indicate a negligible increase in levee instability probabilities (Appendix F).

No significant transport/accumulation of sediments is expected as a result of the construction or operation of the gates. A more thorough assessment and explanation of sedimentation and scouring is presented in Section 5.6.

This impact is less than significant. No mitigation is required.

Dredging

Impact FC-6: Temporary Decrease in Flood Control or Levee Stability during Channel Dredging. Under Alternatives 2A–2C, proposed dredging at each gate site; in Old River, West Canal, and Middle River; and planned maintenance dredging are expected to have no impact on flood control or levee stability. To minimize impacts on fish, dredging is restricted annually to August 1 through November 30, when lower river flow occurs; therefore, there will be no impact on flood control. Dredge operations will be limited to near center-channel locations so as not to adversely affect the long-term waterside stability of levees. Additionally, it is anticipated that dredge spoils will be used in a number of ways, including levee reinforcement. The reinforcement will improve levee stability in general. This impact is considered less than significant. No mitigation is required.

2020 Conditions

Flood control and levee stability are expected to be similar to existing conditions because levee maintenance activities would continue. Therefore, impacts resulting from the implementation of Alternatives 2A–2C would be similar to those described above. All impacts are less than significant, and no mitigation is required.

Stage 2 (Operational Component)

The increased diversions into CCF would result in very small changes in water level within the south Delta and would not increase the risk of flooding. Therefore, there would be no impacts resulting from the implementation of the operational component.

2020 Conditions

Flood control and levee stability are expected to be maintained or improved under 2020 conditions. Therefore, impacts resulting from the implementation of Alternatives 2A–2C would be similar to those described above. All impacts are less than significant, and no mitigation is required.

Interim Operations

Interim operations would not result in any physical changes in the south Delta. The increased diversions into CCF would result in small changes in water level within the south Delta but would not increase the risk of flooding. This impact is less than significant, and no mitigation is required.

Alternative 3B

Stage 1 (Physical/Structural Component)

Fish Control Gate and Flow Control Gates

Impact FC-1: Temporary Decrease in Flood Control or Levee Stability during Construction of Gates. Impacts resulting from the implementation of Alternative 3B are the same as for Alternatives 2A–2C with the exception that no impacts would occur in Grant Line Canal. The hydraulic gate in Grant Line Canal would not be constructed under this alternative. This impact is considered less than significant as described for Alternatives 2A–2C. No mitigation is required.

Impact FC-2: Raise Flood Level Elevations and Increase the Frequency of Flooding. Impacts resulting from the implementation of Alternative 3B are the same as for Alternatives 2A–2C with the exception that no impacts would occur in Grant Line Canal. The hydraulic gate in Grant Line Canal would not be constructed under this alternative. This impact is considered less than significant as described for Alternatives 2A–2C. No mitigation is required.

Impact FC-3: Increase the Degree or Quantity of Seepage, Levee Settlement, Wind Erosion, or Subsidence. Impacts resulting from the implementation of Alternative 3B are the same as for Alternatives 2A–2C with the exception that no impacts would occur in Grant Line Canal. The hydraulic gate in Grant Line Canal would not be constructed under this alternative. This impact is considered less than significant as described for Alternatives 2A–2C. No mitigation is required.

Impact FC-4: Decrease Inspection, Maintenance, and Repair Capabilities, Levee Slope Protection, Emergency Response Capabilities, Channel Capacity, and Seismic Resistance. Impacts resulting from the implementation of Alternative 3B are the same as for Alternatives 2A–2C with the exception that no impacts would occur in Grant Line Canal. The hydraulic gate in Grant Line Canal would not be constructed under this alternative. This impact is considered less than significant as described for Alternatives 2A–2C. No mitigation is required.

Impact FC-5: Substantially Decrease or Degrade the Degree of Public Health and Safety. Impacts resulting from the implementation of Alternative 3B are the same as for Alternatives 2A–2C with the exception that no impacts would occur in Grant Line Canal. The hydraulic gate in Grant Line Canal would not be constructed under this alternative. This impact is considered less than significant as described for Alternatives 2A–2C. No mitigation is required.

Dredging

Impact FC-6: Temporary Decrease in Flood Control or Levee Stability during Channel Dredging. Impacts resulting from the implementation of Alternative 3B are the same as for Alternatives 2A–2C with the exception that no impacts would occur in Grant Line Canal. The hydraulic gate in Grant Line Canal would not be constructed under this alternative. This impact is considered less than significant as described for Alternatives 2A–2C. No mitigation is required.

2020 Conditions

Flood control and levee stability are expected to be maintained or improved under 2020 conditions. Therefore, impacts resulting from the implementation of Alternative 3B would be similar to those described above. All impacts are less than significant and no mitigation is required.

Stage 2 (Operational Component)

The increased diversions into CCF would result in very small changes in water level within the south Delta and would not increase the risk of flooding.

Therefore, there would be no impacts resulting from the implementation of the operational component.

2020 Conditions

The increased diversions into CCF would result in very small changes in water level within the south Delta under 2020 conditions and would not increase the risk of flooding.

Alternative 4B

Stage 1 (Physical/Structural Component)

Fish Control Gate

Impact FC-1: Temporary Decrease in Flood Control or Levee Stability during Construction of Gate. Impacts resulting from the implementation of Alternative 4B are the same as for Alternatives 2A–2C with the significant exception that no impacts would occur in Middle River, Old River at DMC, or Grant Line Canal. The hydraulic gates at these sites would not be constructed under this alternative. This impact is considered less than significant as described for Alternatives 2A–2C. No mitigation is required.

Impact FC-2: Raise Flood Level Elevations and Increase the Frequency of Flooding. Impacts resulting from the implementation of Alternative 4B are the same as for Alternatives 2A–2C with the significant exception that no impacts would occur in Middle River, Old River at DMC, or Grant Line Canal. The hydraulic gates at these sites would not be constructed under this alternative. This impact is considered less than significant as described for Alternatives 2A–2C. No mitigation is required.

Impact FC-3: Increase the Degree or Quantity of Seepage, Levee Settlement, Wind Erosion, or Subsidence. Impacts resulting from the implementation of Alternative 4B are the same as for Alternatives 2A–2C with the significant exception that no impacts would occur in Middle River, Old River at DMC, or Grant Line Canal. The hydraulic gates at these sites would not be constructed under this alternative. This impact is considered less than significant as described for Alternatives 2A–2C. No mitigation is required.

Impact FC-4: Decrease Inspection, Maintenance, and Repair Capabilities, Levee Slope Protection, Emergency Response Capabilities, Channel Capacity, and Seismic Resistance. Impacts resulting from the implementation of Alternative 4B are the same as for Alternatives 2A–2C with the significant exception that no impacts would occur in Middle River, Old River at DMC, or Grant Line Canal. The hydraulic gates at these sites would not be constructed under this alternative. This impact is considered less than significant as described for Alternatives 2A–2C. No mitigation is required.

Impact FC-5: Substantially Decrease or Degrade the Degree of Public Health and Safety. Impacts resulting from the implementation of Alternative 4B are the same as for Alternatives 2A–2C with the significant exception that no impacts would occur in Middle River, Old River at DMC, or Grant Line Canal. The hydraulic gates at these sites would not be constructed under this alternative. This impact is considered less than significant as described for Alternatives 2A–2C. No mitigation is required.

Dredging

Impact FC-6: Temporary Decrease in Flood Control or Levee Stability during Channel Dredging. Impacts resulting from the implementation of Alternative 4B are the same as for Alternatives 2A–2C with the exception that no impacts would occur at the sites of the proposed Middle River, Old River at DMC, or Grant Line Canal gates. Other channel dredging, as described for Alternatives 2A–2C, would occur. This impact is considered less than significant as described for Alternatives 2A–2C. No mitigation is required.

2020 Conditions

Flood control and levee stability are expected to be maintained or improved under 2020 conditions. Therefore, impacts resulting from the implementation of Alternative 4B would be similar to those described above. All impacts are less than significant, and no mitigation is required.

Stage 2 (Operational Component)

The increased diversions into CCF would result in very small changes in water level within the south Delta but would not increase the risk of flooding. Therefore, there would be no impacts resulting from the implementation of the operational component.

2020 Conditions

Flood control and levee stability are expected to be maintained or improved under 2020 conditions. Therefore, impacts resulting from the implementation of Alternative 4B would be similar to those described above. All impacts are less than significant, and no mitigation is required.

Cumulative Evaluation of Impacts

Cumulative impacts on flood control and levee stability are analyzed in Chapter 10, “Cumulative Impacts.” This chapter also summarizes the other foreseeable future projects that may contribute to these impacts.

5.6 Sediment Transport

Introduction

This section describes the existing environmental conditions and the consequences of the SDIP alternatives on sedimentation and scouring in the project vicinity. Specifically, it evaluates and discusses the consequences associated with construction and operation of the project. Significance of impacts is determined by using significance criteria set forth in the State CEQA Guidelines.

The primary concern related to sedimentation and scouring in the south Delta is accumulation of sediments and debris during construction, and operation of the gates and scouring as a result of increased velocities.

Summary of Significant Impacts

There are no significant sedimentation or scouring impacts as a result of implementation of any of the alternatives. The Environmental Consequences section contains a detailed discussion of all impacts and mitigation measures for Alternatives 2A, 2B, 2C, 3B, and 4B.

Affected Environment

Sources of Information

Information sources used in the preparation of this section include:

- *Preliminary Bed Sediment Monitoring in the South Delta Study,* California Department of Water Resources, July 2003;
- *Historic Sediment Loads in the Sacramento–San Joaquin Delta,* California Department of Water Resources, October 1994;
- *Interim South Delta Program Sedimentation Investigation Report*, U.S. Department of the Interior, Bureau of Reclamation, Technical Service Division, September 2001;
- *South Delta Scour Monitoring Program, Central District Memorandum Report,* California Department of Water Resources, July 1998;
- Draft EIR/EIS for the ISDP, July 1996;
- *Water and Sediment Quality Study for the Interim South Delta Program,* California Department of Water Resources, May 1995; and
- *Sacramento–San Joaquin Delta, California Special Study,* Department of the Army, U.S. Army Corps of Engineers, and California Department of Water Resources, March 1993.

Sedimentation in the Delta Region

River Flow Characteristics

The Sacramento–San Joaquin Delta covers approximately 700,000 acres in central California (California Department of Water Resources 1994b). Flows into the Delta come from two major rivers, the Sacramento and San Joaquin, and from smaller rivers such the Mokelumne and Cosumnes Rivers. Outflow from the Delta passes into the San Francisco Bay system and the Pacific Ocean through the Golden Gate.

The Sacramento River provides nearly 80% of all flows into the Delta system. The river flows into the north Delta and does not flow through or into the south Delta area. The next largest inflow is from the San Joaquin River, which enters the Delta from the south and accounts for the majority of the flow and sediment inputs that enter that part of the Delta. The remaining 10% of the flow comes from smaller rivers such as the Cosumnes and Mokelumne.

The Delta itself is a complex set of both human-made and natural channels having a significant tidal influence.

Sediment Inputs

The sediments transported into the Delta by rivers and the Yolo Bypass include fine sands, silts, and clays. Coarser materials are deposited at points higher up in the river basins. The sands typically are transported in the bed load, while the clays and silts move with the suspended load. A large proportion of the suspended sediments are transported through the Delta into the San Francisco Bay.

Bed load movement of sediments is dependent on the velocity of the water flowing over the sediments; the first movements are rolling in nature. At higher velocities, the sediments may leave the bed for short durations, giving the appearance of jumping along the bottom, a process called saltation. If the velocities become high enough, it is possible for the sediments to be suspended and become part of the suspended load. The higher velocities of a river’s flow usually occur farther upstream where bed slopes are steeper. When the river reaches flatter slopes, velocities decrease, causing deposition of some suspended sediments and larger sediments moving with the bed load. Therefore, the sediments are sorted to some extent, with deposited sediment size decreasing as the flow progresses downstream.

The suspended load is made up of generally finer materials moving downstream in the water column. The particles that make up the suspended load are kept from falling by the turbulent motions of the river. As turbulence is reduced, the suspended particles begin to fall out of suspension and are deposited on the bottom of the channel. The smaller particles take longer to fall as they have a lower fall velocity. Because of the slower descent to the bed, the smaller particles are carried farther downstream. In the case of the Delta, deposited sediments are fine sands, silts, and clays. The smaller suspended particles are carried out into the San Francisco Bay system.

Sediment loads entering the Delta are dependent on the spatial and temporal distribution of river inflow. Sediment loads in the San Joaquin River are highest in early to mid-spring during melting of the snowpack. Sediments reaching the Delta from the south are mostly fine sands. It is noteworthy that the sediment load of the San Joaquin River is much smaller than that of the Sacramento River.

Delta Flood Control and Flow Conveyance System

The flow system conveys released reservoir waters from various upstream sources as well as stormwater runoff through the Delta and into San Francisco Bay. These waters contain dissolved and undissolved solids, both of which are transported through the system. Undissolved solids consist primarily of clay-, silt-, and sand-sized particles. Before construction of the flood control and conveyance system, the natural flow of freshwater runoff from the upstream mountainous regions transported significant quantities of silt and clay particles. Because of the wide expanse and flat terrain of the Delta, these particles would settle and form the sediments of the Delta alluvial plain. During the wet season when the volume of runoff water was much larger, the quantity of suspended and unsuspended solids was significant and included sands and, in some cases, gravels.

The natural processes described above continue today but in a modified manner. Much of the naturally eroded and transported solid particles now settle out in instream water storage reservoirs. A percentage of the fine solids, like silts and clays, still are transported during water releases that enter the system from waterways downstream of the reservoirs. These solids enter the Delta channels, and rather than settling out in the alluvial plain (as occurred before the channels were constructed), they now remain within the levee channels. Historically, some deposition of the solids occurred at locations in the Delta channels where water velocities were low. During high-flow periods, a high percentage of these solids were resuspended and moved downstream toward San Francisco Bay.

Sediment Monitoring in the Delta

In response to comments received on the Draft EIR/EIS for the ISDP, DWR has been monitoring sediment in Delta channels since spring 1998. The comments presented the concern that the proposed permanent gates would increase sedimentation in the channels, creating navigation and recreation problems. Beginning in 1991, as a means of assessing impacts of the proposed permanent gates, temporary barriers were installed at or near the proposed permanent gate locations. The fish control barrier at the head of Old River has been installed and removed each spring and fall. Agricultural barriers have been installed each spring and removed each fall. A sediment monitoring program has been set up to use these temporary barriers as a means of evaluating the potential for sediment accumulation attributable to the proposed permanent gates.

The monitoring program has included location survey, sonar sounding, and sediment sampling at 17 Delta locations. The monitoring locations were selected based on their proximity to the planned gate sites; they also provide a representative understanding of sediment patterns in adjoining waterways.

Sediment monitoring of the 17 Delta locations has occurred immediately prior to placement (spring) of the temporary barriers and just prior to their removal (fall). This schedule of monitoring has provided for assessment of channel sediment thickness and distribution under normal unobstructed (barriers removed) channel flow and under obstructed (barriers in place) channel flow.

The general findings of the study were that:

- sediment amounts generally increase in volume when the (temporary) barriers are in place;
- sediment amounts generally decrease in an equal or greater volume following removal of the (temporary) barriers;
- the mean sediment particle size generally decreases with the (temporary) barriers in place; and
- the mean sediment particle size generally increases with the (temporary) barriers removed.

The current study finds that the (temporary) barriers have a negligible impact on sediment accumulation in the Delta. When the (temporary) barriers are in place, the resulting reduced water flow velocity allows smaller sediment particles to settle and reduces transport of larger particles. The opposite occurs when the (temporary) barriers are removed and the water flow velocities increase. The sediment data indicate that there is a general balance between sediment accumulation and transport (scour). These observed field measurements support the forecast of Reclamation’s sediment transport model (Bureau of Reclamation 2001). The model forecast indicates that, in general, sediment transport capacity of the Delta channels exceeds the transport capacity of the San Joaquin River, the main source of sediment load into the south Delta. This suggests that, with the exception of localized accumulations attributable to channel flow characteristics, sediment will be transported through the Delta, past the gate sites, and into downgradient hydraulic structures, including CCF.

Scouring in the Delta Region

Existing scouring (and sedimentation) patterns have been monitored as part of the conveyance system-wide levee maintenance program. Monitoring is performed by the DWR Flood Management Division on a spot-check basis, during wet season flood events, and as required in response to observed cases of both scour and sedimentation.

A monitoring program for scour in the south Delta was begun in August 1969 to measure and document channel conditions at selected sites on portions of the Old River, Middle River, West Canal, and Victoria Canal (California Department of Water Resources 1998b). The program purpose includes providing information for evaluating possible changes in channel conditions.

Since 1969, the program has expanded several times with the addition of new monitoring sites to a current total of 76. Monitoring sites have been resurveyed several times. When significant differences have been discovered in staff gage datum values, the corresponding monitoring site was reestablished. Semiannual measurements of the cross sections at each site provide data to document natural variations in channel bathymetry and long-term trends in sedimentation or scouring. This information is used to evaluate changes in the natural movement of sediment that might occur in these channels under the implementation of any future Delta plan.

Many factors affect the scour (and sedimentation) patterns, including the amount of rainfall in a given year, dredging activities, and levee and channel stability. The cause of channel changes is not always identifiable. In the south Delta, staff from the DWR Temporary Barriers Program seasonally install and remove rock barriers in the waterways of head of Old River, Middle River, Grant Line Canal, and Old River at DMC. The purpose of the program is to improve water surface elevations and circulation patterns in the south Delta.

Environmental Consequences

Assessment Methods

Assessment of environmental impacts associated with sedimentation and scour has been accomplished through application of quantitative modeling and preproject quantitative and semiquantitative studies.

The methods and approach used include the following:

- Quantitative modeling performed as part of the *Interim South Delta Program Sedimentation Investigation Report* (Bureau of Reclamation 2001). This modeling has been used to forecast the potential for, and patterns of, sedimentation in the Delta as a result of the proposed gates.
- Quantitative modeling performed using DSM2. This model has been used to forecast water levels and channel velocities for the various gate and operational scenarios.
- Quantitative field assessment of sedimentation and scour patterns attributable to the temporary barriers program. This preproject assessment, as presented in *Bed Sediment Monitoring in the South Delta* (California Department of

Water Resources 2003c), has been used to evaluate sediment/scour patterns in the vicinity of the temporary barriers. This assessment program is expected to continue for the permanent gates.

- Semiquantitative assessment of sedimentation/scour potential based on existing federal and state channel hydraulic design standards and guidelines.

Regulatory Setting

This section describes the federal, state, and local regulations, laws, and policies that pertain to sedimentation and scour in the Delta.

Delta Protection Act of 1992

The Delta Protection Act of 1992 declares that the basic goals of the state for the Delta are, among other findings, to improve flood protection, and therefore to ensure an increased level of public health and safety, by structural and nonstructural means.

Section 401 of the Clean Water Act and State Regulations in Title 23 California Code of Regulations

This regulation establishes requirements for all dredging activities for navigable waters of the State of California.

Code of Federal Regulations, Title 40, Part 131, Water Quality Standards

This regulation establishes requirements for water quality, including activities related to in-channel construction, dredging, and long-term effects resulting in sediment transport and scouring.

Significance Criteria

The criteria used for determining the significance of an impact on sedimentation and scour are based on the State CEQA Guidelines and professional standards and practices. Impacts may be considered significant if implementation of an alternative would:

- substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner that would result in substantial erosion or siltation on or off site; or

- substantially alter the existing drainage pattern of the site or area, including the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner that would result in flooding on or off site.

CALFED Programmatic Mitigation Measures

The August 2000 CALFED Programmatic ROD includes mitigation measures for agencies to consider and use where appropriate in the development and implementation of project-specific actions. The mitigation measures address the short-term, long-term, and cumulative effects of the CALFED Program.

Applicable CALFED mitigation measures have been incorporated into the SDIP project and are therefore not used to mitigate impacts. A list of those programmatic mitigation measures that were used in the development of the project follows. These programmatic mitigation measures are numbered as they appear in the ROD, and only those measures relevant to sedimentation and scour are listed; therefore, the numbering may appear out of sequence. Because of the inter-relatedness of sedimentation and scouring to physical resources, the mitigation measures are presented based on the relevant primary objective of water quality. For a full listing of CALFED programmatic mitigation measures, refer to Appendix E, “Mitigation Measures Adopted in the CALFED Record of Decision.”

Sedimentation and Scour Mitigation

Water Quality

7. Use best construction and drainage management practices to avoid transport of soils and sediments into waterways.

8. Use cofferdams to construct levees and channel modifications in isolation from existing waterways.

9. Use sediment curtains to contain turbidity plumes during dredging.

Alternative 1 (No Action)

The No Action Alternative would not result in any construction-related or operations-related sedimentation or scour impacts associated with SDIP facilities.

Under the No Action Alternative, the temporary fish control barrier at the head of Old River and flow control barriers on Old River, Middle River, and Grant Line Canal would continue to have the same effects on sedimentation and scour as under existing conditions. This No Action effect is the same as under existing conditions; therefore, no impact would result.

2020 Conditions

Under Future No Action conditions (2020 conditions) SDIP would not be implemented. It is expected that the temporary barriers program would continue and sedimentation and scour rates would be similar to those described above.

Alternatives 2A, 2B, and 2C

Stage 1 (Physical/Structural Component)

Fish Control Gate and Flow Control Gates

Impact SS-1: Temporary Increase in Sediment Accumulation and Scouring during Construction of Gates. Construction of the fish control gate at the head of Old River and flow control gates on Old River at DMC, Middle River, and Grant Line Canal would result in local accumulation of sediments during certain construction phases. This impact is considered less than significant because potential sediment accumulation and scouring would be minimized by:

- use of cofferdams, siltation screens, turbidity monitoring during dredge operations to support operation adjustments, or other methods to reduce the transport of sediments, depending on the method of gate construction; and
- provisions for passing a 100-year storm flow during construction and protection of levee banks including cofferdam design to allow overtopping, removal of in-channel construction equipment and materials, and temporary placement of erosion control materials, depending on method of gate construction.

No mitigation is required.

Impact SS-2: Increase in Sediment Accumulation and Scouring as a Result of the Gates. The presence of the gates is expected to have a minor effect on the patterns of local accumulation of sediments and the occurrence of scouring in the Delta. Significant changes in the accumulation of sediments could adversely affect aquatic habitat as well as channel hydraulics. Based on general federal channel design standards (U.S. Army Corps of Engineers 2000), impacts from the gates could occur if channel flow velocities exceed threshold levels of 2 to 6 feet/sec. This velocity range is generally considered a minimum velocity at which potential sedimentation and scour could occur in various channels, depending on construction type. Velocities less than 2 feet/sec could result in sedimentation of fine, low-density sediments such as silts and clays.

Current velocities and observed empirical velocity data show that the south Delta channel velocities typically range from less than 0 (because of tidal influence) to approximately 3 feet/sec. Based on DSM2 quantitative modeling, average and maximum velocities for a dry critical year and wet year, 2001 and 2020 LOD, and forecast velocities for Alternatives 2A–2C under non-floodflow conditions show typical velocities in the same range (0 to less than 2.7 feet/sec).

Average and maximum velocities are forecast to decrease with gates in place, generally reducing the potential for scour. Sedimentation is expected to increase during gate operation, but sediment transport is expected to be restored when the gates are not in operation. As described in the Reclamation sediment model study (Bureau of Reclamation 2001), the Delta channel sediment transport capacity exceeds the sediment transport capacity of the San Joaquin River. Consequently, other than minor localized accumulations, sediment is expected to be resuspended and transported downgradient during nonoperational periods. Appendix G provides more information on changes in velocities. Therefore, this impact is considered less than significant. No mitigation is required.

Impact SS-3: Increase in Debris Accumulation Resulting in an Increase in Sediment Accumulation and Scouring. The presence of the gates would increase the potential for waterborne debris to accumulate on the upstream side of the gates. During periods of high flows or floodflows, the gates would remain open and debris would not accumulate. Debris would pass over the gate. This impact is considered less than significant because no increase in sediment transport or accumulation is anticipated. No mitigation is required.

Impact SS-4: Change in Sedimentation and Scour Patterns in the South Delta. Operation of the gates under Alternatives 2A–2C would result in small changes in south Delta sedimentation and scour patterns. Predictions of sediment transport, as presented in *ISDP Sedimentation Investigation Report* (Bureau of Reclamation 2001), indicate excess transport capacity of Delta waterways. Observations of actual sediment accumulation and scour as a result of existing temporary barriers do not indicate a significant change in sedimentation or scour patterns (Appendix G). Planned periodic maintenance dredging of channels is expected to address localized accumulations of sediment. This impact is considered less than significant. No mitigation is required.

Dredging

Impact SS-5: Temporary Increase in Sediment Accumulation and Scouring during Channel Dredging. Dredging of the Delta waterways, including Old River, Middle River, and West Canal, would result in the transport and accumulation of sediments during certain dredging phases. This impact is considered less than significant because the potential effects associated with sediment accumulation and scouring would be minimized by:

- use of dredging methods that result in significantly less sediment transport potential where applicable (hydraulic dredging or use of a closed bucket clamshell); and
- use of cofferdams, siltation-screens/turbidity curtains, or other method to reduce the transport of sediments.

No mitigation is required.

2020 Conditions

Implementation of Alternatives 2A–2C under 2020 conditions would result in impacts similar to those impacts described above. All impacts are less than significant, and no mitigation is required.

Stage 2 (Operational Component)

The increased diversions into CCF as a result of implementation of the operational component would not result in noticeable changes in the rates of sedimentation.

2020 Conditions

The increased diversions into CCF as a result of implementation of the operational component would not result in noticeable changes in the rates of sedimentation.

Interim Operations

Interim operations would not result in any physical changes in the south Delta. The increased diversions into CCF would not result in significant changes in the rates of sedimentation. This impact is less than significant, and no mitigation is required.

Alternative 3B

Stage 1 (Physical/Structural Component)

Fish Control Gate and Flow Control Gates

Impact SS-1: Temporary Increase in Sediment Accumulation and Scouring during Construction of Gates. Implementation of this alternative is similar to Alternatives 2A–2C, but the flow control gate in Grant Line Canal would not be constructed under this alternative. This impact is considered less than significant for the other gate sites as described for Alternatives 2A–2C. No mitigation is required.

Impact SS-2: Increase in Sediment Accumulation and Scouring as a Result of the Gates. Implementation of this alternative is similar to Alternatives 2A–2C, but the flow control gate in Grant Line Canal would not be constructed under this alternative. This impact is considered less than significant for the other gate sites. No mitigation is required.

Impact SS-3: Increase in Debris Accumulation Resulting in an Increase in Sediment Accumulation and Scouring. Implementation of this alternative is similar to Alternatives 2A–2C, but the flow control gate in Grant Line Canal would not be constructed under this alternative. This impact is considered less than significant for the other gate sites. No mitigation is required.

Impact SS-4: Change in Sedimentation and Scour Patterns in the South Delta. Operation of the gates under Alternative 3B would result in small changes in south Delta sedimentation and scour patterns. Implementation of this alternative is similar to Alternatives 2A–2C, but the flow control gate in Grant Line Canal would not be constructed under this alternative. This impact is considered less than significant for the other gate sites as described for Alternatives 2A–2C. No mitigation is required.

Dredging

Impact SS-5: Temporary Increase in Sediment Accumulation and Scouring during Channel Dredging. Implementation of this alternative is similar to Alternatives 2A–2C, but the flow control gate in Grant Line Canal would not be constructed under this alternative. This impact is considered less than significant for the other gate sites as described for Alternatives 2A–2C. No mitigation is required.

2020 Conditions

Implementation of Alternative 3B under 2020 conditions would result in impacts similar to those impacts described above. All impacts are less than significant, and no mitigation is required.

Stage 2 (Operational Component)

The increased diversions into CCF as a result of implementation of the operational component would not result in significant changes in the rates of sedimentation. This impact is less than significant, and no mitigation is required.

2020 Conditions

Implementation of Alternative 3B under 2020 conditions is expected to result in impacts similar to what is described above. Therefore, the impacts are less than significant, and no mitigation is required.

Alternative 4B

Stage 1 (Physical/Structural Component)

Fish Control Gate and Flow Control Gates

Impact SS-1: Temporary Increase in Sediment Accumulation and Scouring during Construction of Gates. Implementation of Alternative 4B is similar to Alternatives 2A–2C, except no gates would be constructed in the Grant Line Canal, Middle River, or Old River at DMC under this alternative. This impact is considered less than significant for the head of Old River fish control gate as described for Alternatives 2A–2C. No mitigation is required.

Impact SS-2: Increase in Sediment Accumulation and Scouring as a Result of the Gates. Implementation of Alternative 4B is similar to Alternatives 2A–2C, except no gates would be constructed in the Grant Line Canal, Middle River, or Old River at DMC under this alternative. This impact is considered less than significant for the head of Old River fish control gate as described for Alternatives 2A–2C. No mitigation is required.

Impact SS-3: Increase in Debris Accumulation Resulting in an Increase in Sediment Accumulation and Scouring. Implementation of Alternative 4B is similar to Alternatives 2A–2C, except no gates would be constructed in the Grant Line Canal, Middle River, or Old River at DMC under this alternative. This impact is considered less than significant for head of Old River fish control gate as described for Alternatives 2A–2C. No mitigation is required.

Impact SS-4: Change in Sedimentation and Scour Patterns in the South Delta. Operation of the gate under Alternative 4B would result in small changes in south Delta sedimentation and scour patterns. Implementation of this alternative is similar to Alternatives 2A–2C, except no gates would be constructed in the Grant Line Canal, Middle River, or Old River at DMC under this alternative. This impact is considered less than significant for the head of Old River fish control gate as described for Alternatives 2A–2C. No mitigation is required.

Dredging

Impact SS-5: Temporary Increase in Sediment Accumulation and Scouring during Channel Dredging. Implementation of Alternative 4B is similar to Alternatives 2A–2C, except no gates would be constructed in the Grant Line Canal, Middle River, or Old River at DMC under this alternative. This impact is considered less than significant for head of Old River fish control gate as described for Alternatives 2A–2C. No mitigation is required.

2020 Conditions

Implementation of Alternative 4B under 2020 conditions would result in impacts similar to those impacts described above. All impacts are less than significant, and no mitigation is required.

Stage 2 (Operational Component)

The increased diversions into CCF as a result of implementation of the operational component would not result in significant changes in the rates of sedimentation. This impact is less than significant, and no mitigation is required.

2020 Conditions

Implementation of Alternative 4B under 2020 conditions is expected to result in impacts similar to what is described above. Therefore, the impacts are less than significant, and no mitigation is required.

Cumulative Evaluation of Impacts

Cumulative sedimentation and scour impacts are discussed in Chapter 10, "Cumulative Impacts." This chapter also summarizes the other foreseeable future projects that may contribute to these impacts.

5.7 Groundwater Resources

Introduction

This section describes the existing groundwater conditions and the consequences of constructing and operating the SDIP on groundwater quality, seepage, and storage. Effects on surface water quality are described in Section 5.3. Significance of impacts was determined by applying significance criteria set forth in the State CEQA Guidelines.

The primary concerns related to groundwater resources are groundwater contamination from spills during construction; groundwater contamination from disposal of dredged materials; and increased seepage losses from sloughs and canals.

Summary of Significant Impacts

There are no significant impacts on groundwater resources as a result of constructing or operating any of the alternatives.

Affected Environment

Sources of Information

The following key sources of information were used in the preparation of this section:

- maps and reports by USGS,
- map and reports by CGS,
- maps and report by NRCS,
- San Joaquin and Contra Costa county general plans, and
- Draft EIR/EIS for the ISDP (California Department of Water Resources and Bureau of Reclamation 1996a).

Groundwater Resources

This section describes the characteristics of groundwater in the south Delta region and its groundwater basins and subbasins (Figure 5.7-1). Specific topics covered include hydrogeology, depth to water table, groundwater fluctuations, groundwater gradient, soils' effect on groundwater conditions, groundwater seepage, subsidence, and groundwater quality.

The San Joaquin Valley groundwater basin is one of the groundwater basins in the San Joaquin River hydrologic region. It has three subbasins: the Eastern San Joaquin, Tracy, and Cosumnes subbasins. The SDIP project area is in the northernmost portion of the San Joaquin River hydrologic region and is located within the Tracy subbasin.

The Tracy subbasin, which extends over 345,000 acres (539 square miles), is defined by the extent of unconsolidated to semiconsolidated sedimentary deposits that are bounded by the Diablo Range on the west; the Mokelumne and San Joaquin Rivers on the north; the San Joaquin River to the east; and the San Joaquin–Stanislaus County line on the south.

Water-Bearing Geologic Units

The thick alluvial deposits of the SDIP project area consist of Holocene flood basin deposits, known as the Dos Palos Alluvium. Because of their fine-grained nature, these deposits have low permeability and generally yield low quantities of water to wells. Occasional zones of fresh water are found in the basin deposits, but they generally contain poor quality groundwater. The maximum thickness of the unit is about 1,400 feet (California Department of Water Resources 2003d).

Underlying these alluvial sediments are Pleistocene, Pliocene/Miocene, Jurassic, and Mesozoic/Paleozoic formations. From younger to older, these formations are: older alluvium, fanglomerate deposits, Copper Hill Volcanics, Merced Falls Slate and Salt Springs Slate, Gopher Ridge Volcanics, and ultramafic rocks. Depth to these geologic units is great enough to discourage well-drilling and water extraction (Wagner et al. 1990).

Depth to Water Table, Groundwater Fluctuations, and Groundwater Gradient

There is little hydrologic distinction between surface water and groundwater within the SDIP project area. Based on soil surveys of Contra Costa and San Joaquin Counties (Welch 1977; McElhiney 1992), depth to the seasonal high water table is typically 3–4 feet (Table 5.7-1). DWR groundwater level data (2003e) from wells approximately 1 mile south of Old River are consistent with these depths.

Table 5.7-1. Depth to Seasonal High Water Table and Permeability for Soils in the SDIP Area

Soil Map Unit	Depth to Seasonal High Water Table (feet)	Permeability (inches per hour)
Old River Flow Control Structure		
Fluvaquents, 0–2% slopes, frequently flooded	*	*
Grangeville fine sandy loam, partially drained, 0–2% slopes	4–6	2.0–6.0
Pescadero clay loam, partially drained, 0–2% slopes	3–6	< 0–0.6
Willows clay, partially drained, 0–2% slopes	4–6	< 0.06
Head of Old River Fish Control Structure		
Columbia fine sandy loam, clayey substratum, partially drained, 0–2% slopes	3–5	0.06–6.0
Merritt silty clay loam, partially drained, 0–2% slopes	4–6	0.2–2.0
Grant Line Canal Flow Control Structure		
Grangeville fine sandy loam, partially drained, 0–2% slopes	4–6	2.0–6.0
Peltier mucky clay loam, partially drained, 0–2% slopes	3–4	0.06–2.0
Ryde clay loam, partially drained, 0–2% slopes	3–4	0.2–2.0
Middle River Flow Control Structure		
Kingile muck, partially drained, 0–2% slopes	3–4	0.06–2.0
Merritt silty clay loam, partially drained, 0–2% slopes	4–6	0.2–2.0
Peltier mucky clay loam, partially drained, 0–2% slopes	3–4	0.06–2.0
Rindge muck, partially drained, 0–2% slopes	3–4	0.06–2.0
Tokay fine sandy loam, 0–2% slopes	> 6	2.0–6.0

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* Properties are too variable to be estimated.

Sources: McElhiney 1992 and Welch 1977.

Seasonal groundwater fluctuations from recharge and pumping are minimal because the south Delta region is tidally influenced; however, groundwater levels vary daily. As the surface of water in the channels fluctuates with the tides, so does the groundwater. As indicated by the DSM2 analysis, the surface water elevation of the channels in the SDIP project area fluctuates approximately 4 feet with the tidal cycle. Groundwater levels vary approximately 2 feet with the tidal cycle depending on location.

Review of hydrographs for the Tracy subbasin indicates that, except for some seasonal variation resulting from recharge and pumping, the majority of water levels in wells have remained relatively stable over at least the last 10 years (California Department of Water Resources 2003d).

Groundwater Storage Capacity

There are no published groundwater storage values for the entire basin; however, Hotchkiss and Balding (1971) estimated the groundwater storage capacity for the Tracy-Patterson Storage Unit at 4,040,000 acre-feet. This storage unit includes the southern portion of the currently defined Tracy subbasin from approximately 1 mile north of Tracy to the San Joaquin–Stanislaus County line. Because the Tracy subbasin comprises roughly one-third of the Tracy-Patterson Storage Unit, it can be inferred that the approximate storage capacity of the southern portion of the Tracy subbasin is on the order of 1,300,000 acre-feet (Hotchkiss and Balding 1971).

Soils

The soils in the SDIP area have been mapped by the U.S. Department of Agriculture, Soil Conservation Service (now called the NRCS) and are described in the soil surveys of Contra Costa and San Joaquin Counties (Welch 1977; McElhiney 1992). The Peltier-Egbert, Merritt-Grangeville-Columbia, Rindge-Kingile, Sacramento-Omni, and Willows-Pescadero soil associations occur on the deltas, floodplains, and levees that make up the majority of soils in the SDIP project area (see Table 5.4-1 in Section 5.4, Geology, Seismicity, Soils, and Mineral Resources).

Soils in the SDIP area are predominantly composed of loams, clays, clay loams, silty clay loams, and mucks. In general, most of these soils are very deep, very poorly to poorly drained, and have a slow runoff rate. Additionally, these soils are overall moderately permeable (Table 5.7-1).

It is important to recognize that the soil properties described above characterize the soils in their natural, unaltered condition. The presence of levees and conversion of wetlands into agricultural land have altered soil characteristics. Soils have been effectively drained by the presence of levees and ditches and groundwater pumping. Because most of the construction and dredging activities would occur within the channel boundaries, soil characteristics as described by Welch (1977) and McElhiney (1992) largely do not apply to these areas.

Groundwater Seepage

Groundwater tends to seep through the levees and saturate soils in the island interiors. Because the islands in the SDIP area are typically below sea level, water is regularly pumped from a depth of 2–3 feet below ground level to keep the land from flooding. Seepage rates and dewatering costs increase as the elevation difference between the water surface in the channel and island interior increases. Seepage rates are relatively slow and do not respond measurably to short-term fluctuations in level (See Section 5.4). Percolation of precipitation to groundwater occurs slowly as well.

Land Subsidence

Land subsidence occurs in three ways: as a result of groundwater overdraft, oxidation/compaction of peat soils, and hydrocompaction. Land subsidence as a result of compaction of peat soils and/or hydrocompaction is discussed in detail in the Geology, Seismicity, Soils, and Mineral Resources section of this chapter.

Land subsidence as a result of groundwater pumping is a common problem in the San Joaquin River hydrologic region (Figure 5.4-1). Subsidence in the Delta is primarily attributable to compaction and oxidation of peat soils.

Groundwater Quality Characterization

Groundwater quality is closely related to the surface water quality. Because of the organic composition of the soils in the area, organic compound concentrations in groundwater are significant.

Based on a 1981 USGS report, *Chemical Quality of Ground Water in San Joaquin and Part of Contra Costa Counties*, the northern part of the Tracy subbasin is characterized by a sodium water type, and the southern part of the subbasin is characterized by calcium-sodium type water (Sorenson 1981). The northern part of the subbasin is also characterized by a wide range of anionic water types, including bicarbonate, chloride, and mixed bicarbonate-chloride. Major anions in the southern part of the subbasin include sulfate-chloride and bicarbonate-chloride. Total dissolved solids (TDS) concentrations in well water sampled in San Joaquin and Contra Costa Counties ranged from 50 to 3,520 mg/l, with a mean of 463 and median of 269 (Sorenson 1981). The highest TDS values were found in the central and western portions of the USGS study area, which, in general, correspond with the limits of the Tracy subbasin. Based on analyses of 36 water supply wells in the subbasin, TDS ranges from 210 to 7,800 mg/l and averages about 1,190 mg/l.

Groundwater Impairments

Areas of poor water quality (i.e., TDS greater than 1,000 mg/l) exist throughout the Tracy subbasin. Areas of elevated chloride (i.e., greater than 500 mg/l) occur in several areas, including along the western side of the subbasin, in the vicinity of the City of Tracy, and along the San Joaquin River. Areas of elevated nitrate occur in the northwestern part of the subbasin and in the vicinity of Tracy. Areas of elevated boron occur over a large portion of the subbasin from south of Tracy and extending to the northwestern side of the subbasin.

Environmental Consequences

Assessment Methods

Evaluation of the impacts in this section is based primarily on the results of DSM2 prepared for the project and on professional judgment. See Appendix D for a discussion of DSM2.

The impact analysis also is based partly on the SDIP EIS/EIR Engineering Information for Impacts Analysis (Jones & Stokes unpublished) and information provided by DWR Division of Engineering staff.

DWR Delta Simulation Model 2

DSM2 calculates hydraulic parameters for hundreds of points in Delta channels every 15 minutes. Using simulation of surface water pumping rates, release schedules, and forecasted tides, levels throughout the south Delta channels are predicted. These parameters are used to determine impacts on groundwater resources, if any, of each alternative, as described below. Following is a summary of preliminary results that aid in the determination of impacts on groundwater resources.

Preliminary results from DSM2 suggest that present tidal fluctuations would be slightly reduced (on the order of 1–2 feet for extreme ends of the tides), but mean tide level (i.e., level) would remain within approximately 1 foot of the present level in most areas. Generally, the operation of the fish control gate and three flow control gates would not affect present water levels in the SDIP area. In the event level is predicted to fall below the criteria (water level response plan) the control gates would be operated to maintain state at or above the criteria elevation. Once the low tide event has passed and the level can be preserved through natural means, the control gates would be opened to allow flow through the channels.

Seepage loss from a channel into the surrounding lowlands is a function of hydraulic head, the perimeter area, and the permeability of the channel bottom and wetted perimeters of the channel. A greater head (i.e., a higher level), which is consistent with a greater downward and outward pressure, forces water to move through a permeable unit (e.g., a levee) and discharge on the outside of the unit. A decrease in head decreases this pressure, causing less water to seep through the levee. In areas where level is expected to decrease, seepage losses from the channel to the lowlands would also decrease; however, the decrease would be minimal because of the minor expected decrease in level.

Regulatory Setting

The following regulations exist to protect water resources.

Clean Water Act, Porter-Cologne Water Quality Control Act, and National Pollutant Discharge Elimination System Program

The project may involve disposal of dredged spoils on nearby islands. The disposal may have elements of both an upland site and a direct discharge to waters of the state.

The EPA’s CWA Section 404(b)(1) guidelines provide environmental criteria used in evaluating proposed discharges of dredged materials into waters of the United States. For proposed discharges of dredged material to comply with the guidelines, they must satisfy four requirements found in Section 230.10 and summarized in the *Draft Inland Testing Manual*, as follows. Section 230.10(a) addresses those impacts associated with the loss of aquatic site functions and values of the proposed discharge site by requiring that the discharge site represent the least environmentally damaging, practical alternative. Section 230.10(b) requires compliance with established legal standards (e.g., issuance or waiver of state water quality certification). Section 230.10(c) requires that discharge of dredged material not result in significant degradation of the aquatic ecosystem. Section 230.10(d) requires that all practicable means be used to minimize adverse environmental impacts.

Upland disposal of dredged sediment is regulated by California Water Code 23, Chapter 15. Waste discharges to land are classified according to Article 2 of Chapter 15, which in its introduction states,

> …wastes which can be discharged directly or indirectly to waters of the state are regulated under waste discharge requirements which implement applicable water quality control plans.

This refers to the waste discharge requirements (WDRs) issued for compliance with the state Porter-Cologne Water Quality Control Act (Porter-Cologne Act) under Section 401 of the federal CWA, and NPDES permits authorized under the CWA. The Porter-Cologne Act defines waters of the state as “any surface water or ground water, including saline waters, within the boundaries of the state.”

The Porter-Cologne Act is California’s primary state law protecting California’s waters. The Porter-Cologne Act is codified in Title 23 of the California Water Code. The Porter-Cologne Act gives the state and RWQCBs the authority to regulate discharges of waste, including dredged or fill material, to any waters of the state. Section 402 of the CWA authorizes states to issue NPDES permits for discharges to surface waters from both point sources and nonpoint sources. The permits specify pollution limits and monitoring and reporting requirements for permitted discharges.

The upland disposal of spoil material and subsequent diffuse discharge of water that may affect groundwater quality require compliance with Subchapter 15 of the Porter-Cologne Act. According to this subchapter, the local RWQCB shall regulate discharges of waste that could affect the quality of waters of the state, and discharges of waste into waters of the state through WDRs authorized under the Porter-Cologne Act and through NPDES permits authorized under the CWA.

The RWQCBs issue WDRs to regulate activities of entities subject to the state’s jurisdiction that would discharge waste that may affect groundwater quality or that may discharge waste in a diffused manner (e.g., through erosion from soil disturbance). The types of activities that fall under this requirement include dredging or filling operations, experimental or long-term work in sensitive environments, and the disposal of wastes on land. RWQCBs may determine that a general NPDES permit or general WDR may be more effective for a proposed discharge.

To obtain a WDR, the discharger must submit a Report of Waste Discharge to the RWQCB and include details of the location and type of discharge and proposed method of disposal (often referred to as a *suitability analysis*).

This report should also include specific construction standards, programs for groundwater quality monitoring, a maintenance plan, contingency plan, and monitoring plan.

The dredged material may be classified as a "designated waste." According to Subchapter 15, a designated waste is a:

> ...non-hazardous waste which consists of or contains pollutants which, under ambient environmental conditions at the waste management unit, could be released at concentrations in excess of applicable water quality objectives, or which could cause degradation of waters of the state.

The discharger may establish, to the satisfaction of the RWQCB, that the dredged material is not a designated waste by showing that a particular waste constituent or combination of constituents presents a lower risk of water quality degradation. A designated waste must be discharged to a Waste Management Unit (WMU) that is designed and constructed according Subchapter 15 specifications.

Storm Water Pollution Prevention Plan

As of February 2003, the EPA requires that the project proponent or contractor apply for an NPDES storm water permit and develop a SWPPP for ground-disturbing activities that would affect 1 acre or more. For the purposes of the NPDES program, construction activities are defined as clearing, excavating, grading, or other land-disturbing activities. The State of California has been delegated by EPA to administer this permit, which authorizes stormwater discharges to waters of the United States under its General Permit for Storm Water Discharges Associated with Construction Activities.

The SWPPP describes proposed construction activities, receiving waters, stormwater discharge locations, and BMPs that will be used to reduce project construction effects on receiving water quality. The component of the SWPPP most relevant to groundwater resources is a spill prevention and control plan, described under Environmental Commitments in Chapter 2, "Project Description."

Significance Criteria

The standards of significance described in NEPA, CEQA, and the CWA and professional judgment were used in this analysis, as described in the following sections.

The NEPA CEQ regulations require a discussion of direct and indirect effects of the proposed alternatives (40 CFR 1508.8). Any possible conflicts between the proposed action and the objectives of any land use plans, policies, and controls in the area affected must also be discussed. In determining significance, NEPA requires that context and intensity of the effects be considered. Cumulative impacts must also be analyzed according to NEPA.

According to the guidance provided in the State CEQA Guidelines, the following impacts would be significant if they occurred as a result of any of the alternatives:

- substantial depletion of groundwater supplies or interference with groundwater recharge, creating or exacerbating a condition of long-term groundwater overdraft;
- interfere with the normal operation of existing nearby wells or a substantial increase in pumping cost at those wells such that they could not support existing land uses or planned land uses for which permits have been granted;
- detectable degradation of groundwater quality;
- appreciable land subsidence as a result of groundwater overdraft; or
- increased seepage losses from sloughs, canals, and streams.

Groundwater impacts were assessed at the scale of the project area. The significance of declining (or increasing) groundwater levels depends in part on the duration and permanence of the impact. Because groundwater levels fluctuate naturally as a result of changes in rainfall, short-term changes in groundwater elevations were not considered significant.

CALFED Programmatic Mitigation Measures

The August 2000 CALFED Programmatic ROD includes Mitigation Measures for agencies to consider and use where appropriate in the development and implementation of project-specific actions. The mitigation measures address the short-term, long-term, and cumulative effects of the CALFED Program.

The discussion of significant impacts and mitigation measures in this section will include a citation of one or more of the following programmatic mitigation measures used to build project-specific mitigation measures to offset significant impacts identified from implementation of the SDIP. These programmatic mitigation measures are numbered as they appear in the ROD, and only those measures relevant to the SDIP resource area are listed below; therefore, numbering may appear out of sequence. To see a full listing of CALFED programmatic mitigation measures, please refer to Appendix E, “Mitigation Measures Adopted in the CALFED Record of Decision.”

Groundwater Mitigation Measure

10. Monitor and test groundwater wells and aquifers.

Aquatic and Fishery Resources Mitigation Measure

1. Implement BMPs, including a SWPPP, a spill prevention and control plan, and vegetation protection plan.

Flood Control Mitigation Measure

6. Implement a seepage monitoring program on nonflooded islands adjacent to potential shallow-flooded islands.

Public Health and Environmental Hazards Mitigation Measure

6. Follow established and proper procedures and regulations for identifying, removing, and disposing of contaminated materials.

Alternative 1 (No Action)

Under the No Action Alternative, the project components described below, including fish control and flow control gates, would not be built or operated and diversions to CCF increase. There would be no impact on groundwater resources, and existing conditions as described above would remain.

In the absence of the SDIP flow control gates, the No Action Alternative could result in continued inconsistency of SDWA agricultural diversions because of water quality and quantity in south Delta channels available for crop irrigation. This inconsistency could result in fewer south Delta agricultural diversions and more reliance on groundwater for crop irrigation.

2020 Conditions

Under future no action conditions (2020 conditions) the SDIP would not be implemented, and diversion into CCF and resulting water exports would not change. It is anticipated that groundwater use will follow current trends and continue as a viable source of water supply. Under this alternative, there would be no impacts on groundwater resources.

Alternatives 2A, 2B, and 2C

Stage 1 (Physical/Structural Component)

Fish Control Gate and Flow Control Gates

Impact GW-1: Change in Availability of Groundwater. The construction of the fish control gate and three flow control gates would cause no changes in groundwater levels and rates of recharge or discharge. The change in flow and level in Old River, Grant Line Slough, and Middle River from permanent flow control gates would not measurably affect groundwater levels in the south Delta and would not result in substantially more consumptive use that could result in effects on groundwater. The project also does not involve substantially increasing impermeable surfaces that could affect groundwater recharge. This impact is less than significant. No mitigation is required.

Impact GW-2: Potential Interference with Normal Operation of Existing Wells or a Substantial Increase in Pumping Cost at Those Wells. The construction of the fish control gate and three flow control gates would not interfere with the normal operation of nearby wells or cause a substantial increase in pumping cost at those wells for the same reasons identified above for Impact GW-1. This impact is less than significant. No mitigation is required.

Impact GW-3: Groundwater Contamination from Construction Vehicles and Equipment Spills. Accidental spills of hazardous vehicular and equipment fluids may occur during construction. Although these potential spills, if not contained, could contaminate groundwater, this impact is considered less than significant because DWR will implement a spill prevention and control plan as part of the SWPPP. This plan will include measures for responding to and remediating spills. A description of the SWPPP is included in Chapter 2 "Project Description," under Environmental Commitments.

Impact GW-4: Potential Depletion of Groundwater Supplies or Interference with Groundwater Recharge from Gate Operations. Operation of the fish control gate and the three flow control gates would not significantly affect existing groundwater levels and would not increase the demand to pump additional groundwater, as suggested by DSM2 results. This impact is less than significant. No mitigation is required.

Dredging

Impact GW-5: Groundwater Contamination from Disposal of Dredged Materials. Under Alternatives 2A–2C, the potential exists that disposal of contaminated dredged materials adjacent to dredging locations could result in adverse effects on local groundwater resources. This impact is considered less than significant because the SDIP has incorporated Environmental Commitments into the project to ensure that contaminated materials do not affect surface water or groundwater resources (See Chapter 2). These Environmental Commitments would require an SAP for proposed dredging areas within 1 year of proposed dredging activities. If the SAP concludes that dredged material is found to possess contaminants, its disposal may lead to significant impacts on groundwater quality by leaching contaminants into the underlying soil. However, the SAP would be followed by a suitability analysis in which a suitable environment for the disposal of contaminated soils would be chosen. This impact is less than significant. No mitigation is required.

If this project alternative were to involve the decanting of water to an existing agricultural drainage ditch and pumping into existing surface waters, it would be subject to Sections 401 and 404 of the CWA and WDR permit process as described above.

Compliance with state and federal Water Quality Regulations, such as Sections 401, 402, and 404 of the federal CWA as described in the Regulatory Overview section, would include the following:

- If concentrations are shown to exceed water quality standards based on the suitability analysis described above, the DPS must be shown to have sufficient capacity and attenuation properties to protect groundwater. The SAP and suitability analysis must show that water quality would not be degraded based on the characterization of the dredged sediments and the placement site.
- In the event that the dredged material characterization reveals elevated concentrations that may adversely affect groundwater and the DPS does not have sufficient characteristics or properties to attenuate the constituents of concern, the proposed area of dredged materials disposal could be developed as a Class II WMU. A WMU must be (1) underlain by geologic materials with specific permeability characteristics and thickness; (2) protected by natural or artificial barriers; (3) lined to conform with the requirements of Title 23, Chapter 15 of the California Code of Regulations; (4) designed to prevent inundation or washout from floods with a 100-year return period; (5) set back 200 feet from a known Holocene fault; and (6) designed according to specified engineering criteria.

2020 Conditions

Impacts resulting from the implementation of Alternatives 2A–2C under 2020 conditions would be similar to those described above, as the groundwater resources and uses are expected to be similar. All impacts are less than significant, and no mitigation is required.

Stage 2 (Operational Component)

Increasing the maximum diversions into CCF would not significantly affect existing groundwater levels and would not increase the demand to pump additional groundwater, as suggested by DSM2 results.

2020 Conditions

Operational impacts resulting from the implementation of Alternatives 2A–2C would be similar under 2020 conditions to the impact described above. This impact is less than significant, and no mitigation is required.

Interim Operations

Interim operations would increase the maximum diversions into CCF. This would not significantly affect existing groundwater levels and would not increase the demand to pump additional groundwater, as suggested by DSM2 results. Therefore, there would be no impact, and no mitigation is required.

Alternative 3B

Under Alternative 3B, impacts would be similar to Impacts GW-1 through GW-5 under Alternatives 2A–2C.

Stage 1 (Physical/Structural Component)

Fish Control Gate and Flow Control Gates

Impact GW-1: Change in Availability of Groundwater. The construction of the fish control gate and two flow control gates would cause no changes in groundwater levels and rates of recharge or discharge. The change in flow and level in Old River and Middle River from permanent flow control gates would not measurably affect groundwater levels in the south Delta and would not result in substantially more consumptive use that could result in effects on groundwater. The project also does not involve substantially increasing impermeable surface that could affect groundwater recharge. This impact is less than significant. No mitigation is required.

Impact GW-2: Potential Interference with Normal Operation of Existing Wells or a Substantial Increase in Pumping Cost at Those Wells. The construction of the fish control gate and two flow control gates would not interfere with the normal operation of existing nearby wells or cause a substantial increase in pumping cost at those wells for the same reasons identified above for Impact GW-1. This impact is less than significant. No mitigation is required.

Impact GW-3: Potential Groundwater Contamination from Construction Vehicles and Equipment Spills. The potential impact on groundwater caused by contamination from construction vehicles and equipment spills would be slightly less under Alternative 3B than under Alternatives 2A–2C. Under Alternative 3B, only three gates are proposed instead of the four gates proposed for Alternatives 2A–2C and, therefore, there would be less construction activity and less potential for groundwater contamination from construction vehicles. Although these potential spills, if not contained, could contaminate groundwater, this impact is considered less than significant because DWR will implement a spill prevention and control plan as part of the SWPPP. This plan will include measures for responding to and remediating spills. A description of the SWPPP is included in Chapter, “Project Description,” under Environmental Commitments.

Impact GW-4: Potential Depletion of Groundwater Supplies or Interference with Groundwater Recharge from Gate Operations. Operation of the fish control gate and the two flow control gates would not significantly affect existing groundwater levels and would not increase the demand to pump additional groundwater, as suggested by DSM2 results. This impact is less than significant. No mitigation is required.

Dredging

Impact GW-5: Groundwater Contamination from Disposal of Dredged Materials. Alternative 3B does not include the proposed gate at Grant Line Canal and, therefore, there would be less dredge spoils and less potential for groundwater contamination from disposal of dredged materials. This impact is less than significant. No mitigation is required.

2020 Conditions

Impacts of implementing Alternative 3B under 2020 conditions would be similar to those described above, as the groundwater resources and uses are expected to be similar. All impacts are less than significant, and no mitigation is required.

Stage 2 (Operational Component)

Increasing the maximum diversions into CCF would not significantly affect existing groundwater levels and would not increase the demand to pump additional groundwater, as suggested by DSM2 results.

2020 Conditions

Operational impacts resulting from the implementation of Alternative 3B would be similar to the impact described above. This impact is less than significant, and no mitigation is required.

Alternative 4B

Under Alternative 4B, impacts would be similar to Impacts GW-1 through GW-5 under Alternative 2A–2C.

Stage 1 (Physical/Structural Component)

Fish Control Gate

Impact GW-1: Change in Availability of Groundwater. The construction of the fish control gate would cause no changes in groundwater levels or rates of recharge. This gate would not measurably affect groundwater levels in the south Delta and would not result in substantially more consumptive use that could result in effects on groundwater. The project also does not involve substantially increasing impermeable surface that could affect groundwater recharge. This impact is less than significant. No mitigation is required.

Impact GW-2: Potential Interference with Normal Operation of Existing Wells or a Substantial Increase in Pumping Cost at Those Wells. The construction of the fish control gate would not interfere with the normal operation of existing nearby wells or cause a substantial increase in pumping cost at those wells for the same reasons identified above for Impact GW-1. This impact is less than significant. No mitigation is required.

Impact GW-3: Potential Groundwater Contamination from Construction Vehicles and Equipment Spills. The potential impact on groundwater caused by contamination from construction vehicles and equipment spills would be less under Alternative 4 than under Alternatives 2A–2C. Under Alternative 4B, only one gate is proposed instead of the four gates proposed under Alternatives 2A–2C and therefore, there would be less construction activity and less potential for groundwater contamination from construction vehicles. Although these potential spills, if not contained, could contaminate groundwater, this impact is considered less than significant because DWR will implement a spill prevention and control plan as part of the SWPPP. This plan will include measures for responding to and remediating spills. A description of the SWPPP is included in Chapter "Project Description," under Environmental Commitments.

Impact GW-4: Potential Depletion of Groundwater Supplies or Interference with Groundwater Recharge from Gate Operations. Operation of the fish control gate would not significantly affect existing groundwater levels and would not increase the demand to pump additional groundwater, as suggested by DSM2 results. This impact is less than significant. No mitigation is required.

Dredging

Impact GW-5: Groundwater Contamination from Disposal of Dredged Materials. Under Alternative 4 there would be fewer sites dredged and less dredge spoils and, therefore, there would be less potential for groundwater contamination from disposal of dredged materials than under Alternatives 2A–2C. This impact is less than significant. No mitigation is required.

2020 Conditions

Impacts associated with the implementation of Alternative 4B under 2020 conditions would be similar to those described above, as the groundwater resources and uses are expected to be similar. All impacts are less than significant, and no mitigation is required.

Stage 2 (Operational Component)

Increasing the maximum diversions into CCF would not significantly affect existing groundwater levels and would not increase the demand to pump additional groundwater, as suggested by DSM2 results.

2020 Conditions

Operational impacts resulting from the implementation of Alternative 4B under 2020 conditions would be similar to the impact described above. This impact is less than significant, and no mitigation is required.

Cumulative Evaluation of Impacts

Cumulative impacts on groundwater resources are discussed in Chapter 10, “Cumulative Impacts.” This chapter summarizes the other foreseeable future projects that may contribute to these impacts.

5.8 Transportation and Navigation

Introduction

This section describes existing transportation and navigation conditions within the immediate project area, discloses the potential effects of constructing and operating the gates on transportation and navigation, and recommends mitigation of impacts that are determined to be significant. Transportation and navigation impacts are not expected to occur outside of the immediate project area; therefore, regional transportation and navigation issues are not discussed.

For the transportation discussion, this section focuses on: (1) the existing condition of the roadways that make up the routes that are expected to be used during project construction and the potential effects on those roadways from construction vehicles; (2) the potential effects on circulation patterns on those roads; and (3) the potential effects on other modes of travel (public transportation, bikeways, rail, aviation, and car ferries).

Changes in vehicle/capacity ratios and levels of service (LOS) of affected roadways, and potential impacts on LOS, were not evaluated in this document because construction impacts would be minimal, short-term, and cover a wide geographical project area; permanent impacts from roadway modifications and facility operations would also be minimal, and also cover a wide geographical project area.

For the navigation discussion, the changes in access to Delta waterways by boats and other vessels during construction and operation of the gates, during channel dredging activities, and attributable to changes in water levels/depths are addressed. Because the use of waterways in the project area is limited primarily to recreational boating and some emergency access use, permanent impacts on boat access and navigation use in the Delta waterways are discussed in Section 7.4, Recreation Resources, and in Section 7.8, Public Health and Environmental Hazards.

Summary of Significant Impacts

There are no significant transportation and navigation impacts as a result of implementation of any of the alternatives. The Environmental Consequences section contains a detailed discussion of all impacts and mitigation measures for Alternatives 2A–2C, 3B, and 4B.

Affected Environment

Sources of Information

The following key sources of information were used in the preparation of this section:

- Draft EIR/EIS for the ISDP, Volume I, July 1996;
- Site visits conducted on June 23, 2003, and July 17, 2003;
- Nautical Chart 18661, Sacramento and San Joaquin Rivers, California, 27th Ed., February 1, 2003;
- California Delta Chambers and Visitors Bureau. Web link: CaliforniaDelta.org. <http://www.californiadelta.org/deltamarina.htm> and <http://www.californiadelta.org/deltanavigationaltips.htm>, accessed September 17, 2003; and
- SDIP planning sessions between DWR and Jones & Stokes staff, and information provided by DWR Division of Engineering staff.

Transportation

Roadways

The immediate project area is rural in character and is generally served by two-lane roads. These rural roads provide local access to individual properties, and access to Interstate 5 (I-5), I-205, and SR 4. SR 4 and I-205 are east-west trending roadways, and I-5 is a major north-south transportation corridor (Figure 5.8-1). Two county roads, Byron Highway and Tracy Boulevard, are locally important routes in the project vicinity. They are both north-south roads and are links between SR 4 and I-205.

Land access to those specific channels in which construction of the SDIP would take place is described below.

Head of Old River near Confluence with San Joaquin River

Access to the south levee from I-5 is via Manthey Road, Stewart Road, and San Joaquin Road. Access to the north levee from I-5 is via Howard Road, Roberts Road, Undine Road, and a private road at the southern extension of Undine Road.

Middle River Gate near North Canal

Access to the south levee from I-205 is via Tracy Boulevard, Clifton Court Road, Calpack Road, and Klein Road. Access from I-5 is via Howard Road, Tracy Boulevard, Clifton Court Road, Calpack Road, and Klein Road. Access to the north levee from I-205 is via Tracy Boulevard and a private road about 300 feet north of the Borden Highway Bridge on the Middle River (near SR 4).

Grant Line Canal/Fabian and Bell Canal near Delta-Mendota Canal

Access to the south levee from I-205 or SR 4 is via Tracy Boulevard, Grimes Road, and a private road along the top of the levee. Access to the north levee from I-205 or SR 4 is via Tracy Boulevard, a private road about 300 feet north of the canal, and top of levee road on northern side of Grant Line Canal, or via Tracy Boulevard, Clifton Court Road, and a private road located at the western end of Clifton Court Road.

Old River near Delta-Mendota Canal

Access to the south levee from I-205 is via Byron Road and Kelso Road. From I-580, access is via Altamont Pass Road, Mountain House Road, and Kelso Road. Access to the north levee from I-205 is via Tracy Boulevard and Finck Road.

Old River near Tracy

Access to the south levees from I-205 or I-5 is via Grant Line Road, Tracy Boulevard, and Whitehall Road or MacArthur Drive. Access to the north levees from I-205 or SR 4 is via Tracy Boulevard, Howard Road, Undine Road, and Wing Levee Road. Access from I-5 is via Howard Road, Roberts Road, Undine Road, and Wing Levee Road.

West Canal

Access to the west side of the channel banks from I-205 or SR 4 is via Grant Line Road, Byron Highway, Herdlyn Road, and the top of a levee road (private road).

A site visit was conducted June 23, 2003, to determine the existing condition of the roadways in the south Delta region. The routes used to access the above channels consist of major transportation facilities (I-5, I-205, and SR 4); major rural circulation roads (Byron Highway, Tracy Boulevard, Manthey Road, and Howard Road); and connector roads (consisting of narrower county and private roadways). The condition of these roadways is listed in Table 5.8-1.

Table 5.8-1. Existing Roadway Condition of Roads to Project Construction Sites

Roadway	Number of Lanes	Shoulders	Existing Road Condition[a]
I-5	6–10	Yes	Excellent
I-205	4–6	Yes	Excellent
SR 4[b]	2	No	Excellent
Byron Highway	2	Yes	Good
Manthey Road	2	No	Good
Howard Road	2	Yes	Excellent
Tracy Boulevard	2	Yes	Excellent, except for a short segment from Larch Road to the north City Limits of Tracy. There are areas of raveling[c] pavement and potholes in this section.
Stewart Road	2	No	Poor; road has potholes.
Cohen/San Joaquin Road	2	No	Poor; road has potholes and pavement is distressed[d].

Roadway	Number of Lanes	Shoulders	Existing Road Condition[a]
Roberts Road	2	No	Good
Clifton Court Road	2	No	Good
Calpack Road	2	No	Fair; road has patched potholes.
Klein Road	1.7[e]	No	Fair; road has patched potholes.
Grimes Road	1.7	No	Good
Finck Road	2	No	Fair
Kelso Road	2	No	Fair; road has patched potholes
Herdlyn Road	1.7	No	Good
Bacchetti Road	2	No	Good
Whitehall Road	2	No	Good
MacArthur Road	2	No	Good
Delta Place	1.7	No	Good; however, pavement section may be inadequate for project construction loads
Delta Road	2	No	Good
Stark Road	2	No	Good
Wing Levee Road	2	No	Good
Undine Road	2	No	Good
Bonetti Road	1–2	No	North of Clifton Court Road: good condition South of Clifton Court Road: fair condition, road is dirt, gravel, and oil and screenings[p] in various locations
Top of levee roads	1	No	Paved or ravel roads in fair to good condition
Private roads	1	No	Most are dirt[g] or oil and screenings

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[a] Roadway Condition Ratings: Excellent—pavement in good condition, exhibits good geometrics (i.e., the road is straight and it has large curves to allow cars to maintain their speed while going around the curves), and it has good shoulders. Good roads—pavement in pretty good shape, some patching of the roadway, shoulders not well-maintained, road able to handle project traffic. Fair—very patched road is starting to deteriorate, could potentially be affected by the project. Poor—many visible potholes and would definitely be adversely affected by the project.

[b] A roadway sign on Tracy Boulevard just south of SR 4 indicates that "Tractors/semis over 34 feet kingpin to rear axle not advised on SR 4 west, very sharp curves."

[c] Raveling occurs when pavement loses its oil content over time and becomes dry and brittle. This causes the surface aggregates to become loose and causes the pavement to develop potholes and fail.

[d] Distressed pavement refers to pavement that shows some type of failure, usually failure of the soils under the structural roadway section. This causes depressions in the roadway along the path of the wheels, and eventually creates potholes.

[e] A road with 1.7 lanes is 20 feet wide that is not striped to create lanes.

[f] Oil and screenings is a chip seal road that is typical of county road construction. It is usually constructed of aggregate base material and is given alternating layers of a bituminous oil and 3/8-inch rock to provide an all-weather surface. Sometimes an asphalt concrete layer is placed on the aggregate base before adding the oil and screenings.

[g] A dirt road is a cleared path through a field that is graded to create a uniform surface; it generally is not suitable for all-weather use or heavy loads.

Source: CH2MHill 2003.

Public Transportation

The San Joaquin Regional Transit District (SMART) provides interregional, intercity, and a “hopper” bus services throughout San Joaquin Area Transit (CAT) service area. Greyhound provides services between Stockton and Oakland. The Livermore-Amador Valley Transportation Authority serves unincorporated areas in Alameda County on a demand-response basis. The Stockton Metropolitan Transit District serves the cities of Stockton, Manteca, and Tracy, and Lawrence Livermore Lab. Services in eastern Contra Costa County provide fixed route and dial-a-ride services.

The CAT provides fixed-route service to the cities of Stockton, Lathrop, and Manteca. Additional intercity bus lines provide service to Tracy. CAT also offers dial-a-ride services for both the general public and for the elderly/disabled throughout the county. These dial-a-ride services provide transportation 7 days a week during nontraditional bus hours in rural areas not served by fixed-route lines. The dial-a-ride programs provide connection services to fixed-route lines and to passenger rail (such as Altamont Commuter Express [ACE] and Amtrak). SMART’s Interregional Commuter Service offers bus service to passengers traveling to Alameda, Contra Costa, Santa Clara and Sacramento Counties, including feeder service to BART for employees working in San Francisco and the East Bay. (San Joaquin Regional Transit District 2004)

Bikeways

A Class II[1] bike lane exists along Byron Highway and a Class I[2] bike route exists along the California Aqueduct and Bethany Reservoir in Alameda County. An additional Class II and III [3] bikeway extends south along Midway Road, crosses the DMC and California Aqueduct, intersects I-580, then joins a bikeway along Patterson Pass Road. In addition, a bikeway parallels the Santa Fe Railway system to its intersection with SR 4, then follows SR 4.

Rail

Rail lines in the south Delta region are used for both passenger and freight services. The northwest-southeast Union Railroad located west of the project area and aligned parallel with Byron Highway carries mainly freight traffic. North of the project area, the east-west Burlington Northern and Santa Fe Railway (BNSF) provides passenger service between Stockton and Antioch and cities beyond. Rail services using these lines include Amtrak and the ACE. Amtrak provides services between Stockton and San Jose; the San Joaquin route

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[1] Class II—a striped lane for one-way bike travel in each direction within the paved area (typically on the shoulder) on a street or highway.

[2] Class I—a completely separated right-of-way for the exclusive use of bicycles or pedestrians with cross-flow minimized.

[3] Class III—shared use of lanes with pedestrian or motor vehicle traffic (typically at the right edge of the traveled way without a bike lane stripe).

makes stops in Antioch. ACE provides direct commuter rail service to Silicon Valley (with stops in Stockton, Lathrop, Manteca, and Tracy).

Aviation Facilities

There are numerous airports around the Delta region. The closest airports to the project area are the Sharpe Army Depot, approximately 3 miles east of the confluence of head of Old River with San Joaquin River, and the Byron Airport, located approximately 5 miles west of Grant Line Canal at the DMC. Stockton Metropolitan, Tracy Municipal, and New Jerusalem (in Tracy) are all public airports, and Lind’s Airport, the Precissi Airpark, and the Kingdon Airpark are privately owned. Sacramento International Airport is located approximately 70 miles away, north of the Delta.

There are no airports or nonagricultural landing strips within a quarter-mile of West Canal, Grant Line Canal, Middle River, or Old River. However, some cleared areas may be used for landing strips for agricultural aviation equipment that is often used in the Delta for cropdusting.

Car Ferries

There are five ferries in operation in the Delta that allow public access, but three of them lead to islands that are private property. The two remaining are free to the public. The “Real McCoy” takes people and their cars across Cache Slough to Ryer Island and back. The “J-Mack” transports people and cars across Steamboat Slough. There is one cable-drawn ferry that takes people and cars to Woodward Island, crossing Middle River, approximately 3 miles north of CCF.

Navigation

Most of the waterways in the immediate project vicinity are public waterways navigable by recreational craft, including rowboats, large houseboats, and cabin cruisers. These waterways are also navigable by smaller commercial vessels, including towing and salvage vessels, clamshell dredges, dredges for repair and maintenance of levees and channels, and pile-driving vessels.

Popular access points for boating and other recreational craft in south Delta’s channels are identified in Figure 7.4-1 in Section 7.4, Recreation Resources. Boat access points in the project area include River’s End Marina, located on the south side of the DMC, at the confluence with Old River; Tracy Oasis Marina Resort, located on the east side of Tracy Boulevard and the north side of Old River; and possibly at Heinbockle Harbor, located at Tracy Boulevard, on the south side of Grant Line/Fabian and Bell Canal. According to a California Department of Parks and Recreation (DPR) survey conducted in 1996, minimal boat launching and use occurs in the project area.

Channels in the greater Delta waterways also serve commercial vessels. The Port of Stockton, located on the Stockton DWSC northeast of the project area, is the second largest inland seaport on the West Coast. The Stockton DWSC and the Sacramento DWSC serve deep draft ocean-going vessels at the inland ports of Stockton and Sacramento. Approximately five million tons of cargo is handled annually by the two ports.

The channels within the project area are too small to accommodate large commercial vessels, and because the channels are also part of an existing temporary barriers project, larger vessels cannot use these channels when the barriers are in place. The temporary barriers project involves annually installing and removing barriers at four locations along Middle River, Old River, and Grant Line Canal. This project was originally planned to sunset in November 2003 but has been extended to operate up to 2007 (California Department of Water Resources 2000c). These channels and West Canal are shown in Figure 5.8-1 and are described below.

West Canal and Surrounding Channels

The West Canal is a straightened portion of the Old River and forms the eastern perimeter of CCF. West Canal has a controlling depth[4] of 10 feet. Victoria Canal and North Canal are parallel canals that begin at Old River and extend northeast. They have controlling depths of 6 and 11 feet, respectively. Italian Slough, with a controlling depth of 8 feet, forms the northern and northwestern perimeters of CCF. West Canal is a major throughway for boats entering the south Delta and can be accessed from River's End Marina near the confluence of Old River and the DMC (Doty pers. comm.).

Middle River

Within the south Delta, Middle River runs from North Canal in the west to Old River to the east. This section of the river contains several small islands that support wetland ecosystems. It is very shallow, and because of the islands, very narrow. Currently, a temporary barrier to control flow is installed in the spring and removed in the fall south of the Borden Highway Bridge at North and Trapper Slough. The existing boat portage facility at this site is a gravel ramp, which can be used to carry or drag a small boat across the barrier (California Department of Water Resources 2000c). There are no other boat ramp or boat launch facilities because the Middle River, in this stretch, is navigable only by small boats. Several bridges cross Middle River in this reach, with vertical clearances of 11 to 15 feet at high water elevation and 14 to 18 feet at low water elevation.

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[4] Depths are given in feet in relation to mean lower low water (mllw).

Grant Line Canal

The east-west Grant Line Canal runs parallel with the Fabian and Bell Canal. These two canals are connected at many points along their length by breaks in the center islands. These canals are not throughways, but are considered to be popular boating and fishing areas, and therefore are used exclusively for recreation. The Tracy Oasis Marina is located on the canal approximately 5 miles east of its confluence with the West Canal (National Oceanic and Atmospheric Administration 2003).

Currently a temporary barrier is installed each spring and removed each fall in the Grant Line Canal east of Tracy Boulevard. This barrier may be crossed using a boat launch provided by DWR at the barrier site. It is operable from 6:00 a.m. to 8:00 p.m. every day. It takes approximately 10 minutes and can transport boats up to 25 feet in length.

Old River

Old River is navigable by recreational craft along an approximately 19-mile stretch between Old River, near the DMC to the west, and the San Joaquin River to the east (refer to Section 7.4, Recreation Resources, for more detail). The controlling depth of Old River near the DMC is 7 feet and decreases to a depth of 5 feet near its confluence with the San Joaquin River. The controlling depth of San Joaquin River upstream and downstream of the confluence with Old River is 3 feet.

Currently, barriers are installed and removed annually in the Old River. A temporary flow control barrier, Old River barrier, is installed in the spring and removed each fall near the DMC. A temporary fish control barrier, head of Old River fish barrier, is installed and removed in the spring (April through May) of each year and is sometimes also installed and removed in the fall (October through November), depending on fishery needs.

There is no boat launching available at the temporary fish control barrier at the head of Old River. However, the channel may be accessed at River’s End Marina, approximately 1 mile upstream from the temporary barrier near the DMC. Boaters may access the upstream portion of Old River by using a boat ramp provided by DWR.

Environmental Consequences

Assessment Methods

The significance of potential impacts on transportation and navigation in the project area was determined by comparing thresholds to anticipated impacts from construction- and operation-related activities. For the purposes of analysis, the effects of these project activities were divided into five impact mechanism categories: truck and commute trip impacts on roadways; temporary partial obstructions in navigable waterways from barge trips, dredging, and gate construction activities; navigational obstructions at permanent gate locations; impacts on safety and roadway surface conditions along haul routes; and changes in transportation patterns caused by the creation of new roadways.

Because of the short-term nature of construction-related impacts, wide geographical project area, and minimal permanent impacts expected to result from roadway modifications and facility operations, the LOS of affected roadways and potential impacts on LOS were not included as significance criteria in this analysis.

Regulatory Setting

The following key sources of information were used in the preparation of this section:

- Alameda County General Plan,
- Alameda County Bike Plan,
- Countywide Transportation Plan (Alameda County),
- Contra Costa County General Plan,
- Countywide Bicycle and Pedestrian Plan (Contra Costa County),
- San Joaquin County General Plan,
- San Joaquin County Regional Bicycle Master Plan,
- Regional Transportation Plan (San Joaquin County Council of Governments), and
- San Joaquin County Metropolitan Transportation Plan.

Besides general construction guidelines and practices, San Joaquin, Contra Costa, and Alameda Counties maintain specific guidelines for construction activities within their jurisdictions, particularly within streets and roadways.

Significance Criteria

Criteria to determine the significance of impacts on transportation and navigation are based on relevant thresholds of significance established by agencies with jurisdictional authority and/or applicable laws and regulations. According to the State CEQA Guidelines, the San Joaquin Council of Governments, the CALFED Programmatic ROD, and professional standards, a project may be considered to have a significant effect on the environment if it would result in:

- substantial increase in the traffic delay experienced by drivers;
- substantial deterioration of the roadway surface as a result of construction activities;

- substantial alteration of present patterns of circulation or movement;
- conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks);
- impedance of navigational craft as a result of the installation of cofferdams, or the staging of barges in navigable sections of the south Delta waterways;
- impedance or blockage of navigational craft in the Delta channels where the fish control gate and flow control gates are installed; and
- safety conflicts by operating large, slow-moving dredging equipment on Delta waterways.

CALFED Programmatic Mitigation Measures

The August 2000 CALFED Programmatic ROD includes mitigation measures for agencies to consider and use where appropriate in the development and implementation of project specific actions. The mitigation measures address the short-term, long-term and cumulative effects of the CALFED Program.

As indicated in the Summary of Significant Impacts section, no significant impacts on transportation and navigation were identified. However, the CALFED programmatic mitigation applicable to transportation and navigation was considered during project development. These programmatic mitigation measures are numbered as they appear in the ROD. A full listing of CALFED Programmatic Mitigation Measures is provided in Appendix E, “Mitigation Measures Adopted in the CALFED Record of Decision.”

Transportation Mitigation Measures

3. Encourage use of public transportation and carpooling for construction workers.
4. Clearly mark roadway intersections with warnings where visibility is poor in the project vicinity.
5. Provide boat portage or a stationary jib crane.
6. Relocate boat launch facilities.
7. Relocate emergency access roads.
8. Require contractors to follow appropriate state and federal safety protocols.
9. Coordinate dredging and safety precautions with state and local authorities.
10. Schedule construction at times and seasons to minimize delays.
13. Locate roadways in areas with fewer conflicts.
14. Design roadways to avoid or minimize traffic congestion.

Alternative 1 (No Action)

Under the No Action Alternative, the project components described below, including permanent fish control and flow control gates, would not be constructed, and no increases in diversion to CCF would occur. There would be no change in the characteristics of the regional transportation system provided over local roadways or navigation though Delta channels. No impacts associated with Alternative 1 have been identified. No mitigation is required.

2020 Conditions

Under future no action conditions (2020 conditions), SDIP would not be constructed, and the temporary barriers program would continue. This would not result in changes to traffic or navigation related to existing conditions as described above. However, it is likely that increases in traffic in San Joaquin, Contra Costa, and Alameda Counties would occur as a result of increasing populations. The Future No Action would not contribute to these changes and would not result in impacts on transportation and navigation. No mitigation is required.

Alternatives 2A, 2B, and 2C

Stage 1 (Physical/Structural Component)

Fish Control Gate and Flow Control Gates

Impact TN-1: Temporary Addition of Vehicles to Roadway System and Alteration of Present Patterns of Vehicular Circulation during Construction Activities. Under Alternatives 2A–2C, construction of the four gates would result in the temporary addition of construction trucks, equipment, and commuting workers on the surrounding roadway system, including levee roads, and would result in the temporary alteration of present patterns of vehicular circulation.

The construction workforce required to construct the facilities associated with each alternative would most likely be drawn from the local labor pool in San Joaquin, Contra Costa, and Alameda Counties. Almost all the workforce is anticipated to commute 10 miles or less one way. Alternatives 2A–2C would require a peak construction workforce of about 320 workers during the construction period, which includes both gate construction and dredging.

In addition to the construction workforce and general construction vehicles, traffic would be generated from haul truck trips to and from the project sites. Material quantities for construction purposes depend on the design of each of the facilities constructed. Only the local portion of the truck trips (50 miles round trip [RT]) was accounted for in this analysis.

Imported materials, such as aggregate base, concrete, backfill, reinforcing steel, electrical equipment, and pavement (asphaltic concrete), are expected to come from gravel pits and batch plants located near Tracy. Riprap materials are expected to come from distributors in Jackson, and the gates are expected to come from distributors in Vallejo. Anticipated haul routes are shown in Figure 5.8-2.

Material to be exported is primarily limited to excess excavated material and rubble. Stockpile material is considered part of the local work and is not included as a truck trip. Approximately 40 cubic yards (yds^3) per month of excess excavated material would be hauled off site to the Altamont Landfill and Resource Recovery Facility located in Livermore, 6 miles from the project area. The haul route is assumed to include Byron Highway, Mountain House Parkway, I-580, and Altamont Pass Road, ending at the landfill.

Total truck trips for each gate site were calculated based on construction information tables provided by DWR; these tables are provided in Appendix C of this EIS/EIR. Starting points for haul routes and truck trips at each gate site would vary and are discussed further below.

Head of Old River Fish Control Gate. The construction of the Old River fish control structure would involve the transportation of equipment, materials, debris, and construction personnel on Cohen/San Joaquin Road, Stewart Road, Undine Road, Manthey Road, Roberts Road, SR 4, I-580, I-680, I-5, and I-205. The construction of this facility would involve up to 2 vehicle trips RT per day, for a total of 1,596 vehicle trips RT over a construction period of up to 26 months.

Middle River Flow Control Gate. Roadways used as construction haul routes for the Middle River gate would include Klein Road, Clifton Court Road, Tracy Boulevard, Calpack Road, SR 4, and I-580. Construction would require up to 3 vehicle trips per day, for a to total of 1,789 vehicle trips over a construction period of up to 18 months.

Grant Line Canal Flow Control Gate. The construction of the Grant Line Canal flow control structure would involve the transportation of equipment, materials, and construction personnel on Herdlyn Road, South Bonetti Road, Tracy Boulevard, Clifton Court Road, Calpack Road, Howard Road, SR 4, I-580, I-780, and I-205. Construction would involve up to 2 vehicle trips per day, for a total of 1,340 vehicle trips over a construction period of up to 30 months.

Old River Flow Control Gate at DMC. The construction of the Old River flow control structure near the DMC would involve the transportation of equipment, materials, and construction personnel on Finck Road, Kelso Road, Tracy Boulevard, Howard Road, SR 4, I-580, I-780, and I-205. In addition, temporary haul roads of an aggregate base and oil chip-seal design would be constructed. Construction would involve up to 2 vehicle trips per day, for a total of 1,889 vehicle trips over a construction period of up to 30 months.

This increased truck traffic along haul routes during construction would result in the temporary alteration of present patterns of vehicular circulation. The truck traffic could also temporarily increase response times for emergency services such as fire protection, police, and ambulances along affected roadways. As part of the project's environmental commitments (see Chapter 2) an emergency access plan will be prepared and implemented to reduce construction-related effects on the local roadway and waterway systems and to avoid hazardous traffic and circulation patterns during the construction period.

The impact of additional traffic associated with construction of the SDIP facilities on the present patterns of vehicular circulation would be less than significant because:

- construction activities would be phased, and truck, commute, and equipment trips would occur over a time period of up to 36 months;
- total construction trips at each gate location would not cause a substantial increase in daily traffic as trips would not exceed 10 per day; and
- the project components (gate sites and dredging locations) are dispersed over the south Delta geographical area and are not located on any major roadways.

No mitigation is required.

Impact TN-2: Damage to Roadway Surfaces from Construction Activities. Construction of the project components may result in damage to the roadway surfaces from truck traffic. During construction, the project components would require transporting various materials to and from the construction areas in load-bearing trucks. For all facilities and dredging locations, haul routes would be limited to major roads where feasible. In general, roadways used for hauling construction materials in San Joaquin, Contra Costa, and Alameda Counties would include SR 4, I-5, I-205, I-580, Tracy Boulevard, and Byron Highway. Haul routes and truck trips specific to the construction of each gate are discussed under Impact TN-1.

Maintenance of San Joaquin County truck routes includes periodic inspection to assess structural integrity and need for repairs, followed by implementation of needed repairs. Maintenance of Contra Costa County public roads in the unincorporated county area includes typical maintenance work such as sealing pavement, repairing failed pavement, regrading road shoulders, and traffic striping and signing. In Alameda County, Public Works maintains roadways with the county's Pavement Management System, which provides an objective rating of the condition of the county's roads, allowing engineers to better assess the roads in need of repair and the type of repair needed.

If construction trucks travel on roadways that are not covered by these maintenance programs, roadway damage such as potholes or minor fractures may occur without subsequent inspection and repair. However, environmental commitments (Chapter 2) include the commitment to repair damage to roadway surfaces, including levee roads, not maintained under county programs, following construction activities. Therefore, roadway surfaces would not substantially deteriorate. Incorporation of environmental commitments, such as the implementation of a traffic and navigation control plan, as part of the project will ensure that impacts from the temporary increases in traffic hazards during construction will be less than significant. No mitigation is required.

Impact TN-3: Temporary Reduction in Boat Access during Construction Activities. Results of the DPR boating survey report indicate that very little boat launching and use occurred in the project area (California Department of Parks and Recreation 1997). The construction of the gates could use two potential construction methods—the use of cofferdams in one-half of the channel at a time, or the placement of the preconstructed gate structures by working off the levee or off floating barges (in the wet). Neither of these methods would substantially reduce the navigability through the south Delta as the cofferdams and floating barges would allow approximately half of the channel to remain open for navigational uses. Therefore, construction of the permanent fish control gate on Old River and permanent flow control gates on Old River, Middle River, and Grant Line Canal would minimally affect the ability of boaters using these waterways to navigate through areas of construction activity. This impact is discussed further under Impact REC-6, Temporary Disruption to Recreational Opportunities during Dredging Operations, located in Section 7.4, Recreation Resources, of this document. Construction work would not occur during major summer holiday periods, and, as indicated in the traffic and navigation control plan (Chapter 2), DWR will post signs that conform to the California Uniform State Waterway Marking System upstream and downstream of the dredge areas to warn boaters of work. In addition, levee roads would remain open for recreational and emergency access to the channels. Therefore, this impact is less than significant. No mitigation is required.

Impact TN-4: Temporary Interference with Bicycle Routes during Construction Activities. Construction of the gates would result in construction-related trucks using roadways that are also bikeway routes. Use of these roadways could result in interference with or damage to bike lanes. As part of the traffic and navigation control plan referred to in Impact TN-2 above and in Chapter 2 under Environmental Commitments alternate routes for bicyclists and pedestrians will be provided in the event of interference or damage to bike lanes from activities associated with construction of the gates. In addition, the public will be notified of temporary closures of sidewalks, bike lanes, and recreation trails. Therefore, this temporary interference with bicycle routes is considered a less-than-significant impact. No mitigation is required.

Impact TN-5: Permanent Alteration of Present Patterns of Vehicular Circulation from the Introduction of New or Improved Roadways. Constructing the gates would include constructing new roadways, or improving existing roadways, near the gate sites to accommodate construction equipment and for operations and maintenance activities. New or improved roadways specific to each gate are described below and are shown in Figure 5.8-3.

Head of Old River Fish Control Gate. Constructing the fish control gate at the confluence of the head of Old River and the San Joaquin River would require improvements to approximately 1 mile of private access road beginning at the end of Undine Road, proceeding east directly to the San Joaquin River levee.

The road would then go south and west along the levee to the gate site. The road would be improved with 4–6 inches of aggregate base and would accommodate cranes and loaded 10-wheel trucks. Permanent unlimited access would be established with a permanent easement, and gates would be installed to restrict public access. The site would be fully accessible on the south side of Old River from a public road (Cohen/San Joaquin Road) and access ramp.

Middle River Flow Control Gate. Constructing the flow control gate near the confluence with North Canal would include improving existing access roads in the immediate vicinity of the gate site. The roads would be improved by adding approximately 4–6 inches of aggregate base to the existing road.

Grant Line Canal Flow Control Gate. The flow control gate on Grant Line Canal near the confluence with the DMC would include two new 16-foot-wide, two-lane, paved access roads. One access road would be 15,250 feet long on the north side of the canal, and the other would be 10,000 feet long on the south side of the canal. Gates would be installed on the north side of the canal to restrict public access. After the majority of the gate construction is complete, the access roads on the north and south sides of the canal will be upgraded to a standard DWR access road with aggregate base and chip seal overlay (California Department of Water Resources 2003b).

Old River Flow Control Gate at DMC. The flow control gate on Old River near the confluence with the DMC would require that portions of the private levee roads on both the north and south sides of the river are secured through permanent easements and upgraded to standard DWR aggregate-based chip seal (approximately 4–6 inches) following the completion of the majority of construction (Pedlar pers. comm.).

Introduction of new or improved roadways would result in the permanent alteration of present patterns of vehicular circulation in the vicinity of the new gates. This impact is considered less than significant because the gates and new roadways are dispersed over the predominantly rural south Delta geographical area. Implementation of the traffic and navigation control plan as a part of the project’s environmental commitments would further reduce the significance of this impact.

Impact TN-6: Permanent Alteration of Present Patterns of Vehicular Circulation and the Congestion of Roadways from Maintenance and Operation of the Gates. Maintaining and operating the gates could affect the capacity of roadways in the vicinity of the gates by increasing vehicle trips. Once constructed, the gates would require minimal maintenance. Employees required to maintain and operate the gates would generate a maximum of 16 trips during the peak commute hours daily.

The permanent alteration of present patterns of vehicular circulation resulting from the gate facilities would not be significant because of the small number of commute trips attributed to the gates. In addition, the gates are located in a predominantly rural area. Impacts on circulation and roadway capacity in the project area are considered less than significant. No mitigation is required.

Impact TN-7: Changes in Navigable Areas of the South Delta as a Result of Changes in Water Level. The operation of the gates at Old River at DMC, Grant Line Canal, and Middle River would control the water level of the channels to allow improved operations of agricultural diversions in the south Delta. Currently, the temporary barriers hold the water level at approximately 2 feet msl during the agricultural season (May through September). However, during months in which the temporary barriers are not installed, the water level remains at approximately –1.5 feet msl, which is equivalent to natural low-tide conditions. The channels remain navigable during this time. Although the installation of the permanent gates would change the water level during different times of the year, and throughout each day, the water level would not be lower than –1.5 feet msl. Because south Delta channels remain navigable during low tide, even during months that the temporary barriers are not installed, the channels will remain navigable with the permanent gates in place and operating. Therefore, this impact is less than significant. No mitigation is required.

Dredging

Impact TN-8: Temporary Disruption to Use of Navigable Waters during Dredging Operations. Under Alternatives 2A–2C, proposed dredging of Old River, West Canal, and Middle River (Figure 2-3) and maintenance dredging could temporarily disrupt boating access. Boating would be limited in the dredged area while equipment is being operated during the months of August through November in Old River, Middle River, and West Canal. This project activity could result in delays in boating on the affected channels as approximately half of the channel would be restricted. As indicated in the traffic and navigation control plan, DWR will post signs that conform to the California Uniform State Waterway Marking System upstream and downstream of the dredge areas to warn boaters of work.

Based on available information, it is most likely that only recreational boaters would be affected by the temporary disruption of navigable waters in the channel dredging areas; therefore, this impact is also discussed under Impact REC-6 in Section 7.4, Recreation Resources, of this EIS/EIR. However, there may be boaters who use Old River, West Canal, and Middle River for non-recreational purposes; thus, this impact is included in this section. This impact on navigation is considered less than significant because:

- dredging would not occur on major summer holidays or weekends,
- dredging would be staged to allow continued navigation within south Delta channels, and
- DWR will post signs that conform to the California Uniform State Waterway Marking System upstream and downstream of the dredge areas to warn boaters of work.

No mitigation is required.

2020 Conditions

Under 2020 conditions, traffic and navigation are expected to increase. However, the impacts on traffic and navigation as a result of implementation of Alternatives 2A–2C would be similar to those described above because similar types and magnitudes of changes in traffic and navigation would occur under 2020 conditions as described for existing conditions.

Stage 2 (Operational Component)

Increased diversions into CCF would not result in impacts on navigation or transportation because there would be no noticeable change in water levels or present patterns of vehicular circulation.

2020 Conditions

Impacts on traffic and navigation resulting from increased diversions into CCF under 2020 conditions would be similar to those described above.

Interim Operations

Interim operations would not result in any physical changes in the south Delta. Increased diversion rates would not affect transportation and navigation because there would not be a significant change in water level or existing operations that would require additional vehicle trips. Therefore, there would be no impacts related to the implementation of interim operations.

Alternative 3B

Stage 1 (Physical/Structural Component)

Alternative 3B would result in transportation and navigation impacts similar to those described for Alternatives 2A–2C. However, these impacts would be less than those described for Alternatives 2A–2C because the flow control gate on Grant Line Canal would not be constructed.

Fish Control Gate and Flow Control Gates

Impact TN-1: Temporary Addition of Vehicles to Roadway System and Alteration of Present Patterns of Vehicular Circulation during Construction Activities. Under Alternative 3B, the temporary alteration of present patterns of vehicular circulation during construction activities would be similar to impacts identified for Alternatives 2A–2C, except that fewer construction-related trips would occur because a flow control gate at Grant Line Canal would not be constructed, and South Bonetti Road would not be used. This impact is less than significant. No mitigation is required.

Impact TN-2: Damage to Roadway Surfaces from Construction Activities. Under Alternative 3B, damage to roadway surfaces from construction activities would be similar to impacts identified for Alternatives 2A–2C, except that a flow control gate at Grant Line Canal would not be constructed, and South Bonetti Road would not be used.

Because damage to roadway surfaces from construction activities would be addressed by the San Joaquin, Contra Costa, and Alameda county maintenance programs and implementation of the project's Environmental Commitments (refer to Chapter 2), this impact is less than significant. No mitigation is required.

Impact TN-3: Temporary Reduction in Boat Access during Construction Activities. Under Alternative 3B, temporary interference with navigation during construction activities would be similar to impacts identified for Alternatives 2A–2C, except that a flow control gate at Grant Line Canal would not be constructed. This impact would be less than significant because south Delta waterways would remain navigable during construction, as cofferdams and barges would allow approximately half of the channel to remain open, construction work would not occur during major summer holiday period, and, as indicated in the traffic and navigation control plan, DWR will post signs that conform to the California Uniform State Waterway Marking System upstream and downstream of the dredge areas to warn boaters of work. No mitigation is required.

Impact TN-4: Temporary Interference with Bicycle Routes during Construction Activities. Under Alternative 3B, the temporary interference with bicycle routes during construction activities would be similar to impacts identified for Alternatives 2A–2C, except that a flow control gate at Grant Line Canal would not be constructed, and South Bonetti Road would not be used. This impact is less than significant. No mitigation is required.

Impact TN-5: Permanent Alteration of Present Patterns of Vehicular Circulation from the Introduction of New or Improved Roadways. The permanent alteration of present patterns of vehicular circulation from the introduction of new or improved roadways for Alternative 3B would be similar to impacts identified for Alternatives 2A–2C, except that two new access roads on either sides of the Grant Line Canal would not be improved. Introduction of the new or improved roadways would result in the permanent alteration of present patterns of vehicular circulation in the vicinity of the new flow control gates at Middle River at North Canal and Old River at DMC, and the fish control gate at the head of Old River. This impact is considered less than significant because the gates and new roadways are dispersed over the predominantly rural south Delta geographical area. Implementation of the traffic and navigation control plan as a part of the project's environmental commitments would further reduce the significance of this impact.

Impact TN-6: Permanent Alteration of Present Patterns of Vehicular Circulation and the Congestion of Roadways from Maintenance and

Operation of Gates. Under Alternative 3B, the permanent alteration of present patterns of vehicular circulation from facility operations would be similar to impacts identified for Alternatives 2A–2C, except that a flow control gate at Grant Line Canal would not be constructed and Bonetti Road would not be used.

Because the number of employees and material deliveries would not be substantial and the gate sites are not located close to residential or city streets, the potential for impacts resulting in the congestion of roadways and/or the permanent alteration of present patterns of vehicular circulation in the vicinity of the project sites is considered less than significant. No mitigation is required.

Impact TN-7: Changes in Navigable Areas of the South Delta as a Result of Changes in Water Level. The implementation of Alternative 3B would result in minor changes in water level throughout the south Delta, particularly in areas adjacent to the permanent gates. Specifically, the function of the gates at Old River at DMC and Middle River would be to control the water level of the channels to allow improved operations of agricultural diversions in the south Delta. Currently, the temporary barriers hold the water level at approximately 2 feet msl during the agricultural season (May through September). However, during months in which the temporary barriers are not installed, the water level remains at approximately –1.5 feet msl, which is equivalent to natural low-tide conditions. The channels remain navigable during this time. Although the installation of the permanent gates would change the water level during different times of the year, and throughout each day, the resulting water level would be equal to natural low tide conditions. Because south Delta channels remain navigable during low tide, even during months that the temporary barriers are not installed, the channels will remain navigable upon implementation of the permanent gates. Therefore, this impact is less than significant. No mitigation is required.

Dredging

Impact TN-8: Temporary Disruption to Use of Navigable Waters during Dredging Operations. Under Alternative 3B, the temporary disruption to use of navigable waters during dredging operations would be similar to impacts identified for Alternatives 2A–2C, except that a flow control gate at Grant Line Canal would not be constructed. This impact is considered less than significant because:

- dredging would not occur on major summer holidays or weekends,
- dredging would be staged to allow continued navigation within south Delta channels, and
- DWR will post signs that conform to the California Uniform State Waterway Marking System upstream and downstream of the dredge areas to warn boaters of work.

No mitigation is required.

2020 Conditions

Under 2020 conditions, traffic and navigation are expected to increase. However, the impacts on traffic and navigation as a result of implementation of Alternative 3B would be similar to those described above because similar types and magnitudes of changes in traffic and navigation would occur under 2020 conditions as described for existing conditions.

Stage 2 (Operational Component)

Increased diversions into CCF would not result in impacts on navigation or transportation because there would be no noticeable change in water levels or present patterns of vehicular circulation.

2020 Conditions

Impacts on traffic and navigation resulting from increased diversions into CCF under 2020 conditions would be similar to those described above.

Alternative 4B

Stage 1 (Physical/Structural Component)

Implementation of Alternative 4B would have transportation and navigation impacts similar to those under Alternatives 2A–2C. Under Alternative 4B, however, only one gate would be constructed; thus, construction activities would occur, equipment would be used, and construction-related traffic would occur at one location, lessening the total impacts identified under Alternatives 2A–2C.

Fish Control Gate

Impact TN-1: Temporary Addition of Vehicles to Roadway System and Alteration of Present Patterns of Vehicular Circulation during Construction Activities. Under Alternative 4B, the temporary alteration of present patterns of vehicular circulation during construction activities would be similar to impacts identified for Alternatives 2A–2C, except that fewer construction-related trips would occur because none of the flow control structures would be constructed. This impact is less than significant. No mitigation is required.

Impact TN-2: Damage to Roadway Surfaces from Construction Activities. Under Alternative 4B, damage to roadway surfaces from construction activities would be similar to impacts identified under Alternatives 2A–2C, but substantially less because only the fish control structure on Old River would be constructed (none of the flow control structures would be constructed), and only roadways in the vicinity of the gate facility would be used.

Because damage to roadway surfaces from construction activities would be addressed by the San Joaquin, Contra Costa, and Alameda county maintenance programs, and implementation of the project’s Environmental Commitments (refer to Chapter 2), this impact would be less than significant. No mitigation is required.

Impact TN-3: Temporary Interference with Navigation during Construction Activities. Under Alternative 4B, temporary interference with navigation during construction activities would be similar to impacts identified under Alternatives 2A–2C but substantially less because only the fish control structure on Old River would be constructed, and only roadways in the vicinity of the gate facility would be used.

This impact would be less than significant because south Delta waterways would remain navigable during construction, as cofferdams and barges would allow approximately half of the channel to remain open, construction work would not occur during major summer holiday period, and, as indicated in the traffic and navigation control plan, DWR will post signs that conform to the California Uniform State Waterway Marking System upstream and downstream of the dredge areas to warn boaters of work. No mitigation is required.

Impact TN-4: Temporary Interference with Bicycle Routes during Construction Activities. Under Alternative 4B, the temporary interference with bicycle routes during construction activities would be similar to impacts identified under Alternatives 2A–2C but substantially less because only one fish control structure on Old River would be constructed, and only roadways in the vicinity of the facility would be used. This impact is less than significant. No mitigation is required.

Impact TN-5: Permanent Alteration of Present Patterns of Vehicular Circulation from the Introduction of New or Improved Roadways. The permanent alteration of present patterns of vehicular circulation from the introduction of new or improved roadways for Alternative 4B would be similar to impacts identified under Alternatives 2A–2C, but less, because only the fish control structure on Old River would be constructed, and only one new roadway and one improved roadway in the vicinity of the facility would be introduced. Introduction of the new or improved roadways would result in the permanent alteration of present patterns of vehicular circulation in the vicinity of the new fish control gate. This impact is considered less than significant because the gates and new roadways are dispersed over the predominantly rural south Delta geographical area. Implementation of the traffic and navigation control plan, as a part of the project’s environmental commitments, would further reduce the significance of this impact.

Impact TN-6: Permanent Alteration of Present Patterns of Vehicular Circulation and the Congestion of Roadways from Maintenance and Operation of Gates. Under Alternative 4B, the permanent alteration of present patterns of vehicular circulation from gate operations would be similar to impacts identified under Alternatives 2A–2C, but significantly less because only one fish control structure on Old River would be constructed, and only roadways in the vicinity of the gate would be used.

Because the number of employees and material deliveries would not be substantial and the gate site is not located close to residential or city streets, the potential for impacts resulting in the congestion of roadways and/or the permanent alteration of present patterns of vehicular circulation in the vicinity of the project site is less than significant. No mitigation is required.

Impact TN-7: Changes in Navigable Areas of the South Delta as a Result of Changes in Water Level. The implementation of Alternative 4B would be similar to Alternative 3B, as it would result in minor changes in water level throughout the south Delta, particularly in areas adjacent to the permanent fish control gate at the head of Old River. Currently, the temporary barriers hold the water level at approximately 2 feet msl during the agricultural season (May through September). However, during months in which the temporary barriers are not installed, the water level remains at approximately –1.5 feet msl, which is equivalent to natural low-tide conditions. The channels remain navigable during this time. Although the installation of the permanent gate would change the water level during different times of the year, and throughout each day, the resulting water level would be equal to natural low tide conditions. Because south Delta channels remain navigable during low tide, even during months that the temporary barriers are not installed, the channels will remain navigable upon implementation of the permanent gate. Therefore, this impact is less than significant. No mitigation is required.

Dredging

Impact TN-8: Temporary Disruption to Use of Navigable Waters during Dredging Operations. Under Alternative 4B, the temporary disruption to use of navigable waters during dredging operations would be similar to impacts identified under Alternatives 2A–2C but substantially less because only one fish control structure on Old River would be constructed.

This impact is considered less than significant because:

- dredging would not occur on major summer holidays or weekends,
- dredging would be staged to allow continued navigation within south Delta channels, and
- DWR will post signs that conform to the California Uniform State Waterway Marking System upstream and downstream of the dredge areas to warn boaters of work.

No mitigation is required.

2020 Conditions

Under 2020 conditions, traffic and navigation are expected to increase. However, the impacts on traffic and navigation as a result of implementation of Alternative 4B would be similar to those described above because similar types and magnitudes of changes in traffic and navigation would occur under 2020 conditions as described for existing conditions.

Stage 2 (Operational Component)

Increased diversions into CCF would not result in impacts on navigation or transportation because there would be no noticeable change in water levels or present patterns of vehicular circulation.

2020 Conditions

Impacts on traffic and navigation resulting from increased diversions into CCF under 2020 conditions would be similar to those described above.

Cumulative Evaluation of Impacts

Cumulative impacts on Transportation and Navigation are analyzed in Chapter 10, “Cumulative Impacts.” This chapter also summarizes the other foreseeable future projects that may contribute to these impacts.

5.9 Air Quality

Introduction

This section describes the existing environmental conditions and the consequences of constructing and operating SDIP alternatives on air quality. The primary concern related to air quality is the temporary increase in oxides of nitrogen (NO_x) and PM10 emissions from the operation of mechanical equipment and creation of dust during construction activities, and PM10 from drying dredge spoils.

Summary of Significant Impacts

Table 5.9-S summarizes the significant impacts on Air Quality as a result of implementation of the project alternatives. All impacts are discussed in detail in the Environmental Consequences section.

Table 5.9-S. Summary of Significant Impacts on Air Quality

Impact	Applicable Alternative	Level of Significance before Mitigation	Mitigation Measure	Level of Significance after Mitigation
Impact Air-2: Short-Term Increase in Nitrogen Oxides Emissions in San Joaquin County	2A–2C, 3B, 4B	Significant	Air-MM-1: Incorporate Air Quality Mitigation Measures designed to limit emissions of NO_x as Part of the SDIP Construction Management Plan Air-MM-2: Acquire NO_x emission reduction credits to offset the emission increases that exceed the 50 tons per year conformity thresholds	Less than Significant
Impact Air-3: Short-Term Increase in PM10 Emissions in San Joaquin County	2A–2C, 3B, 4B	Significant	Air-MM-3: Implement Control Measures for Fugitive PM10	Less than Significant
Impact Air-5: Potential Increase in PM10 Emissions from Drying Dredge Spoils in San Joaquin and Contra Costa Counties	2A–2C, 3B, 4B	Significant	Air-MM-3: Regulation VIII Control Measures for Fugitive PM10 (San Joaquin County)	Less than Significant

NO_x = oxides of nitrogen.

PM10 = particulate matter 10 microns in diameter or less.

Affected Environment

The SDIP is located in the southern portion of the Sacramento–San Joaquin River Delta, within the boundaries of San Joaquin County, Contra Costa County, and Alameda County. There are two affected air basins—the San Joaquin Valley Air Basin (SJVAB) and the San Francisco Bay Area Air Basin (SFBAAB). The primary factors that determine air quality are the locations of air pollutant sources, the amount of pollutants emitted, and meteorological and topographical conditions affecting their dispersion. Atmospheric conditions, including wind speed, wind direction, and air temperature gradients, interact with the physical features of the landscape to determine the movement and dispersal of air pollutants. The following paragraphs briefly describe the existing environment as it relates to climate, meteorological conditions, and ambient air quality conditions of these two air basins.

Sources of Information

The following key sources of information were used in the preparation of this section:

- *Guide for Assessing and Mitigating Air Quality Impacts,* San Joaquin Valley Unified Air Pollution Control District, 2002;
- Bay Area Air Quality Management District (BAAQMD) CEQA Guidelines, 1999;
- Draft EIR/EIS for the ISDP, Volumes I and II, 1996; and
- California Air Resources Board website, 2002.

Climate and Meteorological Conditions

The Delta is transitional between the coastal and inland climatic extremes. The topography of the Delta is characterized as two distinct geographic components: the lowlands and the uplands. The lowlands consist of generally flat lands ranging in elevation from below sea level to about 10 feet above msl; and the uplands, a gently sloping alluvial plain rising from about 10 to 100 feet above msl. Some lands in the central and western Delta are more than 15 feet below msl. The effects of the local topography and the continuous interaction of maritime and continental air masses provide a varied climate.

The prevailing winds in the Bay Area during summer are from the west and northwest, reinforced by an inland movement of air caused by the solar heating of the air masses in the Central Valley. This heating effect is greatest during the day and causes a marked diurnal, as well as a seasonal, pattern in wind speed. These prevailing winds are strongest at Carquinez Strait. In the Delta, such winds often blow continuously day and night and are generally from the west-southwest. Winds reach peak speeds of 10–15 miles per hour in the early

Table 5.9-1. National and California Ambient Air Quality Standards

			Standard (ppm)		Standard (µg/m^3)		Violation Criteria	
Pollutant	Symbol	Average Time	California	National	California	National	California	National
Ozone	O_3	1 hour	0.09	0.12	180	235	If exceeded	If exceeded on more than 3 days in 3 years
		8 hours	NA	0.08	NA	157	NA	If exceeded on more than 3 days in 3 years
Carbon monoxide	CO	8 hours	9.0	9	10,000	10,000	If exceeded	If exceeded on more than 1 day per year
		1 hour	20	35	23,000	40,000	If exceeded	If exceeded on more than 1 day per year
(Lake Tahoe only)		8 hours	6	NA	7,000	NA	If equaled or exceeded	NA
Nitrogen dioxide	NO_2	Annual average	NA	0.053	NA	100	NA	If exceeded
		1 hour	0.25	NA	470	NA	If exceeded	If exceeded
Sulfur dioxide	SO_2	Annual average	NA	0.03	NA	80	NA	If exceeded
		24 hours	0.04	0.14	105	365	If exceeded	If exceeded on more than 1 day per year
		1 hour	0.25	NA	655	NA	NA	NA
Hydrogen sulfide	H_2S	1 hour	0.03	NA	42	NA	If equaled or exceeded	NA
Vinyl chloride	C_2H_3Cl	24 hours	0.010	NA	26	NA	If equaled or exceeded	NA
Inhalable particulate matter	PM10	Annual geometric mean	NA	NA	20	NA	If exceeded	NA
		Annual arithmetic mean	NA	NA	NA	50	NA	If exceeded
		24 hours	NA	NA	50	150	If exceeded	If average 1% over 3 years is exceeded
	PM2.5	Annual geometric mean	NA	NA	12	NA	If exceeded	NA
		Annual arithmetic mean	NA	NA	NA	15	NA	If exceeded
		24 hours	NA	NA	NA	65	NA	If average 2% over 3 years is exceeded
Sulfate particles	SO_4	24 hours	NA	NA	24	NA	If equaled or exceeded	NA
Lead particles	Pb	Calendar quarter	NA	NA	NA	1.5	NA	If exceeded no more than 1 day per year
		30 days	NA	NA	1.5	NA	If equaled or exceeded	NA

Notes:

µg/m^3 = micrograms per cubic meter.

NA = not applicable.

PM2.5 = particulate matter 2.5 microns in diameter or less.

PM10 = particulate matter 10 microns in diameter or less.

ppm = parts per million.

All standards are based on measurements at 25ºC and 1 atmosphere pressure.

National standards shown are the primary (health effects) standards.

evening. The summer airflow at Stockton is strongest in the afternoon and throughout the day generally blows from the west-northwest.

The topography and climate have great effects on the area's air quality. Relatively light winds, surrounding higher terrain, and frequent warm temperatures are conducive to the creation of ozone. In winter months, high atmospheric stability, calm winds, and cold temperatures combine to create ideal conditions for the buildup of pollutants such as carbon monoxide (CO) and PM10.

Ambient Air Quality

The determination of general air quality is based on compliance with federal and State emission standards that have been established for specific benchmark pollutants. At the federal level, the National Ambient Air Quality Standards (NAAQS) set emission limits for ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, lead, and suspended particulate matter. California also has set emission standards for the pollutants identified by the NAAQS, with the adoption of the California Ambient Air Quality Standards (CAAQS). In addition to the pollutants identified in the NAAQS, the CAAQS set emission limits for sulfates, hydrogen sulfide, and visibility. Table 5.9-1 shows the emission limits for the NAAQS and the CAAQS.

If pollutant concentration exceeds any of these standards in the basin or subregions of the basin, that area is designated *nonattainment* for that pollutant. The NAAQS generally can be exceeded no more than once per year for short-term standards and not at all for annual standards, and the CAAQS are not to be equaled or exceeded for either short-term or annual standards. Both the federal and state Clean Air Acts require basins that do not meet these standards to prepare a plan for bringing the area into compliance.

All of the SJVAB, including San Joaquin County, has been designated nonattainment for the 1-hour and 8-hour federal ozone (O_3) and PM10 standards. The SJVAB, which includes San Joaquin County, is also nonattainment for state ozone and PM10 standards. The SFBAAB is currently classified as a nonattainment area for the state PM10 standards and for the state and federal ozone standards. The SFBAAB is an unclassified area for the federal PM10 standards. Table 5.9-2 summarizes the attainment/nonattainment status of criteria pollutants in the SJVAB and the SFBAAB.

Table 5.9-2. Summary of Attainment/Nonattainment Status for Criteria Pollutants Standards

	San Joaquin Valley Air Basin		San Francisco Bay Area Air Basin	
Pollutant	Federal	State	Federal	State
Ozone, 1-hour	nonattainment/ extreme	nonattainment/ severe	nonattainment/ moderate	nonattainment/ serious
Ozone, 8-hour	nonattainment/ serious	nonattainment/ severe	nonattainment/ marginal	nonattainment/ serious
PM10	nonattainment	nonattainment	unclassified	nonattainment
PM2.5	nonattainment	nonattainment	attainment	nonattainment
CO	unclassified/ nonattainment	attainment	unclassified/ attainment	attainment
NO_2	unclassified/ attainment	attainment	unclassified/ attainment	attainment
SO_2	unclassified	attainment	attainment	attainment
Pb	attainment	attainment	attainment	attainment

Sensitive Receptors

Sensitive populations (sensitive receptors) are more susceptible to the effects of air pollution than is the population at large. The San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD) defines sensitive receptors as: “schools, day care facilities, hospitals, health care facilities, convalescent homes, senior residence facilities or otherwise specified by the APCD.” Sensitive receptors that are near localized sources of toxins and CO are of particular concern. For the purposes of impact assessment, the definition of sensitive receptors is typically expanded to include residences, playgrounds, rehabilitation centers, and athletic facilities.

Based on site reconnaissance and available information, sensitive receptors as defined by SJVUAPCD are located within 1 mile of the SDIP project components. A farm complex, including a residence, is located approximately 500 feet west of the Middle River temporary barrier. The closest residences to the Old River temporary barrier are located approximately 1,500 feet to the southeast and to the northwest. Southeast of the barrier is a farm complex with at least one residence, and possibly up to two additional residences. Northwest of the barrier, up to thirteen residences extend north along the Old River bank up to Old River’s confluence with the DMC.

Environmental Consequences

Assessment Methods

Construction of the gates would generate pollutant emissions from a variety of emission sources and activities. All phases of the project would generate air emissions. They include project mobilization, site preparation, site clearing and grubbing, and construction of the gates.

The primary pollutant-generating activities associated with these phases include:

- exhaust emissions from off-road construction vehicles and equipment;
- exhaust emissions from vehicles used to deliver supplies to the project site or to haul materials from the site;
- exhaust emissions from worker commute trips; and
- fugitive dust from equipment operating on exposed earth, and from the handling of sand, gravel, aggregate, and associated construction materials.

Emissions for off-road equipment were determined using the following procedure. First, estimates were made of the number and type of off-road construction equipment that would be required for each project phase and the number of hours that each type of equipment would operate each year. Those equipment hours were then multiplied by the equipment horsepower, by the equipment load factor, and by the equipment emission rate to obtain total emissions for each equipment type. Finally, emissions were summed across all equipment types. The emission rates used for off-road equipment were based on the California Air Resources Board's (CARB's) off-road model.

Emissions for on-road construction equipment were based on the CARB's EMFAC2002 model and assumed 100% heavy-heavy duty vehicles (California Air Resources Board 2002). The majority of on-road truck trips would be to and from sites to obtain aggregate, sand, rock, and materials needed for project construction. The number of truck trips was based on the amount of material required. The assumptions for the number of truck trips and miles traveled are presented in Appendix H.

Emissions associated with worker commute trips assumed that the average one-way trip would equal 10 miles. The CARB's EMFAC2002 model was used to estimate worker commute trip emissions (California Air Resources Board 2002). Fugitive dust emissions assumed that 5 acres would be disturbed per day during each day of construction over the construction period (260 days construction per year). An emission rate of 10 pounds of PM10 per acre per day was used (Midwest Research Institute 1996).

Regulatory Setting

County and regional plans and regulations apply to air emissions associated with SDIP project components. These include air quality attainment plans, air quality regulations, and county general plans. Each of these is described in the following paragraphs.

The SJVUAPCD prepared an Air Quality Attainment Plan in 1991. The BAAQMD also produced a Clean Air Plan in 2000. Both include strategies for reducing ozone by reducing ozone precursors such as reactive organic compounds (ROC) and NO_x. The SJVUAPCD 1991 Air Quality Attainment Plan has not been replaced yet. However, several other air quality plans have been prepared for the area over the last few years, including the following: The 1994 Ozone Attainment Demonstration Plan, the 1997 PM10 Attainment Demonstration Plan, and the 2002 and 2005 Rate of Progress Plan. These documents are prepared primarily in response to the requirement of the federal Clean Air Act and provide assessment of attainment status and identify needs for further control if required. Similarly BAAQMD has prepared the 2001 Ozone Attainment Plan pursuant to the requirements of the federal Clean Air Act and the 2000 Bay Area Clean Air Plan, in response to the California requirements.

Implementation of the SDIP would require compliance with several rules of SJVUAPCD. These include: (1) Rule 8020: Fugitive dust requirements for control of PM10 from construction, demolition, excavation, and extraction activities; (2) Rule 8030: Fugitive dust requirements for control of PM10 from handling and storage of bulk material; and (3) Rule 8070: Fugitive dust requirements for control of PM10 from vehicle and/or equipment parking, shipping, receiving, transfer, fueling, and service areas.

The Contra Costa County General Plan requires activities to be conducted in such a way as to: (1) meet federal air quality standards for all air pollutants; (2) continue to support federal, State, and regional efforts to reduce air pollution in order to protect human and environmental health; and (3) restore air quality in the area to a more healthful level and in accordance with the policy reduce vehicular emissions throughout the county.

San Joaquin County General Plan contains implementation strategies for reducing air emissions related to area sources such as: (1) implementing dust control practices for construction sites; (2) requiring projects to mitigate potential high levels of air pollutants; and (3) protecting residential areas and other sensitive receptors from air pollution sources.

In addition to the above-mentioned applicable plans and regulations, the general conformity requirements of the 1990 federal Clean Air Act would apply to the SDIP project. The conformity provisions of the act are designed essentially to ensure that federal agencies contribute to, instead of jeopardizing, efforts to achieve the NAAQS. In November 1993, EPA issued two regulations implementing these provisions. The transportation conformity regulation deals with transportation projects. The general conformity regulation addresses actions of federal agencies other than the Federal Highway Administration (FHWA) and the Federal Transit Administration.

General conformity applies to a wide range of actions or approvals by federal agencies. Essentially, projects are subject to general conformity if they generate more emissions than minimum thresholds set in the conformity rule. Because the project would include the expenditure of federal funds, it is subject to the thresholds established in the conformity rule.

Significance Criteria

According to the State CEQA Guidelines, a project will normally have a significant effect on the environment if it will:

- violate any ambient air quality standard,
- contribute substantially to an existing or projected air quality violation, or
- expose sensitive receptors to substantial pollutant concentrations.

Construction-related air emissions occurring within the SJVAB and the SFBAAB are considered exempt. However, because the SDIP includes federal funding of some of the project components, thresholds were developed based on EPA's general conformity thresholds. Emission thresholds are used for each of the two air basins in which the project would be located (Table 5.9-3). The thresholds shown in Table 5.9-3 represent applicable construction-related thresholds because the air emissions generated by the project would result primarily from construction activities.

Table 5.9-3. Construction-Related Significance Thresholds (tons per year)

	ROG		NO_x		CO		PM10	
Air Basin (County)	lbs/day	tpy	lbs/day	tpy	lbs/day	tpy	lbs/day	tpy
San Francisco Bay Area Air Basin (Contra Costa)	NA	50	NA	100	NA	100	NA	NA
San Joaquin Valley Air Basin (San Joaquin)	NA	50	NA	50	NA	100	NA	70

Notes: The San Joaquin Valley Air Basin's construction-related significance thresholds are based on its 8-hour ozone classification as a serious non-attainment area.

CO = carbon monoxide.
lbs/day = pounds per day.
NA = not available.
NO_x = oxides of nitrogen.
PM10 = particulate matter 10 microns in diameter or less.
ROG = reactive organic gases.
tpy = tons per year.

The applicable significance thresholds for construction projects within Contra Costa County are summarized in Table 5.9-3. For the portion of the project within the SFBAAB, the EPA's general conformity thresholds were used. The BAAQMD does not have any daily or annual significance thresholds for construction activities. The BAAQMD does, however, have feasible control measures for construction emissions of PM10, which require that specific actions be taken to minimize dust generation from construction activities (Table 5.9-4).

The applicable significant thresholds for construction projects within San Joaquin County are summarized in Table 5.9-3. For the portion of the project within the SJVAB (San Joaquin County), the EPA's general conformity thresholds were used. The SJVUAPCD does not have any daily or annual significance thresholds for construction activities. The SJVUAPCD does, however, have Regulation VIII, which requires that specific actions be taken to minimize dust generation from construction activities.

Table 5.9-4. Bay Area Air Quality Management District Feasible Control Measures for Construction Emissions of PM10

Basic Control Measures—The following controls should be implemented at all construction sites.

- Water all active construction areas at least twice daily.
- Cover all trucks hauling soil, sand, and other loose materials or require all trucks to maintain at least 2 feet of freeboard.
- Pave, apply water three times daily, or apply (nontoxic) soil stabilizers on all unpaved access roads, parking areas, and staging areas at construction sites.
- Sweep daily (with water sweepers) all paved access roads, parking areas, and staging areas at construction sites.
- Sweep streets daily (with water sweepers) if visible soil material is carried onto adjacent public streets.

Enhanced Control Measures—The following measures should be implemented at construction sites greater than 4 acres in area.

- Hydroseed or apply (nontoxic) soil stabilizers to inactive construction areas (previously graded areas inactive for 10 days or more).
- Enclose, cover, water twice daily, or apply (nontoxic) soil binders to exposed stockpiles (dirt, sand, etc.)
- Limit traffic speeds on unpaved roads to 15 miles per hour.
- Install sandbags or other erosion control measures to prevent silt runoff to public roadways.
- Replant vegetation in disturbed areas as quickly as possible.

Optional Control Measures—The following control measures are strongly encouraged at construction sites that are large in area, located near sensitive receptors, or that for any other reason may warrant additional emissions reductions.

- 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/vegetative wind breaks at windward side(s) of construction areas.
- Suspend excavation and grading activity when winds (instantaneous gusts) exceed 25 mph.
- Limit the area subject to excavation, grading, and other construction activity at any one time.

Source: Bay Area Air Quality Management District 1999.

CALFED Programmatic Mitigation Measures

The August 2000 CALFED Programmatic ROD includes Mitigation Measures for agencies to consider and use where appropriate in the development and implementation of project specific actions. The mitigation measures address the short-term, long-term and cumulative effects of the CALFED Program.

The discussion of significant impacts and mitigation measures within this chapter section will include a citation of one or more of the following programmatic mitigation measures used to build project-specific mitigation measures to offset significant impacts identified from implementation of the SDIP. These Programmatic Mitigation Measures are numbered as they appear in the ROD, and only those measures relevant to the SDIP resource area are listed below; therefore, numbering may appear out of sequence. To see a full listing of CALFED Programmatic Mitigation Measures, please refer to Appendix E, "Mitigation Measures Adopted in the CALFED Record of Decision."

Air Quality Mitigation Measures

1. Set traffic limits on construction vehicles.
2. Maintain properly tuned equipment.
3. Limit the hours of operation or amount of equipment.
6. Regularly water construction sites to control levels of dust in the air.
7. Use soil stabilizers and dust suppressants on unpaved service roadways.
9. Limit vehicle idling time.
10. Use alternatively fueled equipment.
12. Implement construction practices that reduce generation of particulate matter.
13. Hydroseed and mulch exposed areas.
15. Follow air basin management plans to avoid or minimize vehicle-related emissions.
20. Encourage use of public transportation and carpooling for construction workers.
21. Obtain replacement power from non-emitting sources such as other hydro, solar, and wind sources. This can occur through construction of, or the use of incentives to construct non-emitting power plants. This approach is consistent with state and federal policies related to promoting use of renewable resource type generation as expressed in Public Utility Code Section 381(c) (part of what is commonly referred to as AB 1890) and Executive Order 12902.

Alternative 1 (No Action)

Under the No Action Alternative, the project components would not be built or operated. There would be no impact on air quality, and existing conditions as described above would remain unchanged.

2020 Conditions

Under future no action conditions (2020 conditions) the SDIP would not be implemented and there would be no impact on air quality; existing conditions as described above would be the same.

Alternatives 2A, 2B, and 2C

Stage 1 (Physical/Structural Component)

Fish Control Gate and Flow Control Gates and Dredging

Impact Air-1: Short-Term Increase in Reactive Organic Gases and Carbon Monoxide Emissions in San Joaquin County. Construction and dredging (channel and gate areas) associated with Alternatives 2A–2C would result in short-term emission levels of ROG and CO below the significance thresholds. Table 5.9-5 shows construction- and dredging-related emissions by construction year. Because emissions would be below the significance thresholds, the air quality impacts for these pollutants are less than significant. No mitigation is required.

Table 5.9-5. Alternative 2 Total Emissions in San Joaquin County (tons per year)

Year	ROG	CO	NO_x	PM10
2005	7.8	57.6	59.3	8.2
2006	13.2	100.0	96.8	28.7
2007	11.3	87.2	79.9	29.4
2008	3.6	28.8	25.0	3.6
2009	0.4	2.8	2.4	0.1
2012	5.7	46.6	37.9	1.5

Notes:
CO = carbon monoxide.
NOx = oxides of nitrogen.
PM10 = particulate matter 10 microns in diameter or less.
ROG = reactive organic gases.
Year 2012 represents maintenance dredging.

Impact Air-2: Short-Term Increase in Nitrogen Oxides Emissions in San Joaquin County. Construction- and dredging-related NO_x emissions would be above the general conformity threshold of 50 tons per year (tpy) for the years 2005 through 2007 (refer to Table 5.9-5). This impact is considered significant. Mitigation Measure Air-MM-1 will also include elements of CALFED Programmatic Air Quality Mitigation Measures 2, 3, 9, 10, and 15, plus additional mitigation needed to reduce impacts. Implementation of Air-MM-1 will reduce NO_x emissions in 2005 to less than the NO_x significance thresholds. However, NO_x emissions in 2006 and 2007 would still exceed the thresholds.

The project applicant will also need to implement mitigation measure Air-MM-2 to obtain emission reduction credits of 27.5 tons NO_x for year 2006 and 14 tons NO_x for 2007. Implementation of Mitigation Measure Air-MM-1 and Air-MM-2 would reduce this impact to a less-than-significant level.

Mitigation Measure Air-MM-1: Incorporate Air Quality Mitigation Measures designed to limit emissions of NO_x as Part of the SDIP Construction Management Plan. The following measures established by the SJVAPCD are designed to limit emissions of NO_x, and are consistent with the CALFED Mitigation Measures listed above. DWR and Reclamation will incorporate them into the construction management plan for the project. The plan should be submitted to SJVAPCD and should include the following measures:

- Use of alternative-fueled or catalyst-equipped diesel construction equipment capable of achieving at least a 20% NO_x reduction in all on- and off-road construction equipment.
- Minimize idling time (e.g., 10-minute maximum).
- Limit the hours of operation of heavy-duty equipment and/or the amount of equipment in use.
- Properly maintain all equipment per manufacturers' specifications.
- Use equipment powered by electricity where feasible.
- Curtail construction during periods of high ambient pollutant concentrations; this may include ceasing of construction activity during the peak hour of vehicular traffic on adjacent roadways.
- Implement activity management (e.g., rescheduling activities to reduce short-term impacts).

These mitigation measures will reduce emissions to the levels shown in Table 5.9-6.

Table 5.9-6. Alternative 2 Total Mitigated Emissions in San Joaquin County (tons per year)

Year	ROG	CO	NO_x	PM10
2005	7.8	57.6	47.4	8.2
2006	13.2	100.0	77.5	28.7
2007	11.3	87.2	64.0	29.4
2008	3.6	28.8	20.0	3.6
2009	0.4	2.8	2.0	0.1
2012	5.7	46.6	30.3	1.5

Notes: Emissions assume a 20% reduction in NO_x as specified in Air -MM-1. This table shows emissions after implementation of Air-MM-1, but not Air-MM-2.

CO = carbon monoxide.
NO_x = oxides of nitrogen.
PM10 = particulate matter 10 microns in diameter or less.
ROG = reactive organic gases.

Year 2012 represents maintenance dredging.

Mitigation Measure Air-MM-2: Acquire NO_x emission reduction credits to offset the emission increases that exceed the 50 tons per year conformity thresholds. DWR will work with the San Joaquin Valley Air District to obtain emission credits that can be used to offset the construction-related NO_x emissions that exceed 50 tons per year and that would occur within the San Joaquin Valley Air Basin. For Alternative 2, the NO_x offsets consist of 27.5 tons in 2006 and 14 tons in 2007. (Other project alternatives will require differing quantities of emission credit purchases.) Acquisition of emission offset credits, in combination with the mitigation measures specified in Air-MM-1, will reduce project impacts to a less than significant level.

Impact Air-3: Short-Term Increase in PM10 Emissions in San Joaquin County. Construction- and gate dredging–related PM10 emissions would contribute to the current nonattainment status of San Joaquin County under state and federal PM10 standards. A sensitive receptor is also located approximately 500 feet from the proposed Middle River gate site and may be exposed to PM10 emissions from truck trips occurring on a nearby dirt and gravel roadway during construction. These impacts are considered significant.

The SJVUAPCD has determined that compliance with its Regulation VIII Fugitive PM10 Prohibitions, including implementation of all feasible control measures specified in its *Guide for Assessing Air Quality Impacts* (San Joaquin Valley Unified Air Pollution Control District 2002), is sufficient mitigation to minimize adverse air quality effects from construction. Consequently, this air quality analysis assumes that DWR and Reclamation will comply with Regulation VIII. It also assumes that this compliance would be sufficient to reduce any significant PM10 air quality impacts generated by construction activities to a less-than-significant level. Mitigation Measure Air-MM-3 would minimize the impact of contributing to the County air quality violation of PM10, and minimize the impact from PM10 emissions during construction on sensitive receptors, to a less-than-significant level. Implementation of Mitigation Measure Air-MM-3 will also include elements of CALFED Programmatic Air Quality Mitigation Measures 6, 7, 12, and 13.

Mitigation Measure Air-MM-3: Implement Control Measures for Fugitive PM10. During construction, the following dust control measures (San Joaquin Valley Unified Air Pollution Control District 2002) will be implemented to reduce PM10 emissions to a less than significant level:

- All disturbed areas, including storage piles, that are not being actively used for construction purposes, shall be effectively stabilized of dust emissions using water, chemical stabilizer/suppressant, or covered with a tarp or other suitable cover or vegetative ground cover.
- All on-site unpaved roads and off-site unpaved access roads shall be effectively stabilized of dust emissions using water or chemical stabilizer/suppressant.
- All land clearing, grubbing, scraping, excavation, land leveling, grading, cut and fill, and demolition activities shall be effectively controlled of fugitive dust emissions using application of water or by presoaking.
- When materials are transported off site, all material shall be covered, or effectively wetted to limit visible dust emissions, and at least 6 inches of freeboard space from the top of the container shall be maintained.
- All operations shall limit or expeditiously remove the accumulation of mud or dirt from adjacent public streets at the end of each workday. (The use of dry rotary brushes is expressly prohibited except where preceded or accompanied by sufficient wetting to limit the visible dust emissions.) (Use of blower devices is expressly forbidden.)
- Following the addition of materials to, or the removal of materials from, the surface of outdoor storage piles, said piles shall be effectively stabilized of fugitive dust emissions using sufficient water or chemical stabilizer/suppressant.
- Any site with 150 or more vehicle trips per day shall prevent carryout and trackout.

Impact Air-4: Short-Term Increase in Reactive Organic Gases, Nitrogen Oxides, and Carbon Monoxide Emissions in Contra Costa County. Channel dredging would result in short-term emission levels of ROG, NO_x, and CO that are less than the significance thresholds. Table 5.9-7 shows dredging-related emissions by construction year. Because emissions would be below the significance thresholds, the air quality impacts for these pollutants are less than significant. No mitigation is required.

Table 5.9-7. Alternative 2 Total Emissions in Contra Costa County (tons per year)

Year	ROG	CO	NO_x	PM10
2005	2.6	19.2	20.0	0.9
2006	0.8	6.2	6.5	0.3
2012	0.4	3.2	2.6	0.1

Notes:

CO = carbon monoxide.
NO_x = oxides of nitrogen.
PM10 = particulate matter 10 microns in diameter or less.
ROG = reactive organic gases.

Year 2012 represents maintenance dredging.

Impact Air-5: Potential Increase in PM10 Emissions from Drying Dredge Spoils in San Joaquin and Contra Costa Counties. Dredging activities along portions of the Middle River, Old River and West Canal channels, would require the disposal of approximately 250,000 cubic yards of dredge spoils adjacent to the Delta channels. As the spoil ponds dry, the spoils may emit PM10 particles into the air, contributing to the nonattainment status of San Joaquin County and Contra Costa County for PM10. This impact is considered significant. Implementation of Mitigation Measure Air-MM-3 will reduce this impact to a less-than-significant level.

Impact Air-6: Construction-Related Diesel Health Risk. Conversation with SJVUAPCD staff indicates that the SJVUAPCD does not consider construction equipment diesel-related cancer risks to be an issue because of the short-term nature of construction activities (Guerra pers. comm.). The assessment of cancer risk is typically based on a 70-year exposure period. Construction activities are sporadic, transitory, and short-term in nature, and once construction activities have ceased, so too have emissions from construction. Because exposure to diesel exhaust will be well below the 70-year exposure period, construction of Alternatives 2A–2C is not anticipated to result in an elevated cancer risk to exposed persons. Consequently, the estimation of diesel risks associated with construction activities is considered to be less than significant. No mitigation is required.

Impact Air-7: Increased Emissions Resulting from Gate Operation. The operation of the permanent gates would result in the emission of criteria pollutants well below the established thresholds of significance. Therefore, impacts on air quality associated with gate operation would be less than significant. No mitigation is required.

2020 Conditions

Under 2020 conditions, impacts on air quality as a result of implementation of Alternatives 2A–2C would be the same as described above because it is expected that similar equipment and construction methods would be used.

Stage 2 (Operational Component)

Increased diversions would result in the emission of criteria pollutants well below the established thresholds of significance. Therefore, impacts on air quality associated with the operational component would be less than significant. No mitigation is required.

2020 Conditions

Impacts resulting from increased diversions as a result of implementation of Alternatives 2A–2C under 2020 conditions would be the same as described above because operation would not result in the emission of criteria pollutants above established thresholds. The impacts would be less than significant, and no mitigation is required.

Interim Operations

Interim operations would not have a physical effect on the environment, as only operations in the south Delta would change. These changes in operation would result in the emission of criteria pollutants well below the established thresholds of significance. Therefore, impacts on air quality associated with interim operations would be less than significant. No mitigation is required.

Alternative 3B

Stage 1 (Physical/Structural Component)

Fish Control Gate and Flow Control Gates and Dredging

Under Alternative 3B, one less gate would be constructed and all other project components would be the same as under Alternatives 2A–2C. Therefore, impacts and associated mitigation measures would be similar to Impacts Air-1 through Air-7 and Mitigation Measures Air-MM-1 through Air-MM-3 under Alternatives 2A–2C. The construction emissions of Alternative 3B in San Joaquin County are summarized in Table 5.9-8. Emissions in Contra Costa County are the same as under Alternative 2 and are summarized in Table 5.9-7.

Table 5.9-8. Alternative 3 Total Emissions in San Joaquin County (tons per year)

Year	ROG	CO	NO_x	PM10
2005	7.2	53.6	55.4	4.8
2006	11.0	83.7	80.7	21.4
2007	10.4	80.7	73.8	22.6
2008	3.6	28.8	25.0	3.6
2009	0.4	2.8	2.4	0.1
2012	5.7	46.6	37.9	1.5

Notes:

CO = carbon monoxide.
NO_x = oxides of nitrogen.
PM10 = particulate matter 10 microns in diameter or less.
ROG = reactive organic gases.

Year 2012 represents maintenance dredging.

Impact Air-1: Short-Term Increase in Reactive Organic Gases and Carbon Monoxide Emissions in San Joaquin County. Construction and channel dredging under Alternative 3B would result in short-term emission levels of ROG and CO that are less than the significance thresholds. Table 5.9-8 shows construction- and dredging-related emissions by construction year. Because emissions would be below the significance thresholds, the air quality impacts for these pollutants are less than significant. No mitigation is required.

Impact Air-2: Short-Term Increase in NO_x Emissions in San Joaquin County. Under Alternative 3B, construction- and dredging-related NO_x emissions would be over the general conformity threshold of 50 tpy for the years 2005 through 2007. (Refer to Table 5.9-8.) This impact is considered significant. Mitigation Measure Air-MM-1 includes elements of CALFED Programmatic Air Quality Mitigation Measures 2, 3, 9, 10, and 15, plus additional mitigation needed to reduce impacts.

Implementation of the Air-MM-1 mitigation measures will reduce emissions to levels shown in Table 5.9-9. With implementation of Air-MM-1, NO_x emissions in all years except 2006 and 2007 would be reduced to less than the significance thresholds. However, NO_x emissions in 2006 and 2007 would still exceed the 50-ton per year threshold.

The project applicant will also need to implement mitigation measure Air-MM-2 to obtain emission reduction credits of 14.5 tons NO_x for year 2006 and 9.1 tons NO_x for 2007. Implementation of Mitigation Measure Air-MM-1 and Air-MM-2 would reduce this impact to a less-than-significant level.

Table 5.9-9. Alternative 3 Total Mitigated Emissions in San Joaquin County (tons per year)

Year	ROG	CO	NO_x	PM10
2005	7.2	53.6	44.4	4.8
2006	11.0	83.7	64.5	21.4
2007	10.4	80.7	59.1	22.6
2008	3.6	28.8	20.0	3.6
2009	0.4	2.8	2.0	0.1
2012	5.7	46.6	30.3	1.5

Notes: Emissions assume a 20% reduction in NO_x as specified in Air -MM-1. This table shows emissions after implementation of Air-MM-1, but not Air-MM-2.

CO = carbon monoxide.
NO_x = oxides of nitrogen.
PM10 = particulate matter 10 microns in diameter or less.
ROG = reactive organic gases.

Year 2012 represents maintenance dredging.

Impact Air-3: Short-Term Increase in PM10 Emissions in San Joaquin County. Under Alternative 3B, construction- and dredging-related PM10 emissions would contribute to the current nonattainment status of San Joaquin County under state and federal PM10 standards. A sensitive receptor is also located approximately 500 feet from the proposed Middle River gate site and may be exposed to PM10 emissions from truck trips occurring on a nearby dirt and gravel roadway during construction. These impacts are considered significant.

Implementation of Mitigation Measure Air-MM-3 would reduce these impacts to a less-than-significant level. Mitigation Measure Air-MM-3 will also include elements of CALFED Programmatic Air Quality Mitigation Measures 6, 7, 12, and 13.

Impact Air-4: Short-Term Increase in Reactive Organic Gases, Nitrogen Oxides, and Carbon Monoxide Emissions in Contra Costa County. Channel dredging under Alternative 3B would result in short-term emission levels of ROG, $NO_{x,}$ and CO that are less than the significance thresholds. Table 5.9-7 shows dredging-related emissions by construction year. Because emissions would be below the significance thresholds, the air quality impacts for these pollutants are less than significant. No mitigation is required.

Impact Air-5: Potential Increase in PM10 Emissions from Drying Dredge Spoils in San Joaquin and Contra Costa Counties. Excavation activities along portions of the Middle River, Old River, and DMC channels, would require the disposal of approximately 1.58 million yds^3 of dredge spoils adjacent to the Delta channels. As the spoil beds dry, the spoils may emit PM10 particles into the air, contributing to the nonattainment status of San Joaquin County and Contra Costa County for PM10. This impact is considered significant. Implementation of Mitigation Measure Air-MM-3 will reduce this impact to a less-than-significant level. Mitigation Measure Air-MM-3 will also include elements of CALFED Programmatic Air Quality Mitigation Measures 6, 7, 12, and 13.

Impact Air-6: Construction-Related Diesel Health Risk. This impact is similar to Impact Air-6 under Alternative 2; the impact is less than significant.

Impact Air-7: Increased Emissions Resulting from Gate Operation. The operation of the permanent gates would result in the emission of criteria pollutants well below the established thresholds of significance. Therefore, impacts on air quality associated with gate operation would be less than significant. No mitigation is required.

2020 Conditions

Under 2020 conditions, impacts on air quality as a result of implementation of Stage 1 of Alternative 3B would be the same as described above because it is expected that similar equipment and construction methods would be used.

Stage 2 (Operational Component)

Under Alternative 3B, one less gate would be constructed and operated, and gate operations would be the same as those described for Alternatives 2A–2C. Increased diversions would result in the emission of criteria pollutants well below the established thresholds of significance. Therefore, impacts on air quality associated with the operational component would be less than significant. No mitigation is required.

2020 Conditions

Impacts resulting from increased diversions as a result of implementation of Stage 2 of Alternative 3B under 2020 conditions would be the same as described above because operation would not result in the emission of criteria pollutants above established thresholds. The impacts would be less than significant, and no mitigation is required.

Alternative 4B

Stage 1 (Physical/Structural Component)

Fish Control Gate and Dredging

Under Alternative 4B, only the fish control gate would be constructed, and all three channel locations would be dredged. Therefore, impacts would be less than impacts under Alternatives 2A–2C.

Impact Air-1: Short-Term Increase in Reactive Organic Gases and Carbon Monoxide Emissions in San Joaquin County. Construction and channel dredging under Alternative 4 would result in short-term emission levels of ROG and CO that are less than the significance thresholds. Table 5.9-10 shows construction- and dredging-related emissions by construction year. Because emissions would be below the significance thresholds, the air quality impacts for these pollutants are less than significant. No mitigation is required.

Table 5.9-10. Alternative 4 Total Emissions (tons per year)

Year	ROG	CO	NO_x	PM10
2005	7.2	53.6	55.4	4.8
2006	8.7	65.7	63.9	9.4
2007	7.6	58.5	53.8	8.8
2008	3.4	27.2	23.7	1.6
2009	0.4	2.8	2.4	0.1
2012	5.7	46.6	37.9	1.5

Notes:
CO = carbon monoxide.
NO_x = oxides of nitrogen.
PM10 = particulate matter 10 microns in diameter or less.
ROG = reactive organic gases.
Year 2012 represents maintenance dredging.

Impact Air-2: Short-Term Increase in Nitrogen Oxides Emissions in San Joaquin County. Under Alternative 4B, construction- and dredging-related NO_x emissions would be above the general conformity threshold of 50 tpy for the years 2005 through 2007. (Refer to Table 5.9-10.) This impact is considered significant. Mitigation Measure Air-MM-1 will also include elements of CALFED Programmatic Air Quality Mitigation Measures 2, 3, 9, 10, and 15, plus additional mitigation needed to reduce impacts.

Implementation of the Air-MM-1 mitigation measures will reduce emissions to levels shown in Table 5.9-11. With implementation of Air-MM-1, NO_x emissions in all construction years except 2006 would be reduced to less than the significance thresholds. However, NO_x emissions in 2006 would still exceed the 50 ton per year threshold.

The project applicant will also need to implement mitigation measure Air-MM-2 to obtain emission reduction credits of 1.1 tons NO_x for year in 2006. Implementation of Mitigation Measure Air-MM-1 and Air-MM-2 would reduce this impact to a less-than-significant level.

Table 5.9-11. Alternative 4 Total Mitigated Emissions (tons per year)

Year	ROG	CO	NO_x	PM10
2005	7.2	53.6	44.4	4.8
2006	8.7	65.7	51.1	9.4
2007	7.6	58.5	43.0	8.8
2008	3.4	27.2	18.9	1.6
2009	0.4	2.8	2.0	0.1
2012	5.7	46.6	30.3	1.5

Notes: Emissions assume a 20% reduction in NO_x as specified in Air -MM-1. This table shows emissions after implementation of Air-MM-1, but not Air-MM-2.

CO = carbon monoxide.
NO_x = oxides of nitrogen.
PM10 = particulate matter 10 microns in diameter or less.
ROG = reactive organic gases.

Year 2012 represents maintenance dredging.

Impact Air-3: Short-Term Increase in PM10 Emissions in San Joaquin County. Under Alternative 4B, construction- and dredging-related PM10 emissions would contribute to the current nonattainment status of San Joaquin County under state and federal PM10 standards. A sensitive receptor is also located approximately 500 feet from the proposed Middle River gate site and may be exposed to PM10 emissions from truck trips occurring on a nearby dirt and gravel roadway during construction. These impacts are considered significant.

Implementation of Mitigation Measure Air-MM-3 would reduce these impacts to a less-than-significant level. Mitigation Measure Air-MM-3 will also include elements of CALFED Programmatic Air Quality Mitigation Measures 6, 7, 12, and 13.

Impact Air-4: Short-Term Increase in Reactive Organic Gases, Nitrogen Oxides, and Carbon Monoxide Emissions in Contra Costa County. Channel dredging under Alternative 4B would result in short-term emission levels of ROG, $NO_{x,}$ and CO that are less than the significance thresholds. Table 5.9-7 shows dredging-related emissions by construction year. Because emissions would be below the significance thresholds, the air quality impacts for these pollutants are less than significant. No mitigation is required.

Impact Air-5: Potential Increase in PM10 Emissions from Drying Dredge Spoils in San Joaquin and Contra Costa Counties. Excavation activities along portions of the Middle River, Old River and DMC channels, would require the disposal of approximately 1.58 million yds^3 of dredge spoils adjacent to the Delta channels. As the spoil beds dry, the spoils may emit PM10 particles into the air, contributing to the nonattainment status of San Joaquin

County and Contra Costa County for PM10. This impact is considered significant. Implementation of Mitigation Measure Air-MM-3 will reduce this impact to a less-than-significant level. Mitigation Measure Air-MM-3 will also include elements of CALFED Programmatic Air Quality Mitigation Measures 6, 7, 12, and 13.

Impact Air-6: Construction Related Diesel Health Risk. This impact is similar to Impact Air-6 under Alternatives 2A–2C; the impact is less than significant. No mitigation is required.

Impact Air-7: Increased Emissions Resulting from Gate Operation. Under Alternative 4B, only the head of Old River fish control gate would be constructed and operated. The operation of the permanent gate would result in the emission of criteria pollutants well below the established thresholds of significance. Therefore, impacts on air quality associated with gate operation would be less than significant. No mitigation is required.

2020 Conditions

Under 2020 conditions, impacts on air quality as a result of implementation of Alternative 4B would be the same as described above because it is expected that similar equipment and construction methods would be used.

Stage 2 (Operational Component)

Operations at the CCF and SWP Banks (pumping, diversion, and use) would be the same as that described under Alternative 2A–2C. Therefore, impacts under Alternative 4B would be similar to the less-than-significant impact identified under Alternatives 2A–2C. No mitigation is required.

2020 Conditions

Impacts resulting from the operation of the gate as a result of implementation of Alternative 4B under 2020 conditions would be the same as described above because operation would not result in the emission of criteria pollutants above established thresholds. The impacts would be less than significant, and no mitigation is required.

Cumulative Evaluation of Impacts

Cumulative air quality impacts are analyzed in Chapter 10, “Cumulative Impacts.” This chapter also summarizes the other foreseeable future projects that may contribute to these impacts.

5.10 Noise

Introduction

This section evaluates noise and vibration impacts resulting from constructing and operating the SDIP and identifies mitigation to comply with local noise requirements.

Summary of Significant Impacts

Constructing and operating the SDIP alternatives will not result in significant noise or vibration impacts.

Affected Environment

The SDIP is located in the southern portion of the Delta, within the boundaries of Alameda, Contra Costa, and San Joaquin Counties. The following discussion provides background information on noise terminology and describes the existing environment in terms of sensitive receptors, existing noise levels, and regulatory requirements.

Sources of Information

The following key sources of information were used in preparation of this section:

- Alameda County General Plan, Noise Element, 1994;
- Guidelines for the Preparation and Content of the Noise Element of the General Plan, Appendix A in State of California General Plan Guidelines, November, 1998;
- Draft EIR/EIS for the ISDP, Volumes I and II, July 1996;
- Transit noise and vibration impact assessment, 1995;
- Noise measurements of a clamshell dredge taken on September 23, 1997, to support the Oakland Harbor Navigation Improvement Project EIS;
- Noise control for buildings, manufacturing plants, equipment and products, 1996;
- San Joaquin County General Plan 2010: Volume I, 1992;
- Dynamic effects of pile installations on adjacent structures. A synthesis of highway practice, 1997.

Noise Terminology

Background information on environmental acoustics and state and federal noise regulations is provided in Appendix I. The following are brief definitions of acoustic and vibration terminology used in this chapter:

- **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.
- **Decibel (dB).** A unitless measure of sound on a logarithmic scale, which 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 which approximates the frequency response of the human ear.
- **Maximum Sound Level (L_{max}).** The maximum sound level measured during the measurement period.
- **Minimum Sound Level (L_{min}).** The minimum sound level measured during the measurement period.
- **Equivalent Sound Level (L_{eq}).** The equivalent steady state sound level that in a stated period of time would contain the same acoustical energy.
- **Percentile-Exceeded Sound Level (L_{xx}).** The sound level exceeded “x” percent of a specific time period. L_{10} is the sound level exceeded 10% of the time.
- **Day-Night Level (L_{dn}).** The energy average of the A-weighted sound levels occurring during a 24-hour period, with 10 dB added to the A-weighted sound levels occurring during the period from 10:00 p.m. to 7:00 a.m.
- **Community Noise Equivalent Level (CNEL).** The energy average of the A-weighted sound levels occurring during a 24-hour period with 5 dB added to the A-weighted sound levels occurring during the period from 7:00 p.m. to 10:00 p.m. and 10 dB added to the A-weighted sound levels occurring during the period from 10:00 p.m. to 7:00 a.m.
- **Peak Particle Velocity (PPV).** The maximum velocity of a particle in vibrating medium such as soil. PPV us usually expressed in inches/second.

L_{dn} and CNEL values rarely differ by more than 1 dB. 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 dB is just noticeable, a change of 5 dB is clearly noticeable, and a change of 10 dB is perceived as doubling or halving the sound level.

Existing Noise Environment

The project area is primarily agricultural lands with very few noise-sensitive land uses. The existing noise environment in the project area is governed primarily by vehicular traffic along SR 4 and other roadways, occasional aircraft overflights, and agricultural practices. Noise sources also include noise associated from the placement and removal of temporary canal barriers and agricultural operations near the SDIP project area. Table 5.10-1 was included in the noise chapter of the 2000 CALFED's Programmatic EIS/EIR and can be used to generally characterize noise conditions in the project area.

Table 5.10-1. Population Density and Associated Ambient Noise Levels

Location	L_{dn} (A-Weighted Decibel)
Rural	
Undeveloped	35
Partially developed	40
Suburban	
Quiet	45
Normal	50
Urban	
Normal	55
Noisy	60
Very noisy	65

Noise-Sensitive Receptors

A noise-sensitive land use is generally defined as any type of location or land use where people reside or where the presence of unwanted sound could adversely affect the use of the land. Noise-sensitive land uses typically include residences, hospitals, schools, guest lodging, libraries, and certain types of recreational uses. Very few noise-sensitive receptors are located in the project area. Receptors located in the project area are described below:

- Head of Old River—One residence is located approximately 1,500 feet to the west and one residence is located approximately 2,500 feet to the north.
- Middle River at North Canal—A farm complex, including a residence, is located approximately 500 feet to the west. In addition, up to 10 residences are located approximately 2,000 feet to the north.
- Grant Line at DMC—Up to four residences are located approximately 1,500 feet to the west, and up to four residences are located approximately 2,000 feet to the northwest.

- Old River at DMC—A farm complex with at least one residence, and possibly up to two additional residences, is located approximately 1,500 feet to the southeast. Up to thirteen residences along the Old River bank up to Old River's confluence with the DMC are located approximately 1,500 feet to the southeast.
- West Canal, Middle River, and Old River—A few receptors are located along the waterways.

Environmental Consequences

Assessment Methods

The assessment of potential construction noise impacts was conducted using methodology developed by the Federal Transit Administration (FTA) (Federal Transit Administration 1995). For the purposes of this analysis, vibration impacts were included as a subset of noise impacts. Vibration impacts from pile driving were also assessed using methods developed by FTA. Based on data provided by the project engineers, it is assumed that construction activities would occur during normal working hours, between 7:00 a.m. and 7:00 p.m., Monday through Friday, and between 8:00 a.m. and 5:00 p.m. Saturday and Sunday. Specific assumptions used are discussed under each impact.

Regulatory Setting

Federal

Federal noise standards are established for highway-related noise only. As such, Reclamation does not have any noise standards. While there are no federal noise standards, the FTA has established a methodology for assessing noise from construction activities (Federal Transit Administration 1995). This methodology was used in the assessment of construction noise impacts.

There are no commonly accepted thresholds for acceptable levels of ground vibration from pile driving. However, the U.S. Department of Transportation suggests a vibration damage threshold of 0.20 inch per second (in/sec) for fragile buildings and 0.12 in/sec for extremely fragile historic buildings (Federal Transit Administration 1995). The Transportation Research Board (Transportation Research Board 1997) suggests maximum allowable peak particle velocities from pile driving for various structure types and conditions. Table 5.10-2 summarizes these values.

Table 5.10-2. Transportation Research Board Building Structure Vibration Criteria

Structure and Condition	Limiting PPV (in/sec)
Historic and some old buildings	0.5
Residential structures	0.5
New residential structures	1.0
Industrial buildings	2.0
Bridges	2.0

Notes:

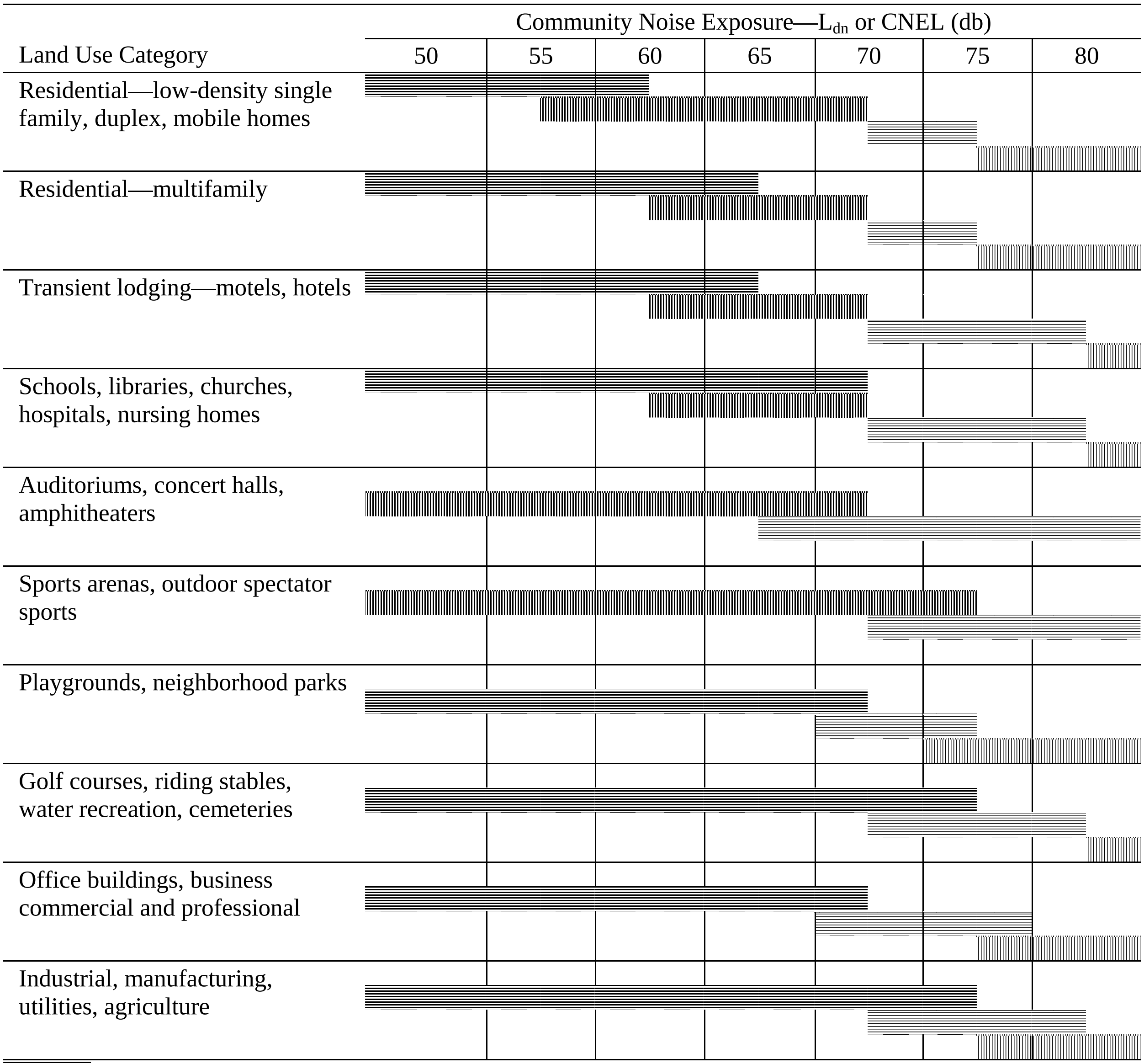
in/sec = inches per second
PPV = Peak Particle Velocity

Source: Transportation Research Board 1997.

State

DWR does not have any noise standards. The State of California requires each local government entity to implement a noise element as part of its general plan. California Administrative Code, Title 4, has guidelines for evaluating the compatibility of various land uses as a function of community noise exposure. The state land use compatibility guidelines are listed in Table 5.10-3.

Table 5.10-3. State Land Use Compatibility Standards for Community Noise Environment



▤ **Normally Acceptable**
Specified land use is satisfactory, based on the assumption that any buildings involved are of normal conventional construction, without any special noise insulation requirements.

▥ **Conditionally Acceptable**
New construction or development should be undertaken only after a detailed analysis of the noise reduction requirements is made and needed noise insulation features are included in the design. Conventional construction, but with closed windows and fresh air supply systems or air conditioning, will normally suffice.

▤ **Normally Unacceptable**
New construction or development should generally be discouraged. If new construction or development does proceed, a detailed analysis of the noise-reduction requirements must be made and needed noise insulation features included in the design.

▥ **Clearly Unacceptable**
New construction or development generally should not be undertaken.

Source: California Governor's Office of Planning and Research 2003.

Local

The SDIP project area lies within Contra Costa County and San Joaquin County, and is adjacent to Alameda County. These counties have established policies and regulations in the form of General Plans and ordinances which address the generation and control of noise that could adversely affect their citizens and noise-sensitive land uses.

The noise element of the General Plan contains goals and policies to support the achievement of planning guidelines, but is not legally enforceable. The county's noise ordinance section of the county's code is legally enforceable.

In San Joaquin County and Alameda County, construction activities are exempt from compliance with noise standards during specified daytime hours. Although each jurisdiction has adopted slightly different standards, they are generally consistent with normal working hours. In San Joaquin County, construction activities that occur between 6:00 a.m. and 9:00 p.m., Sunday through Saturday, are exempt from the County's noise ordinance. Outside of these hours, construction activities within County of San Joaquin are subject to the County's stationary noise source limits, which are 45 dB, L_{eq} and 65 dB, L_{max}, as measured at the property line of the nearest receiver. In Alameda County, construction activities that occur between 7:00 a.m. and 7:00 p.m., Monday through Friday, and between 8:00 a.m. and 5:00 p.m., Saturday and Sunday, are exempt from the County's noise ordinance.

In addition, work performed by private or public utilities in the maintenance or modification of its facilities is exempt from the San Joaquin County noise ordinance. Construction and maintenance and repair operations conducted by public agencies and/or utility companies or their contractors which are deemed necessary to serve the best interests of the public are exempt from Alameda County's noise ordinance.

The Contra Costa County General Plan indicates that projects are required to meet the state's land use compatibility guidelines (Table 5.10-3). Contra Costa County has no noise ordinance.

Significance Criteria

The 2000 CALFED's Programmatic EIS/EIR stated that a noise-related impact would be significant if construction or operations of facilities would cause a substantial increase in the existing (ambient) noise conditions in the affected area. For the purposes of this assessment, more specific criteria, based on local standards, was used in the assessment of noise impacts.

Standards for Determining Significance under CEQA

The State CEQA Guidelines, county standards, and standard professional practice were used to determine whether constructing and operating the project alternatives would result in a significant noise impact. Impacts resulting from noise generated by constructing or operating the project would be considered significant if it would:

- expose persons to or generate noise levels in excess of standards established in a local general plan or noise ordinance or applicable standards of other agencies;
- expose persons to or generate excessive groundborne vibration or groundborne noise levels;
- result in a substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project;
- result in a substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project;
- be located within an airport land use plan area, or, where such a plan has not been adopted, within 2 miles of a public airport or public use airport and expose people residing or working in the project area to excessive noise levels; or
- be located in the vicinity of a private airstrip and expose people residing or working in the project area to excessive noise levels.

Based on local noise criteria (County of San Joaquin), the Governor’s Office of Planning and Research (OPR) standards, and FTA criteria, the following thresholds of significance have been developed for this project. Noise resulting from a project alternative is considered significant if:

- construction noise would exceed 45 dBA at the nearest noise-sensitive land uses between 9:00 p.m. and 6:00 a.m. on any day (any construction occurring outside of these hours are exempt from the county’s noise ordinance and are considered to result in less-than-significant noise impacts);
- operation of facilities would result in noise that exceeds the acceptable noise standards of the relevant jurisdictions or existing or presumed ambient sound level by more than 5 dB at sensitive receptor locations;
- fragile or historic building structures would be exposed to ground vibration in excess of 0.20 in/sec from pile-driving activities; or
- other building structures (nonfragile or nonhistoric) would be exposed to ground vibration in excess of 0.5 in/sec.

CALFED Programmatic Mitigation Measures

The August 2000 CALFED Programmatic ROD includes mitigation measures for agencies to consider and use where appropriate in the development and implementation of project-specific actions. The mitigation measures address the short-term, long-term and cumulative effects of the CALFED Program.

These programmatic mitigation measures are numbered as they appear in the ROD, and only those measures relevant to the SDIP resource area are listed below; therefore, numbering may appear out of sequence. To see a full listing of CALFED programmatic mitigation measures, please refer to Appendix E, “Mitigation Measures Adopted in the CALFED Record of Decision.”

Noise Mitigation Measures

1. Use electrically powered equipment instead of internal combustion equipment where feasible.
2. Locate staging and stockpile areas and supply and construction vehicle routes as far away from sensitive receptors as possible.
3. Establish and enforce construction site and haul road speed limits.
4. Restrict the use of bells, whistles, alarms, and horns to safety warning purposes.
5. Design equipment to conform with local noise standards.
6. Locate equipment as far from sensitive receptors as possible.
7. Equip all construction vehicles and equipment with appropriate mufflers and air inlet silencers.
8. Restrict hours of construction to periods permitted by local ordinances.
9. Locate noisy equipment within suitable sound-absorbing enclosures.
10. Erect sound wall barriers or noise attenuation berms between noise generation sources and sensitive receptors.
12. Locate redirected roadways away from sensitive receptors.
13. Encourage use of public transportation and carpooling for construction workers.
15. Conduct project-specific noise analyses for actions with noise impacts.

Alternative 1 (No Action)

Under the No Action Alternative, expected and potential noise sources would continue as at present. Noise sources would include noise generated during the placement and removal of temporary canal barriers, agricultural operations, traffic noise from surrounding roadways, and aircraft overflights. Because no new facilities would be constructed and modifications to existing facilities would not occur, there would be no increase in existing noise levels, and thus no noise-related impacts.

2020 Conditions

Under the future no action conditions (2020 conditions) the SDIP would not be implemented, and there would be no additional noise in the project area as a result of construction or operation. It is expected that minimal development would occur in this area and that 2020 noise conditions would be similar to the existing conditions described above.

Alternatives 2A, 2B, and 2C

Stage 1 (Physical/Structural Component)

Fish Control Gate and Flow Control Gates

Impact NZ-1: Exposure of Noise-Sensitive Land Uses to Noise from General Construction Activities. Noise generated during construction of Alternatives 2A, 2B, and 2C was estimated by calculating the amount of noise generated on the anticipated worst-case day of construction activity. Table 5.10-4 summarizes noise generated by construction equipment likely to be used during construction.

Table 5.10-4. Construction Equipment Inventory and Noise Emission Levels

Equipment	Typical Noise Level (dBA) 50 Feet from Source
Backhoe	80
Concrete Pump	82
Crane, Derrick	88
Dozer	85
Dredge, Clamshell	84
Dredge, Hydraulic	79
Excavator/Shovel	82
Grader	85
Loader	85
Paver	89
Pile Driver (Impact)	101
Pump (Dewatering)	74
Roller/Sheep’s Foot	74
Scraper	89
Truck	88
Tugboat	82

Sources: Federal Transit Administration 1995, Geier & Geier Consulting 1997, Jones & Stokes measurements from ESA 2004, Jones & Stokes calculations based on Hoover and Keith 1996.

Noise levels presented in Table 5.10-4 were used in this analysis to estimate construction noise. The magnitude of construction noise impacts depends on the type of construction activity, the noise level generated by various pieces of construction equipment, the duration of the activity, the distance between the activity and noise-sensitive receivers, and any shielding effects that might result from intervening barriers, including topography.

A reasonable worst-case assumption is that the three loudest pieces of equipment would operate simultaneously and continuously over at least a 1-hour period for a combined source noise level. Based on the noise levels summarized in Table 5.10-4, Table 5.10-5 shows the estimated sound levels from construction activities as a function of distance. Simultaneous operation of a paver, a scraper, and a truck for a combined source level of 93 dBA at 50 feet is assumed. Point-source attenuation of 6 dB per doubling of distance, as well as molecular absorption of 0.7 dB per 1,000 feet and anomalous excess attenuation of 1 dB per 1,000 feet, is also assumed based on guidance in Hoover and Keith 1996.

Table 5.10-5. Estimated Construction Noise in the Vicinity of an Active Construction Site as a Function of Distance

Distance Attenuation	
Distance to Receptor (feet)	Sound Level at Receptor (dBA)
50	93
100	87
200	81
250	**79**
400	74
500	72
800	68
1,000	65
1,500	61
2,000	58
2,500	55
3,000	52
4,000	48
5,280	44

The following assumptions were used:

Basic sound level drop-off rate:	6.0 dB per doubling of distance
Molecular absorption coefficient:	0.7 dB per 1,000 feet
Anomalous excess attenuation:	1.0 dB per 1,000 feet
Reference sound level:	93 dBA
Distance for reference sound level:	50 feet

Notes: This calculation does not include the effects, if any, of local shielding, which may reduce sound levels further.

Estimates are based on Jones & Stokes' calculations for a paver, a scraper, and a truck using methods described in Hoover and Keith 1996.

In addition to standard construction equipment, pumps may be used to dewater areas of the channels during construction of gates. Dewatering will be required at gate locations to remove groundwater and seepage from the construction site. The pumps used for dewatering will be gasoline-powered, and the horsepower is anticipated to be between 5 and 20 horsepower (Hp). It is anticipated that up to eight dewatering pumps may be used at any one gate construction site.

Noise levels from operation of dewatering pumps were calculated based on information provided by the project engineers, methodology developed by the FTA, and methodology developed by Hoover and Keith (Hoover and Keith 1996). As indicated in Table 5.10-4, a single 20-Hp dewatering pump is anticipated to generate a noise level of 74 dBA at a distance of 50 feet. This noise level is a combined source noise level that takes into account noise from the pump drive motor and impeller blade tips (58 dBA), as well as noise from the gasoline motor powering the pump (74 dBA).

As stated previously, data provided by the project engineers indicates up to eight dewatering pumps may be used at any one gate construction site. A reasonable worst-case assumption is that eight pumps would operate simultaneously and continuously over at least a 1-hour period. Simultaneous operation of eight dewatering pumps would result in a combined source level of 83 dBA at 50 feet Table 5.10-6 calculates estimated sound levels from the operation of dewatering pumps as a function of distance. Point-source attenuation of 6 dB per doubling of distance, as well as molecular absorption of 0.7 dB per 1,000 feet and anomalous excess attenuation of 1 dB per 1,000 feet, is also assumed (Hoover and Keith 1996).

Table 5.10-6. Estimated Dewatering Pump Noise Levels as a Function of Distance

Distance Attenuation	
Distance to Receptor (feet)	Sound Level at Receptor (dBA)
50	83
100	77
200	71
250	**69**
400	64
500	62
600	60
1,000	55
1,500	51
2,000	48
2,500	45
3,000	42
4,000	38
5,280	34

The following assumptions were used:

Basic sound level drop-off rate:	6.0 dB per doubling of distance
Molecular absorption coefficient:	0.7 dB per 1,000 feet
Anomalous excess attenuation:	1.0 dB per 1,000 feet
Reference sound level:	83 dBA
Distance for reference sound level:	50 feet

Notes: This calculation does not include the effects, if any, of local shielding, which may reduce sound levels further.

Estimates are based on Jones & Stokes' calculations for the simultaneous operation of eight dewatering pumps.

The results in Tables 5.10-5 and 5.10-6 indicate that construction noise may exceed 45 dBA within 1 mile of the fish control and flow control gate sites. Noise-sensitive land uses are located within 1 mile of each of the gate sites. This impact is considered less than significant because construction activities would occur between 6:00 a.m. and 9:00 p.m. and would be in compliance with the San Joaquin County construction noise ordinance. The "Environmental Commitments" section of Chapter 2 specifies that construction of the gates would occur only within the time periods specified by county noise ordinances. No mitigation is required.

Impact NZ-2: Exposure of Noise-Sensitive Land Uses to Noise from Pile-Driving Activities. Impact pile driving may occur at the gate sites for the installation of the sheetpile cofferdams, or for in-the-wet construction methods. Pile driving creates seismic waves that radiate along the surface of the earth and downward into the earth. These surface waves can be felt as ground vibration.

Pile driving can result in effects ranging from annoyance of people to damage of structures.

Table 5.10-7 calculates estimated sound levels from pile-driving activities as a function of distance based on the noise levels summarized in Table 5.10-4. Point-source attenuation of 6 dB per doubling of distance, as well as molecular absorption of 0.7 dB per 1,000 feet and anomalous excess attenuation of 1 dB per 1,000 feet, is also assumed (Hoover and Keith 1996).

Table 5.10-7. Estimated Impact Pile-Driving Noise Levels as a Function of Distance

Distance Attenuation	
Distance to Receptor (feet)	Sound Level at Receptor (dBA)
50	101
100	95
200	89
250	**87**
400	82
500	78
800	76
1,000	73
1,500	69
2,000	66
2,500	63
3,000	60
4,000	56
5,280	52

The following assumptions were used:

Basic sound level drop-off rate:	6.0 dB per doubling of distance
Molecular absorption coefficient:	0.7 dB per 1,000 feet
Anomalous excess attenuation:	1.0 dB per 1,000 feet
Reference sound level:	101 dBA
Distance for reference sound level:	50 feet

Note: This calculation does not include the effects, if any, of local shielding, which may reduce sound levels further. Estimates are based on Jones & Stokes' calculations for pile-driving activities.

The results of the analysis shown in Table 5.10-7 indicate that construction noise generated by pile driving may exceed 45 dBA within 1 mile of the fish control and flow control gate sites. Noise-sensitive land uses are located within 1 mile of each of the gate sites. This impact is considered less than significant because construction activities would occur between 6:00 a.m. and 9:00 p.m. and would be in compliance with the San Joaquin County construction noise ordinance. The "Environmental Commitments" section of Chapter 2 specifies that construction of the gates would occur only within the time periods specified by county noise ordinances. No mitigation is required.

Impact NZ-3: Exposure of Noise-Sensitive Land Uses to Haul Truck Traffic Noise. Construction of Alternatives 2A–2C would require the delivery of construction materials on-site, with concrete and aggregate comprising the bulk of project deliveries. For the purposes of this assessment, a truck load involves two total trips—a trip to a destination and a trip from a destination. Information provided by the project engineers indicates that the head of Old River fish control gate will require 750 total truck loads (1,500 total trips), Old River at DMC gate will require 510 total truck loads (1,020 total trips), Grant Line Canal gate will require 811 total truck loads (1,622 total trips), and Middle River gate will require 410 total truck loads (820 total trips).

To determine the general project-wide impacts from haul-truck traffic, the project component with the greatest number of truck trips, Grant Line Canal gate, was used in the assessment of haul truck traffic noise to present the maximum truck traffic noise that could result from Alternatives 2A–2C. Construction of the Grant Line Canal gate will entail approximately 1,622 total truck trips for the delivery of construction materials. The number of trips per day is based on the total truck trips, an estimate of typical haul truck loads, hours of construction per day, duration of construction, and average haul route distance. Based on 1,622 total truck trips needed, it was assumed that this would correspond to 40 trips per day.

Noise modeling was conducted to assess impacts on sensitive receptors along expected haul routes from haul truck activities (refer to Figure 5.8-2 for project haul truck routes). This analysis assumes trucking occurs 8 hours per day and as a worst-case scenario, there would be a maximum of five truck trips per hour. Using the FHWA Traffic Noise Prediction Model (FHWA-RD-77-108) and assuming a speed of 35 mph, the predicted truck noise level at a reference distance of 50 feet is 55 dBA. This indicates that haul truck noise most likely would not exceed the threshold of 45 dBA. Because the noise levels generated from truck traffic would be below the threshold criteria, this impact is considered less than significant. No mitigation is required.

Impact NZ-4: Exposure of Noise-Sensitive Land Uses to Groundborne Vibration from Impact Pile-Driving Activities. As indicated above, impact pile-driving activities will occur at the gate construction sites for the installation of the sheetpile cofferdams, or for in-the-wet construction methods. Pile driving creates seismic waves that radiate along the surface of the earth and downward into the earth. These surface waves can be felt as ground vibration. Pile driving can result in effects ranging from annoyance of people to damage of structures.

Table 5.10-8 presents vibration source levels (vibration levels at receptor peak particle velocity) generated from typical impact pile driver activity as a function of distance. The table was based from FTA methodology (Federal Transit

Administration 1995) and was used in this analysis to estimate vibration from pile-driving activities.

Table 5.10-8. Vibration Source Levels from Typical Impact Pile-Driving Activities

Distance to Receptor (feet)	Vibration Level at Receptor PPV (in/sec)
50	0.228
100	0.081
150	0.044
200	0.028
250	**0.020**
300	0.015
500	0.007
750	0.004
1000	0.003
1500	0.001
2500	0.001
5280	0.000

Notes:
in/sec = inches per second
PPV = Peak Particle Velocity

The nearest sensitive land use in the vicinity of pile-driving activities is the farm complex, 500 feet from the Middle River gate site, and would be exposed to vibration source level of 0.007 in/sec (Table 5.10-8). Additional residences located approximately 1,500 feet away from the Old River at DMC gate site would be exposed to vibration source levels of 0.001 in/sec (Table 5.10-8). Because the predicted vibration levels are well below the threshold of 0.5 in/sec, vibration impacts on noise-sensitive land uses from pile-driving activities would be less than significant. No mitigation is required.

Impact NZ-5: Exposure of Noise-Sensitive Land Uses to Noise from Clamshell or Dragline Dredging Activities at the Gate Site. Clamshell or dragline dredging would be required at gate sites located on portions of the Middle River, Old River, and Grant Line Canal. As indicated in Table 5.10-4, a clamshell dredge is anticipated to generate a noise level of 84 dBA at a distance of 50 feet. Dragline dredge methods would require equipment similar in horsepower to clamshell dredging equipment and would result in the generation of similar noise levels. Table 5.10-9 calculates estimated sound levels from dredging activities as a function of distance. Point-source attenuation of 6 dB per doubling of distance, as well as molecular absorption of 0.7 dB per 1,000 feet and anomalous excess attenuation of 1 dB per 1,000 feet, is also assumed (Hoover and Keith 1996).

Table 5.10-9. Estimated Clamshell/Dragline Dredging Noise Levels as a Function of Distance

Distance Attenuation	
Distance to Receptor (feet)	Sound Level at Receptor (dBA)
50	84
100	78
200	72
250	**70**
500	63
600	61
800	59
1,000	56
1,500	52
2,000	49
2,500	46
3,000	43
4,000	39
5,280	35

The following assumptions were used:

Basic sound level drop-off rate:	6.0 dB per doubling of distance
Molecular absorption coefficient:	0.7 dB per 1,000 feet
Anomalous excess attenuation:	1.0 dB per 1,000 feet
Reference sound level:	84 dBA
Distance for reference sound level:	50 feet

Notes: This calculation does not include the effects, if any, of local shielding, which may reduce sound levels further.

Estimates are based on Jones & Stokes' calculations for the operation of a clamshell dredge.

The results of the analysis shown in Table 5.10-9 indicate that construction noise generated by clamshell or dragline dredging may exceed 45 dBA at sensitive receptors in the vicinity of the gate sites. This impact is considered less than significant because construction activities would occur between 6:00 a.m. and 9:00 p.m. and would be in compliance with the San Joaquin County construction noise ordinance. The "Environmental Commitments" section of Chapter 2 specifies that construction of the gates would occur only within the time periods specified by county noise ordinances. No mitigation is required.

Impact NZ-6: Exposure of Noise-Sensitive Land Uses to Noise from Operation of Gates. Throughout the project area, operable flow control barriers will be installed to control the flow of water and improve existing water level and circulation patterns for south Delta water users. The flow control barriers will have operable gates that will be raised and lowered as necessary to maintain the desired water level. Operation of the flow control gates, as well as boat lock gates, will be controlled using inflatable rubber bladders. The inflatable rubber bladders will be filled with air using up to two 50-Hp air compressors. The gates will be lowered by exhausting the air from the bladders through a discharge pipe. The discharge pipe will be fitted with a muffler. The compressors will be contained in enclosures. In the event of a power outage, the compressors will be powered by an emergency generator. The generator uses an internal combustion engine fueled by liquid petroleum gas (LPG) and is not anticipated to generate noise in excess of 5 dB over existing ambient noise levels at sensitive receptor locations. Consequently, this impact is considered less than significant, and no mitigation is required.

Impact NZ-7: Exposure of Noise-Sensitive Land Uses to Noise from Maintenance Activities at the Gates. Operations at each of the gate locations would require maintenance activities including motors, and control system maintenance using a service truck; and fuel deliveries.

These maintenance activities will be short-term: maintenance on the motors, cables and control system would occur annually; and fuel deliveries would occur four times per year.

Because of the short-term nature and extensive time periods of inactivity involving maintenance activities, the dispersed locations of the gates, and distance of the gates to sensitive land uses, maintenance activities at the gate sites would not result in excesses of 5 dB over existing ambient noise levels at sensitive receptor locations. Therefore, impacts are considered less than significant. No mitigation is required.

Dredging

Impact NZ-8: Exposure of Noise-Sensitive Land Uses to Noise from Hydraulic Dredging Activities at Gate Sites. Hydraulic dredging may be required at gate sites located on portions of the Middle River, Old River, and Grant Line Canal. As indicated in Table 5.10-4, a hydraulic dredge is anticipated to generate a noise level of 79 dBA at a distance of 50 feet. Table 5.10-10 calculates estimated sound levels from dredging activities as a function of distance. Point-source attenuation of 6 dB per doubling of distance, as well as molecular absorption of 0.7 dB per 1,000 feet and anomalous excess attenuation of 1 dB per 1,000 feet, is also assumed (Hoover and Keith 1996).

Table 5.10-10. Estimated Hydraulic Dredging Noise Levels as a Function of Distance

Distance Attenuation	
Distance to Receptor (feet)	Sound Level at Receptor (dBA)
50	79
100	73
200	67
250	**65**
400	60
600	56
800	54
1,000	51
1,500	47
2,000	44
2,500	41
3,000	38
4,000	34
5,280	30

The following assumptions were used:

Basic sound level drop-off rate:	6.0 dB per doubling of distance
Molecular absorption coefficient:	0.7 dB per 1,000 feet
Anomalous excess attenuation:	1.0 dB per 1,000 feet
Reference sound level:	79 dBA
Distance for reference sound level:	50 feet

Note: This calculation does not include the effects, if any, of local shielding, which may reduce sound levels further. Estimates are based on Jones & Stokes' calculations for the operation of a hydraulic dredge.

The results of the analysis shown in Table 5.10-10 indicate that construction noise generated by hydraulic dredging may exceed 45 dBA at sensitive receptors in the vicinity of the gate sites. This impact is considered less than significant because construction activities would occur between 6:00 a.m. and 9:00 p.m. and would be in compliance with the San Joaquin County construction noise ordinance. The "Environmental Commitments" section of Chapter 2 specifies that construction of the gates would occur only within the time periods specified by county noise ordinances. No mitigation is required.

Impact NZ-9: Exposure of Noise-Sensitive Land Uses to Noise from Hydraulic Dredging Activities along Portions of the Middle River, Old River, and West Canal. Hydraulic dredging will be conducted on portions of the Middle River, Old River, and West Canal. As indicated in Table 5.10-4, a hydraulic dredge is anticipated to generate a noise level of 79 dBA at a distance of 50 feet. Table 5.10-10 calculates estimated sound levels from dredging activities as a function of distance. Point-source attenuation of 6 dB per doubling of distance, as well as molecular absorption of 0.7 dB per 1,000 feet and anomalous excess attenuation of 1 dB per 1,000 feet, is also assumed (Hoover and Keith 1996).

The results in Table 5.10-10 indicate that the threshold of 45 dBA could be exceeded at noise-sensitive land uses within about 1,900 feet dredging activities. Because there are residences located directly on the banks of the canals and adjacent to all channel dredging locations on Middle River, Old River, and West Canal, noise impacts from dredging under Alternatives 2A–2C would be significant.

The results of the analysis shown in Table 5.10-10 indicate that construction noise generated by hydraulic dredging may exceed 45 dBA at sensitive receptors in the vicinity of the gate sites. This impact is considered less than significant because few sensitive receptors are located in the construction area and any dredging occurring during nighttime hours would be of short duration. No mitigation is required.

2020 Conditions

Impacts associated with the implementation of Alternatives 2A–2C under 2020 conditions would be similar to those described above because the same type of construction activities are expected to occur and no substantial increase in the number of sensitive receptors in the project area is expected.

Stage 2 (Operational Component)

Impact NZ-10: Exposure of Noise-Sensitive Land Uses to Noise from Increased Diversions into Clifton Court Forebay and Pumping at the SWP Banks Pumping Plant. A component of Alternatives 2A–2C would increase water diversions into the CCF and pumping at the SWP Banks utilizing the existing intake and pumping structures. No new facilities would be constructed and no new pumps would be added.

Existing enclosures and buildings surrounding the pumps are expected to attenuate noise from increased pumping operations at SWP Banks and increased diversions into the CCF, preventing the generation of noise levels greater than 5 dB over existing ambient noise levels at sensitive receptor locations.

Noise-sensitive land uses are also located far enough from the facilities to avoid the potential for exposure to noise levels in excess of operational noise level thresholds. Because no new facilities would be added to the pumping plant or CCF, existing structures are in place to attenuate noise levels from increased operations, and noise-sensitive land uses will not be exposed to noise exceeding operational thresholds levels, this impact is considered less than significant and no mitigation is required.

2020 Conditions

Under 2020 conditions, the increased diversions under Alternatives 2A–2C and associated impacts would be similar to those described above because the proposed operation would be the same.

Interim Operations

Interim operations would not have a physical effect on the environment, as only operations in the south Delta would change. These changes in operation would not result in changes in ambient noise levels or vibrations. Therefore, noise impacts as a result of interim operations would be less than significant. No mitigation is required.

Alternative 3B

Stage 1 (Physical/Structural Component)

Fish Control Gate and Flow Control Gates

Implementation of Alternative 3B would have similar types of noise impacts as Alternatives 2A–2C, but the Grant Line Canal gate would not be constructed and therefore the location of impacts from constructing and operating gates would differ slightly, and overall impacts would be less than under Alternative 2A–2C. Construction activities would occur and equipment would be used at one less location, decreasing the total production of noise identified under Alternative 2A–2C.

Impact NZ-1: Exposure of Noise-Sensitive Land Uses to Noise from General Construction Activities. Under Alternative 3B, exposure of noise-sensitive land uses to general construction noise would be similar to noise impacts identified for Alternatives 2A–2C, except that a flow control gate at Grant Line Canal would not be constructed. This impact is considered less than significant because construction activities would occur between 6:00 a.m. and 9:00 p.m. and would be in compliance with the San Joaquin County construction noise ordinance. No mitigation is required.

Impact NZ-2: Exposure of Noise-Sensitive Land Uses to Noise from Pile-Driving Activities. Under Alternative 3B, exposure of noise-sensitive land uses to noise generated from pile-driving activities would be similar to noise impacts identified for Alternatives 2A–2C, except that a flow control gate at Grant Line Canal would not be constructed. This impact is considered less than significant because construction activities would occur between 6:00 a.m. and 9:00 p.m. and would be in compliance with the San Joaquin County construction noise ordinance. No mitigation is required.

Impact NZ-3: Exposure of Noise-Sensitive Land Uses to Haul Truck Traffic Noise. Under Alternative 3B, exposure of noise-sensitive land uses to noise from haul truck traffic would be similar to noise impacts identified for Alternatives 2A–2C, except that a flow control gate at Grant Line Canal would not be constructed. Because the noise levels generated from truck traffic would be below the threshold criteria of 45 dBA at the Middle River and Old River gate sites, this impact is considered less than significant. No mitigation is required.

Impact NZ-4: Exposure of Noise-Sensitive Land Uses to Groundborne Vibration from Impact Pile-Driving Activities. Under Alternative 3B, exposure of noise-sensitive land uses to groundborne vibration from pile driving would be similar to noise impacts identified for Alternatives 2A–2C, except that a flow control gate at Grant Line Canal would not be constructed. Because the groundborne vibration generated from pile driving would be below the threshold criterion of 0.5 in/sec at the Middle River and Old River gate sites (Table 5.10-8), this impact is considered less than significant. No mitigation is required.

Impact NZ-5: Exposure of Noise-Sensitive Land Uses to Noise from Clamshell or Dragline Dredging Activities at the Gate Site. Under Alternative 3B, exposure of noise-sensitive land uses to noise from clamshell or dragline dredging would be similar to noise impacts identified for Alternatives 2A–2C, except that a flow control gate at Grant Line Canal would not be constructed. This impact is considered less than significant because construction activities would occur between 6:00 a.m. and 9:00 p.m. and would be in compliance with the San Joaquin County construction noise ordinance. No mitigation is required.

Impact NZ-6: Exposure of Noise-Sensitive Land Uses to Noise from Operation of Gates. This impact would be similar to Alternatives 2A–2C, but with one less flow control gate. Operation of the flow control gates, as well as boat lock gates, will be controlled using inflatable rubber bladders. The inflatable rubber bladders will be filled with air using up to two 50-Hp air compressors, and would not exceed noise thresholds. This impact is less than significant and does not require mitigation.

Impact NZ-7: Exposure of Noise-Sensitive Land Uses to Noise from Maintenance Activities at the Gates. This impact would be similar to Alternatives 2A–2C, but with one less gate requiring maintenance activities. Because overall noise levels generated by maintenance activities under Alternative 3B would be slightly less than those generated by Alternatives 2A–2C, impacts would be less than significant. No mitigation is required.

Dredging

Impact NZ-8: Exposure of Noise-Sensitive Land Uses to Noise from Hydraulic Dredging Activities at Gate Sites. Under Alternative 3B, exposure of noise-sensitive land uses to noise from hydraulic dredging would be similar to noise impacts identified for Alternatives 2A–2C, except that a flow control gate at Grant Line Canal would not be constructed. This impact is considered less than significant because construction activities would occur between 6:00 a.m. and 9:00 p.m. and would be in compliance with the San Joaquin County construction noise ordinance. No mitigation is required.

Impact NZ-9: Exposure of Noise-Sensitive Land Uses to Noise from Hydraulic Dredging Activities along Portions of the Middle River, Old River, and West Canal. Under Alternative 3B, exposure of noise-sensitive land uses to noise from hydraulic dredging activities would be similar to noise impacts identified under Alternatives 2A–2C. The results of the analysis shown in Table 5.10-10 indicate that construction noise generated by hydraulic dredging may exceed 45 dBA at sensitive receptors in the vicinity of the gate sites. This impact is considered less than significant because few sensitive receptors are located in the construction area and any dredging occurring during nighttime hours would be of short duration. No mitigation is required.

2020 Conditions

Impacts associated with the implementation of Alternative 3B would be similar to those described above because the same type of construction activities equipment and are expected to occur and no substantial change in the number of sensitive receptors is expected. Recommended mitigation would reduce significant impacts to a less-than-significant level.

Stage 2 (Operational Component)

Impact NZ-10: Exposure of Noise-Sensitive Land Uses to Noise from Increased Diversions into Clifton Court Forebay and Pumping at the SWP Banks Pumping Plant. This impact would be the same as Alternatives 2A–2C. There will be no addition of pumps to the pumping plant, and therefore no measurable change in the amount of noise reaching sensitive receptors. This impact is less than significant and requires no mitigation.

2020 Conditions

Under 2020 conditions, the increased diversions under Alternatives 2A–2C and associated impacts would be similar to those described above because the proposed operation would be the same.

Alternative 4B

Under Alternative 4B, only the head of Old River fish control gate would be constructed, and noise impacts would be less than those identified for Alternatives 2A, 2B, 2C, and 3B.

Stage 1 Physical/Structural Component)

Fish Control Gate

Implementation of Alternative 4B would have similar types of noise impacts to Alternatives 2A–2C and 3B, but the location of impacts from constructing and operating gates would differ slightly, and overall impacts would be less than under Alternative 2A–2C and 3B. Under Alternative 3B, only the fish control gate would be constructed; thus, construction activities would occur and equipment would be used at only one location, decreasing the total production of noise identified under the other alternatives.

Impact NZ-1: Exposure of Noise-Sensitive Land Uses to Noise from General Construction Activities. Under Alternative 4B, exposure of noise-sensitive land uses to general construction noise would be similar to noise impacts identified for Alternatives 2A–2C. This impact is considered less than significant because construction activities would occur between 6:00 a.m. and 9:00 p.m. and would be in compliance with the San Joaquin County construction noise ordinance. No mitigation is required.

Impact NZ-2: Exposure of Noise-Sensitive Land Uses to Noise from Pile-Driving Activities. Under Alternative 4B, exposure of noise-sensitive land uses to noise generated from pile-driving activities would be similar to noise impacts identified for Alternatives 2A–2C. This impact is considered less than significant because construction activities would occur between 6:00 a.m. and 9:00 p.m. and would be in compliance with the San Joaquin County construction noise ordinance. No mitigation is required.

Impact NZ-3: Exposure of Noise-Sensitive Land Uses to Haul Truck Traffic Noise. Under Alternative 4B, exposure of noise-sensitive land uses to noise from haul truck traffic would be similar to noise impacts identified for Alternatives 2A–2C. Because the noise levels generated from truck traffic would be below the threshold criteria of 45 dBA, this impact is considered less than significant. No mitigation is required.

Impact NZ-4: Exposure of Noise-Sensitive Land Uses to Groundborne Vibration from Impact Pile-Driving Activities. Under Alternative 4B, exposure of noise-sensitive land uses to groundborne vibration from pile driving would be similar to noise impacts identified for Alternatives 2A–2C, except that only the fish control gate would be constructed. Because the groundborne vibration generated from pile driving would be below the threshold criterion of 0.5 in/second, the impact is considered less than significant. No mitigation is required.

Impact NZ-5: Exposure of Noise-Sensitive Land Uses to Noise from Clamshell or Dragline Dredging Activities at the Gate Site. Under Alternative 4B, exposure of noise-sensitive land uses to noise from clamshell or dragline dredging would be similar to noise impacts identified for Alternatives 2A–2C, except that only the fish control gate would be constructed. This impact is considered less than significant because construction activities would occur between 6:00 a.m. and 9:00 p.m. and would be in compliance with the San Joaquin County construction noise ordinance. No mitigation is required.

Impact NZ-6: Exposure of Noise-Sensitive Land Uses to Noise from Operation of Gates. This impact would be similar to Alternatives 2A–2C, but with one less flow control gate. Operation of the fish control gate, as well as boat lock gates, will be controlled using inflatable rubber bladders. The inflatable rubber bladders will be filled with air using up to two 50-Hp air compressors, and would not exceed noise thresholds. This impact is less than significant and does not require mitigation.

Impact NZ-7: Exposure of Noise-Sensitive Land Uses to Noise from Maintenance Activities at the Gates. This impact would be similar to Alternatives 2A–2C, but with one less gate requiring maintenance activities. Overall noise levels generated by maintenance activities under Alternative 4B would be slightly less than those generated by Alternatives 2A–2C and impacts would be less than significant. No mitigation is required.

Dredging

Impact NZ-8: Exposure of Noise-Sensitive Land Uses to Noise from Hydraulic Dredging Activities at Gate Sites. Under Alternative 4B, exposure of noise-sensitive land uses to noise from hydraulic dredging would be similar to noise impacts identified for Alternatives 2A–2C, except that only the fish control gate at the head of Old River would be constructed. This impact is considered less than significant because construction activities would occur between 6:00 a.m. and 9:00 p.m. and would be in compliance with the San Joaquin County construction noise ordinance. No mitigation is required.

Impact NZ-9: Exposure of Noise-Sensitive Land Uses to Noise from Hydraulic Dredging Activities along Portions of the Middle River, Old River, and West Canal. Under Alternative 4B, exposure of noise-sensitive land uses to noise from hydraulic dredging activities would be similar to noise impacts identified under Alternatives 2A–2C. The results of the analysis shown in Table 5.10-10 indicate that construction noise generated by hydraulic dredging may exceed 45 dBA at sensitive receptors in the vicinity of the gate sites. This impact is considered less than significant because few sensitive receptors are located in the construction area and any dredging occurring during nighttime hours would be of short duration. No mitigation is required.

2020 Conditions

Impacts associated with the implementation of Alternative 4B under 2020 conditions would be similar to those described above because the same type of construction activities are expected to occur and no substantial change in the number of sensitive receptors is expected.

Stage 2 (Operational Component)

Impact NZ-10: Exposure of Noise-Sensitive Land Uses to Noise from Increased Diversions into Clifton Court Forebay and Pumping at the SWP Banks Pumping Plant. This impact would be the same as Alternatives 2A–2C. There will be no addition of pumps to the pumping plant, and therefore no measurable change in the amount of noise reaching sensitive receptors. This impact is less than significant and requires no mitigation.

2020 Conditions

Under 2020 conditions, the increased diversions under Alternative 4B and associated impacts would be similar to those described above because the proposed operation would be the same.

Cumulative Evaluation of Impacts

Cumulative noise impacts are analyzed in Chapter 10, “Cumulative Impacts.” This chapter also summarizes the other foreseeable future projects that may contribute to these impacts.